Feasibility Study

Airport Kwik Stop Site
Ione, Washington

for
Washington State Department of Ecology

June 28, 2013

GeoEngineers
Earth Science + Technology

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June 28, 2013

Prepared for:

Washington State Department of Ecology
Toxics Cleanup Program
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GEOENGINEERS

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ACRONYMS

ASTs - above ground storage tanks
bgs - below ground surface
BTEX - benzene, toluene, ethylbenzene and xylenes
BV – bioventing
CAP- Cleanup Action Plan
CAOs – Cleanup Action Objectives
COCs – contaminents of concern
DCA – disproportionate cost analysis
Ecology - Washington State Department of Ecology
EDB - 1,2-dibromoethane
EDC - 1,2-dichloroethane
EDR – Engineering Design Report
Fe - Iron
FS - Feasibility Study
GAC – granular activated carbon
gpm - gallons per minute
GRPH - gasoline-range petroleum hydrocarbons
H_2O_2 – hydrogen peroxide
ISCO – In-Situ chemical oxidation
kg – kilogram
LNAPL - light non-aqueous phase liquid
mg/kg - milligrams per kilogram
MTBE – Methyl-tertiary butyl ether
MTCA - Model Toxics Control Act
ORP – oxygen reduction potential
PQL - practical quantitation limit
RBCA – Risk-based corrective action
RI - remedial investigation
RI/FS –remedial investigation/feasibility study
Site – Airport Kwik Stop Site
SVE – soil vapor extraction
TEE - terrestrial ecological evaluation
µg/L – microgams per liter
UST – underground storage tank
WAC - Washington Administrative Code
VOCs - volatile organic compounds

1.0 INTRODUCTION

This report presents the feasibility study (FS) conducted for the Airport Kwik Stop Site (Site), located near the intersection of Greenhouse Road and State Highway 31 near Ione, Washington. The approximate location of the Site is shown with respect to surrounding physical features in the Vicinity Map, Figure 1. The Site is listed on the Washington State Department of Ecology (Ecology) Facility Database (ID 32584416) and includes several surrounding properties, which are not included in the Facility Site Database.

The FS was conducted to develop and evaluate cleanup action alternatives for addressing contamination identified in the remedial investigation (RI) report, and to select a preferred alternative for cleanup. This report was completed for Ecology in accordance with the requirements of the Model Toxics Control Act (MTCA) Cleanup Regulation, Chapter 173-340 Washington Administrative Code (WAC).

2.0 SITE DESCRIPTION

The Site is located about 1½ miles south of the town of Ione, Washington, and about ¼ mile west of the Pend Oreille River, near the intersections of State Highway 31 and Greenhouse/Dewitt Roads. The properties that comprise the Site are shown in Site Plan, Figure 2 and include:

- The Airport Kwik Stop property (Property ID No. 6477, Geographic ID 433707449008 based on Pend Oreille County assessor records) located northeast of the intersection of State Highway 31 and Greenhouse Road.
- The Cabin Grill property (Property ID No. 6714 Geographic ID 433718519001) located southwest of the intersection of State Highway 31 and Dewitt Road.
- Vacant property (Property ID No. 6475, 6422 and 6611, Geographic ID 433707449006, 433707040004 and 433717529009) located east and south of the Airport Kwik Stop.
- Several private residences (Property ID No. 6628, 6606, 6607, 6608, 6609 and 6610; Geographic ID 433717530018, 433717529004, 433717529005, 433717529007, 433717529006 and 433717529008) located southeast of the Airport Kwik Stop property.
- State and county right-of-way located along State Highway 31 and Greenhouse and Dewitt Roads.

The Site generally slopes gently down towards the Pend Oreille River, with a slight topographic high area located southeast of the Cabin Grill Restaurant. Most of the ground surface within the Site is undeveloped and covered with field grass and pine and fir trees, with the exception of the existing roads within the Site boundaries, portions of the Airport Kwik Stop property, and portions of the Cabin Grill property. The area of the Airport Kwik Stop property near the building and pump islands is covered with a combination of asphalt concrete pavement, portland cement concrete and gravel. A gravel-surfaced parking area also is present at the Cabin Grill property, located west of the restaurant building.

The Site overlies a shallow unconfined aquifer. Water wells drilled into this aquifer supply water to the Airport Kwik Stop property, the Cabin Grill property and the private residences located southeast of the Airport Kwik Stop. Results of groundwater monitoring of Site monitoring wells indicates that groundwater flow direction near the Site is generally towards the east-southeast.

The earliest available Ecology records regarding the Airport Kwik Stop are from 1987, which indicate that three underground storage tanks (USTs) were on the property at that time (two approximately 2,000 gallon tanks, and one tank with a capacity less than 500 gallons). The smaller tank reportedly last stored gasoline in 1984, and was reportedly emptied. The 500-gallon tank was discovered during the construction of the soil vapor extraction (SVE) system, and was subsequently closed in place. The two larger tanks were reportedly closed in 1989. The 1989 tank closure notice indicates that the two larger tanks had been in-place for 6 years and 9 years, respectively, at the time of closure. The Airport Kwik Stop continued to dispense gasoline using above ground storage tanks (ASTs) located west of the Airport Kwik Stop building. In May of 2008, a flex pipe beneath the premium fuel dispenser was observed to be spraying gasoline inside the dispenser. Fuel was present in the sump under the dispenser up to the elevation of the pipe boot, indicating that fuel was leaking out of the sump into the ground. The flex pipe was repaired and subsequently, after passing a tightness test, returned to service. Records are not available which would indicate the length of time the flex pipe was leaking, or estimates of the volume of gasoline which might have leaked. The Airport Kwik stop closed and discontinued selling petroleum products in the fall of 2008. It briefly reopened in the spring/summer of 2011 as a convenience store and restaurant, and closed down again in the fall/winter of 2011/2012.

The Cabin Grill property was developed in 1985 as a realty office. Subsequent site uses included a cabinet maker, a pottery business, Pend Oreille North Realty, and currently, the Cabin Grill restaurant. The Cabin Grill Restaurant closed for business during the winter of 2012/2013. The current owners sold the grill and most of the kitchen appliances. Based on conversations with the owners, the owners plan on using the building as their primary residence. Records indicate the domestic water well at the Cabin Grill property was installed in 1986. Petroleum compounds have been detected in groundwater samples collected from the domestic well on at least two separate occasions prior to the 2010-2012 site characterization and remedial investigation activities. Ecology conducted an initial investigation in 1993 following notification by Pend Oreille North Realty of a strong petroleum odor emanating from the drinking water tap. A water sample was collected and sent to North Creek Analytical in Spokane, Washington for analysis of gasoline-range petroleum hydrocarbons (GRPH) and volatile organic compounds (VOCs). Results indicated that the water sample was contaminated with GRPH and benzene at concentrations greater than MTCA Method A cleanup levels. Ecology was notified in April 2008 by the Cabin Grill owners of a strong petroleum odor emanating from the drinking water tap. A water sample was collected and submitted to TestAmerica (formerly North Creek Analytical) in Spokane, Washington for analysis of VOCs. Results indicated that the water sample was contaminated with benzene, toluene and total xylenes at concentrations greater than applicable MTCA Method A cleanup levels.

In May 2008, the Department of Health issued a Health Advisory for the Cabin Grill. Following the Health Advisory, the Cabin Grill began using bottled water. The Cabin Grill burned down in July 2008, and was subsequently rebuilt and reopened in March 2009. A carbon filtration system was installed during reconstruction of the restaurant. The filtration system consists of two carbon canisters and associated plumbing, located within a shed situated between the well and the Cabin Grill restaurant. The Cabin Grill Restaurant ceased operations in late winter/early spring 2013. The water well continues to serve a private residence on the property.

3.0 SUMMARY OF SITE CONDITIONS

The FS utilizes information collected during prior investigations and the recent RI report (GeoEngineers, January 29, 2013). This section summarizes pertinent environmental conditions at the Site such as the nature and extent of contamination and an overview of the conceptual site exposure model.

3.1. Summary of Remedial Investigations

The extent and nature of contamination at the Site is documented in the RI report and reports of previous site characterization and groundwater monitoring activities completed at the Site. Exploration Locations and Feasibility Study Remediation Component Site Areas, Figure 3 provides a visual overview of potential areas of concern outlined by these studies at the time of the RI. The estimated extent of petroleum contamination in groundwater, also shown on Figure 3, is defined by groundwater monitoring wells that have had contaminants of concern (COC) exceedances greater than MTCA Method A cleanup levels. More detailed descriptions of Site conditions are provided in the RI.

The RI identified the following areas of petroleum contamination at the Site:

- Vadose zone soil contamination is present at the Airport Kwik Stop. The area of vadose zone contamination is located near the fuel dispensers, and extends from near the ground surface to the groundwater table (located about 34 to 35 feet below ground surface [bgs]).
- Floating light, non-aqueous phase liquid (LNAPL) has been measured at monitoring well MW-5, located on the Cabin Grill property about 300 feet to 350 feet southeast of the Airport Kwik Stop fuel dispensers and about 50 feet west of the Cabin Grill domestic well, during quarterly groundwater monitoring events completed at the Site. LNAPL has been observed in wells MW-4 and MW-8 on one occasion each.
- A plume of petroleum-contaminated groundwater is present beneath the Site within the shallow unconfined aquifer, and extends from near the fuel dispensers at the Airport Kwik Stop, towards the east and southeast approximately 1,400 lineal feet. To date, the plume has impacted the Cabin Grill domestic water well and the domestic water wells associated with properties ID No. 6607 and 6608/6609. Results of groundwater monitoring indicate that the plume continues to migrate towards the east-southeast and most recently toward monitoring well MW-18, located about 800 feet east-northeast of the Airport Kwik Stop. Soil near and below the groundwater interface also is contaminated.

These areas and COCs are described further in the sections below.

3.2. Contaminants of Concern

COCs identified in soil and/or groundwater at the Site include GRPH and VOCs including benzene, toluene, ethylbenzene and total xylenes (BTEX) compounds, 1,2-dichloroethane (EDC), methyl-tertiary butyl ether (MTBE) and naphthalene. These contaminants represent chemicals with concentrations at one or more locations that exceeded the preliminary cleanup levels presented in the RI.

1,2-dibromoethane (EDB) also might be present in soil and groundwater at the Site at concentrations greater than applicable MTCA Method A cleanup levels. However, due to the relatively high concentrations of other contaminants present in some samples, and the dilutions required by the analytical laboratory to prepare and analyze those samples, the practical quantitation limits (PQLs) for EDB in samples containing other COCs were often greater than the applicable MTCA Method A cleanup levels for EDB.

3.3. Exposure Pathways and Receptors

Complete exposure pathways and potential receptors were identified for the COCs detected in various environmental media at the Site. A complete exposure pathway consists of: (1) an identified contaminant source; (2) a release/transport mechanism from the source to locations (exposure points) where potential receptors might come in contact with COC; and (3) an exposure route (for example, soil ingestion) where potential receptors might be exposed to COC.

3.3.1. Human Exposure Pathways

Potential human exposure pathways and receptors include:

1. Ingestion of contaminated groundwater – on-site residents with impacted wells.
2. Dermal contact with contaminated groundwater – on-site residents with impacted wells.
3. Inhalation of contaminated vapors – Inhalation of contaminated vapors for visitors and residents using affected wells and on-site workers during excavation activities.
4. Dermal contact with contaminated soil during excavation work – on-site workers.
5. Dermal contact with contaminated surface water runoff during excavation work – on-site workers.

3.3.2. Environmental Exposure Pathways

The terrestrial ecological evaluation was re-evaluated following the Remedial Investigation (RI) report, and limited to locations where: (1) soil contamination was encountered at depths shallower than 15 feet; or (2) results of groundwater monitoring indicate petroleum-contaminated groundwater is present at depths less than 15 feet, which in turn could result in contaminated soil. The only location where soil contamination has been identified at depths shallower than 15 feet is at the Airport Kwik Stop. The only location where contaminated groundwater currently is documented at depths shallower than 15 feet is near monitoring well MW-16. Therefore, the terrestrial ecological evaluation was limited to the Airport Kwik Stop property, as well as portions of the site downgradient of monitoring well MW-16.

A review was performed using the terrestrial ecological evaluation (TEE) forms (Terrestrial Ecological Evaluation Process – Primary Exclusions Documentation Form). Based on WAC 173-340-7491, the site does not meet the criteria for a TEE exclusion, because there are more than 1.5 acres of undeveloped land at, or within 500 feet of areas identified with shallow contamination. The on-line Priority Habitat and Species (PHS) database (http://fortress.wa.gov/mapping/phs/) from the Washington State Department of Fish and Wildlife, was utilized to evaluate the potential presence of threatened, endangered or priority species at the Site. The database identified two listed species with habitats mapped at the Site: the gray wolf and northeast whitetail deer.

The only location where contaminated soil has been documented at depths shallow than 15 feet is at the Airport Kwik Stop. The area of shallow contamination at the Airport Kwik Stop is covered by a combination of portland cement concrete pavement and asphalt concrete pavement. Therefore, there currently is not a complete exposure pathway at the Airport Kwik Stop for these listed wildlife species, nor is there a documented complete exposure pathway for plant species. At monitoring well MW-16, the depth to groundwater has ranged from about 13 to 15 feet below grade; this is the shallowest depth where soil contamination near this well might be found. A complete exposure pathway does not appear likely because this is deeper than the biologically active soil zone [6 feet per 173-340-7490(4)]; however, establishing a conditional point of compliance will require institutional controls. On this basis, further evaluation of a site-specific TEE was discontinued. The Terrestrial Ecological Evaluation Process-Simplified Evaluation Documentation Form (Ecology, 2008)] was used to evaluate requirements for completing a simplified TEE. Based on that review, exposure analysis was completed for the Airport Kwik Stop property consistent with the criteria in WAC 173-340-7492(2)(a)(ii). The following values were used in Table 749-1 as part of the simplified TEE:

1. Box 1 (Area Size): 8 points for approximately 2 acres of undeveloped land surrounding, and downslope of monitoring well MW-16.
2. Box 2 (Site Use): 1 point for non-commercial property near well MW-16.
3. Box 3 (Habitat Quality): 2 points for intermediate habitat quality – It is likely that the area surrounding MW-16 is used by wildlife. However, the level of development near the site is greater than surrounding areas.
4. Box 4 (Wildlife Attraction): 1 point for potential for the Site to attract wildlife.
5. Box 5 (Contaminants Present): 4 points, Contaminants included in Table 749-1 include: chlorinated dibenzo-p-dioxins/dibenzofurans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endoslfan, endrin, heptachlor, benzene, hexacloride, toxaphene, hexachlorobenzene, pentachlorphenol and pentachlorobenzene. Most of these compounds were previously used as pesticides or fungicides, and therefore are most commonly present in agricultural or wood treatment settings, or places where these chemicals were manufactured or stored. PCB mixtures are most commonly found in electrical transformer and capacitor manufacturing and repair facilities, facilities containing hydraulic lifts and hoists, and facilities containing waste oil storage tanks. Dioxins and furans are the by-products of industrial processes involving manufacture of chlorinated compounds such as pesticides, PVC and pulp and paper bleaching processes. Based on review of the site history, the site was not used for the purposes generally associated with the listed contaminants.
6. Box 6 Summary of above scores in Boxes 2 through 5: 8 points – If the Box 6 total is greater than the Box 1 value, the simplified TEE is complete.

The summation of Box 2 through Box 5 (8 points) equaled the value in Box 1 (8 points). Based on the results of the exposure analysis, the simplified TEE was further evaluated based on pathways analysis in accordance with the criteria in WAC 173-340-7492(b). At this time, there are no documented complete exposure pathways for listed wildlife. However, there are potential exposure pathways for soil biota. The only contaminant of concern listed in Table 749-2 known or expected to be present at the site is gasoline-range organics. Table 749-2 indicates that the screening level concentration of gasoline range organics is 200 mg/kg for unrestricted land use, to be protective of ecological receptors. Based on the results of previous sampling and analyses, GRPH has not been detected in soil or groundwater samples collected from MW-16. Benzene concentrations in groundwater have been less than 40.6 micrograms per liter. Therefore, concentrations of contaminants in soil near MW-16 do not exceed the screening level concentration in Table 749-2. GRPH concentrations in shallow soil at the Airport Kwik Stop have exceeded the screening level concentration listed in Table 749-2. However, the Airport Kwik Stop is a commercial property. Therefore, only potential exposure pathways for wildlife (small mammals, birds) need to be considered. Also, as stated previously, the area of shallow contamination at the Airport Kwik Stop is covered with pavement. Additionally, an on-going interim remedial action is in place at the Airport Kwik Stop to remove vadose zone contamination.

Based on the TEE described herein, there are no expected impacts to wildlife at the Airport Kwik Stop, or areas downgradient of monitoring well MW-16. Future TEEs might be necessary in the event future evaluation and sampling indicates that contaminated groundwater emerges within seeps and springs along the banks of the Pend Oreille River within other areas of the Site. If results of future TEEs, if completed, indicate a potential impact to terrestrial organisms, modifications to the CAP might be warranted to address those potential impacts.

However, if the plume of contaminated groundwater reaches the Pend Oreille River, or seeps along the river bank, then additional potential receptors and exposure pathways could include:

- Human - ingestion of contaminated surface water – on-site residents and users of the Pend Oreille River.
- Human - dermal contact with contaminated surface water - on-site residents and users of the Pend Oreille River.
- Human - ingestion of contaminated soil – on-site residents.
- Human – ingestion of plants or fauna that have ingested or absorbed contaminants from contaminated soil or surface water – on-site residents and users of the Pend Oreille River.
- Wildlife- direct contact with contaminated surface water – small mammals, birds, soil biota, aquatic organisms.
- Wildlife - ingestion of contaminated soil –small mammals and birds.
- Wildlife - Ingestion of plants or fauna that have ingested or absorbed contaminants from contaminated soil or surface water –predatory mammals and birds.

3.4. Locations and Media Requiring Cleanup Action Evaluation

Analytical results from the RI were compared against preliminary cleanup levels (see "Section 4.0" below) to identify contaminated areas and media that could pose a risk to human health and the environment and, therefore, require an evaluation of cleanup alternatives. These areas and environmental media (soil and groundwater) are summarized in Table 1 below and shown in Figure 3. The approximate aerial extent of soil contamination at the Airport Kwik Stop is presented in Airport Kwik Stop Vadose Zone Contamination, Figure 4. A cross section showing the approximate extent of soil contamination at the Airport Kwik Stop is shown in Cross Section D-D', Figure 5.

The areas shown in Figure 3 are estimated for the purposes of this FS, but the actual extent of exceedances in areas could vary because of uncertainty associated with interpreting data between sample locations and the nature of limited sampling density. Additional information regarding the assumptions used in developing extent of impacted areas and media are described in the RI. The following three areas and media require evaluation for cleanup action in the FS.

TABLE 1. SUMMARY OF AREAS AND MEDIA REQUIRING CLEANUP ACTION EVALUATION

Location	COCs	Approximate Impacted Soil Depth (feet)	Media	Description
Airport Kwik Stop	GRPH, VOCs (BTEX)	0 to 35	2,105 bank cubic yards of soil	Heavily Contaminated Soil: A radius of about 15 feet extending from about 2 feet bgs to a depth of about 25 feet bgs, for a total volume of 660 cubic yards. Contaminated Vadose Zone Soil: A truncated cone with a radius of 15 feet at the ground surface widening to a radius of 30 feet at groundwater (35 feet bgs), less the volume of heavily contaminated soil, for a total volume of 1,445 cubic yards.
Cabin Grill	GRPH	35 to 38	7,400 gallons of liquid petroleum hydrocarbons in soil	Volume of floating LNAPL is estimated assuming a volume of conical shape with a thickness of 0.67 feet at the center tapering to 0 feet at the radial boundary, multiplied by a porosity of 0.25 for a volume of 980 cubic feet, or 7,400 gallons.
Site Wide	GRPH, VOCs (BTEX)	13 to 42	2,100 pounds (335 gallons) of GRPH in groundwater	The mass of dissolved petroleum hydrocarbons were estimated in the RI by calculating areas of eight concentration contours multiplied by a saturation thickness of 9 feet and a porosity of 0.25, for a total mass of about 2,100 pounds and about 335 gallons assuming a specific gravity of 0.75.

3.5. Existing Soil and Groundwater Remediation System

Subsequent to completion of RI activities, an interim remedial action was designed and constructed to remove GRPH and VOCs from heavily contaminated vadose zone soil at the Airport Kwik Stop property. The interim remedial action consists of a SVE/bioventing (BV) system. The intent of the system is to initially operate as an SVE system by applying a vacuum to wells screened within the contaminated vadose zone, thereby volatilizing and extracting petroleum contaminants from the soil, removing them as a source for additional groundwater contamination. Operations also include pumping air into the vadose zone soil (BV), thereby stimulating biodegradation of remaining petroleum contamination in the vadose zone. Based on evaluation of contaminant vapor concentrations within extracted subsurface air, collected during periodic site visits, the estimated time to substantially remove contaminants is in the range of about 1 to 2½ years. This estimate is based on small sample sizes, which provide a semi-quantitative indication of contaminant removal rates. The actual time required to achieve cleanup levels within vadose zone soil will be based on continued monitoring of the SVE/BV system and post-treatment confirmation soil sampling.

4.0 CLEANUP STANDARDS

Cleanup standards consist of: (1) cleanup levels that are protective of human health and the environment; and (2) the point of compliance at which the cleanup levels must be met. Under MTCA, final cleanup standards for the Site will be established in the Cleanup Action Plan (CAP) which will be prepared by Ecology after completion of the 30 day public comment period for the RI/FS. Preliminary cleanup standards presented in this section are adopted for the purpose of developing cleanup action objectives (CAOs) for the Site.

Summary of Preliminary Cleanup Standards

- Soil Cleanup standards based on MTCA Method A for Unrestricted land use and standard MTCA point of compliance: ground surface to a depth of 15 feet. Soil cleanup standards also are based on protection of groundwater; therefore the point of compliance is throughout the soil column from the ground surface to groundwater.
- Groundwater Cleanup standards are based on MTCA Method A for protection of drinking water and the standard point of compliance will be all groundwater in the saturated zone beneath the site.

4.1. Cleanup Levels

Preliminary cleanup levels for the COC are summarized in Table 2 below. Soil cleanup levels are based on MTCA Method A Soil Cleanup Levels [WAC 173-340-740(2) and Chapter 173-340 WAC Table 745-1] for Unrestricted land use.

Cleanup levels for groundwater are based on drinking water protection. Preliminary groundwater cleanup levels were selected from MTCA Method A Cleanup Levels Groundwater WAC 173-340-720(3) and Chapter 173-340 WAC Table 720-1.

TABLE 2. PRELIMINARY CLEANUP LEVELS FOR CONTAMINANTS OF CONCERN

COC	Soil (milligrams per kilogram [mg/kg])	Groundwater (micrograms per liter [µg/L])
GRPH	100	800
Benzene	0.03	5
Toluene	7	1,000
Ethylbenzene	6	700
Xylenes	9	1,000
MTBE	0.1	20

COC	Soil (milligrams per kilogram [mg/kg])	Groundwater (micrograms per liter [µg/L])
EDB	0.005	0.001
EDC	-	5
Naphthalene	5	160

4.2. Points of Compliance

Under MTCA, the point of compliance is the point or location on a site where cleanup levels must be attained. The points of compliance for affected media will be presented in the CAP. However, it is necessary to identify proposed points of compliance in order to develop and evaluate the effectiveness of cleanup action alternatives in the FS. This section describes the proposed points of compliance for soil and groundwater.

4.2.1. Soil

The standard point of compliance for soil cleanup levels to protect humans from direct contact will be throughout the soil column from the ground surface to 15 feet, in accordance with WAC 173-340-740(6)(d) and WAC 173-340-7490(4)(b). The standard point of compliance for preliminary soil cleanup levels based on protection of groundwater shown in Table 1 will be throughout the soil column [WAC 173-340-740(6)(b]).

4.2.2. Groundwater

The standard point of compliance for groundwater cleanup levels will be all groundwater beneath the Site.

5.0 SCREENING OF ALTERNATIVES

Successful cleanup will require multiple remedial components to meet MTCA cleanup criteria because environmental impact spans multiple media (soil, groundwater, air) across a wide area. This subsection describes an initial screening of media-specific remedial alternative components. The purpose of screening is to qualitatively identify those components acceptable for detailed analysis and reject those that are clearly disproportionate or not technically feasible. For the purposes of this screening, each component is considered separately and retained, as appropriate, for inclusion into aggregated alternatives for detailed analysis. The following media-specific remedial components were considered during screening:

5.1. Soil

Complete excavation and removal of soil within source areas. Source areas at the site and downgradient of the site would be excavated and replaced with clean soil. The volume of soil under this alternative component comprises the Kwik Stop heavily contaminated soil zone (approximately 660 bank cubic yards), the Kwik Stop contaminated vadose zone soil (1445 bank cubic yards), and Cabin Grill floating product area (650 bank cubic yards). Excavated soil would be removed for off-site disposal and/or treatment. Complete excavation of contaminated soil at both the Airport Kwik Stop and Cabin Grill properties would require excavating to depths greater than

30 feet below site grades. Given the proximity of existing buildings, roads and other site improvements to the locations of contaminated soil, excavating to such depths would require either: (1) demolishing the Airport Kwik Stop building, and constructing structural shoring adjacent to State Highway 31; or (2) underpinning the existing Airport Kwik Stop building, and constructing structural shoring around the entire excavation. Demolishing existing structures likely would be more cost effective than underpinning. Demolishing the Cabin Grill building also might be required in order to facilitate excavation at the Cabin Grill property. Additionally, it is likely that contaminated soil extends below the footprint of the Airport Kwik Stop Building. Therefore, leaving the Airport Kwik Stop building in place likely would result in contaminated soil remaining at the site after implementation of this cleanup component.

Given the depth of excavation, a tied-back structural shoring system likely would be required at the Airport Kwik Stop. Assuming a unit cost of $100 per square foot for a tied-back structural shoring system, and 12,000 square feet of shoring wall (400 lineal feet by 30 feet deep), the estimated cost for a structural shoring system at the Airport Kwik Stop could be on the order of about $1,200,000. Additionally, assuming 1,445 bank yards of contaminated soil at the Airport Kwik Stop (and a corresponding 2,200 tons of excavated and backfilled soil at a conversion factor of 1.5 tons per cubic yard), a unit cost of $15 per cubic yard for excavating and staging excavated soil, a unit cost of $65 per ton for off-site disposal of contaminated soil, and a unit cost of $15 per cubic yard for backfilling, the estimated cost for complete removal of contaminated soil at the Airport Kwik Stop is estimated to be about $1,400,000.

Costs of complete excavation and removal of contaminated soil at the Cabin Grill are difficult to estimate, given the unknown extent of soil contamination. However, considerable cost would be expended to excavate uncontaminated soil in order to reach the thin zone of contaminated soil located near the groundwater table. Assuming an excavation depth of 35 feet, a bottom area 150 feet in diameter, and a temporary excavation slope of 1.5H:1V (horizontal to vertical) in accordance with state and federal regulations, the volume of uncontaminated soil which would have to be excavated is on the order of about 46,000 cubic yards. At a cost of $15 per cubic yard for excavation, and $15 per cubic yard for backfilling, that equates to an estimated cost of about $1,380,000 to excavate and replace uncontaminated site soil. Costs could be significantly more if the zone of soil contamination is greater in extent. This does not include the additional costs of mobilization, and removal and disposal of floating LNAPL.

In addition to costs, complete removal of source areas near State Highway 31 would be technically difficult, and might not be acceptable to the public as a result of demolishing the existing Airport Kwik Stop and Cabin Grill buildings, and safety issues involving a deep shored excavation immediately adjacent to the highway. ***<u>This component is rejected</u>*** as clearly cost-disproportionate as well as potentially unacceptable to the public.

Partial excavation of soil within vadose zone contamination source area. This component includes excavation of the heavily contaminated zone soil at the Kwik Stop site near the premium fuel dispensers. Soil would be excavated where concentrations of petroleum hydrocarbons exceed about 10,000 milligrams per kilogram (mg/kg) to an estimated depth of approximately 25 feet. This alternative would likely require demolition of the Kwik Stop building and shoring of sidewalls to preserve the structural integrity of the State Hwy 31 and Greenhouse Road road-prisms.

Approximately 660 bank cubic yards of soil would be removed for off-site disposal and/or treatment. The timeframe required to complete the excavation work likely would be several months, including installing temporary shoring. ***This component is retained.***

Continued operation of the soil vapor extraction/bioventing system that was installed in 2012 as an interim remedial action. Based on estimates of contaminant concentrations and removal rates, the SVE/BV would operate approximately 2½ years to remove 30,000 pounds of petroleum hydrocarbons. However, dual operation of both SVE and BV could reduce the estimated operational timeframe. ***This component is retained.***

Natural attenuation/degradation of source area contamination. Under MTCA, natural attenuation is not acceptable when floating product is present. Additionally, high concentrations of contaminants within source areas would limit activity of biological degradation processes. The resulting long timeframe of source reduction would not be protective of human health and the environment and therefore not be consistent with MTCA. ***This component is rejected.***

5.2. Groundwater – Floating LNAPL

Hydraulic containment of floating product areas using groundwater depression and product removal. Floating LNAPL located on groundwater near the Cabin Grill would be captured using groundwater depression techniques. The elevation of groundwater in floating LNAPL areas would be depressed using pumps installed in one or more extraction wells, creating a capture zone around the well(s). As groundwater is depressed, floating product would remain within the created capture zone and a portion of the LNAPL would flow, through gravity, to the capture point to be removed by either the groundwater depression pumps or by LNAPL removal pumps. Recovered LNAPL would be appropriately disposed or recycled off-site and extracted groundwater would be treated through air-stripping and/or activated carbon adsorption prior to permitted discharge. The estimated timeframe for removal of mobile floating product is approximately 2 years. ***This component is retained.***

Design and implementation of this component must consider potential impacts to the Cabin Grill domestic well and other downgradient domestic wells, screened within the shallow aquifer. Preliminarily, given the current understanding of the shallow aquifer characteristics, it is unlikely that downgradient wells located on Property IDs 6606, 6607, 6608/6609 and 6610 will be significantly impacted with regard to available water quantity. It is possible that the available discharge rate from the Cabin Grill domestic well could be impacted as a result of withdrawing groundwater from extraction wells, and the resulting drawdown of the groundwater table surrounding those wells. Mitigation of such impacts should be evaluated during design based on results of pumping tests completed at the Cabin Grill property. Potential mitigation measures for reduced discharge rates from the Cabin Grill domestic well could include drilling the Cabin Grill well deeper to provide a larger storage volume within the well casing, and/or installing larger pressure tanks for aboveground water storage to account for reduced withdrawal rates from the Cabin Grill domestic well.

Enhanced removal and hydraulic containment of floating LNAPL areas using groundwater depression, reinjection and vacuum-enhanced LNAPL removal. Similar to the previous component, floating LNAPL located on groundwater near the Cabin Grill would be captured using groundwater depression techniques. However, LNAPL removal would be enhanced by applying a vacuum to the recovery well(s) resulting in a broader capture zone. LNAPL removed from the ground would be disposed/recycled off-site. Recovered groundwater would be treated through air-stripping and/or activated carbon adsorption and re-injected at strategically-placed locations to optimize recovery of LNAPL through hydraulic control. Petroleum vapors would be treated using granular activated carbon or catalytic oxidizer. The estimated time frame for enhanced removal of floating product is approximately 1½ years. ***This component is retained.*** Design and implementation of this component also must consider potential impacts to the Cabin Grill domestic well and other downgradient wells.

Air-sparging to volatize and recover floating LNAPL. This component would introduce air into groundwater to volatilize floating LNAPL. Volatilized LNAPL would be captured by SVE. The SVE system exhaust would be treated to oxidize or capture GRPH. Pilot testing of air-sparging was conducted during the RI and was determined to not be technically feasible because the thickness of the saturated soil zone above the confining clay layer was too small to result in a broad radius of influence and because site characteristics such as large soil pore spaces and correspondingly low surface tension forces, which result in ineffective transfer of oxygen to groundwater. ***This component is rejected.***

Physical containment of floating LNAPL areas. Floating LNAPL areas would be contained within a barrier wall constructed of sheet-pile or grout. Approximately 300 to 400 lineal feet of barrier wall would be constructed downgradient of the floating LNAPL area to prevent additional migration of floating LNAPL and to attenuate additional dissolution of soluble petroleum hydrocarbons. The lower portion of the barrier would extend into the underlying low permeability silt/clay formation, and the configuration of the containment wall possibly could include gates to focus groundwater flow paths. Unit cost to construct a grout-based barrier is on the order of $50 per square foot of wall face; sheet pile construction likely would cost more than $50 per square foot of wall face. Estimated costs for construction of a barrier wall are on the order of $1,000,000. ***This component is rejected*** because it is clearly cost-disproportionate and by itself does not meet the standard of a permanent groundwater cleanup action defined WAC 173-340-360(2)(c)(ii)(A).

5.3. Groundwater – Dissolved GRPH

Natural attenuation of dissolved GRPH. Dissolved contaminants within the contaminant plume would be allowed to passively (naturally) attenuate. Findings of the RI indicate that biological oxidation of dissolved contaminants is occurring (low dissolved oxygen concentration and negative oxygen reduction potential). Long-term performance monitoring would be conducted to monitor groundwater geochemical conditions and contaminant attenuation. The estimated time frame for natural attenuation is approximately three to seven years, depending on selection of source area removal components. ***This component is retained.***

In-situ chemical oxidation (ISCO) of dissolved GRPH. Chemical oxidation would include injecting Fenton's reaction chemicals including hydrogen peroxide (H_2O_2) and iron (Fe) or similar oxygenation chemicals into dissolved contaminant areas to oxidize dissolved GRPH. Pulse or continuous injection of oxidation chemicals would be discontinued when contaminant reduction becomes asymptotic. Natural attenuation would be implemented following chemical oxidation, if necessary, to meet groundwater cleanup performance criteria. For preliminary estimating purposes, the estimated time frame for ISCO injection is approximately two years, equal to the estimated time frame to groundwater depression and product removal. Long-term performance monitoring would be conducted to monitor groundwater contaminant reduction. For preliminary estimating purposes, the time frame for monitored natural attenuation following ISCO is approximately four years. ***This component is retained.***

Air-sparging and enhanced biological oxidation of dissolved GRPH. This component would introduce oxygen into groundwater to enhance biological oxidation of dissolved GRPH. As mentioned, pilot testing of air-sparging was conducted during the RI and was determined to not be technically feasible. ***This component is rejected.***

Risk-Based Corrective Action (RBCA). This component would use a risk assessment based approach to achieve cleanup standards at the site. Under this scenario, institutional controls such as a site-specific risk assessment, land and groundwater use restrictions, deed covenants, and other methods would be used to refine and control risks to human health and the environment. Currently, groundwater and soil contaminant concentrations would exceed most if not all risk-based cleanup criteria. However, in the future, RBCA might be viable to achieve site closure following application of other physical remedial components and after site contaminant concentrations have been reduced. Therefore, ***this component is retained*** but will be evaluated for site applicability after site contaminant reduction has occurred.

6.0 SUMMARY OF CLEANUP ALTERNATIVES

Remedial components retained following initial screening were combined to form four cleanup alternatives for evaluation against MTCA requirements. Each alternative addresses contaminated media with a combination of remedial technologies appropriate for Site conditions. The four alternatives represent a reasonable number and range of potentially applicable cleanup components to provide a basis for evaluation.

Summary of Cleanup Alternatives

1. Soil vapor extraction/bioventing for vadose zone contamination; groundwater depression, groundwater treatment, and product removal for floating LNAPL areas; and natural attenuation for dissolved groundwater contaminants. Treated groundwater would be disposed through irrigation or permitted discharge.
2. Soil vapor extraction/bioventing for vadose zone contamination; groundwater depression, groundwater treatment, and product removal enhanced with vacuum for floating LNAPL areas; and natural attenuation for dissolved groundwater contaminants. Treated groundwater would be re-injected for hydraulic control near floating LNAPL areas.
3. Partial excavation of vadose zone soil contamination; groundwater depression, groundwater treatment, and product removal enhanced with vacuum for floating LNAPL areas; and in-situ chemical oxygenation of dissolved groundwater contaminants. Treated groundwater would be re-injected for hydraulic control near floating LNAPL areas.
4. Soil vapor extraction/bioventing for vadose zone contamination; groundwater depression, groundwater treatment to remove contaminants, and product removal enhanced with vacuum for floating LNAPL areas; and in-situ chemical oxygenation of dissolved groundwater contaminants. Treated groundwater would be re-injected for hydraulic control near floating LNAPL areas.

The design parameters used to develop the alternatives are based on engineering judgment and current knowledge of Site conditions. The selected alternative likely will require additional assessment and analysis to define specific cleanup action design criteria, which will be identified as a work item in the Scope of Work.

The four remedial alternatives were developed to be consistent with current and future land uses of the site and surrounding areas. To address site contamination, the alternatives involve various combinations of vadose zone soil remediation, groundwater and product extraction and treatment, and dissolved phase remediation. Summary of Cleanup Action Alternatives, Table 3, summarizes the remedial components employed in each alternative.

6.1. Remedial Alternative 1: Source Area SVE/BV, Product Removal, and Natural Attenuation

Remedial Alternative 1 involves continued operation of the SVE/BV system that was installed during the late fall and early winter of 2012 as an interim action to remediate vadose zone soil present at the Airport Kwik Stop property. The SVE/BV system would continue to operate until applicable cleanup standards or other defined ending criteria have been met. The SVE/BV system would operate for approximately 2½ years removing approximately 30,000 pounds of petroleum hydrocarbons.

Floating product located on groundwater near the Cabin Grill would be captured using groundwater depression techniques. The elevation of groundwater in floating product areas would be depressed using pumps installed in one or more extraction wells, creating a capture zone around the well(s). As groundwater is depressed, floating product would remain within the created capture zone and a portion of the product would flow, through gravity, to the capture point to be removed by either the groundwater depression pumps or by product removal pumps. This equation methods were used to develop preliminary estimates of cone of depression configuration and removal rates. Based on this analysis, stabilized groundwater removal rates are estimated to be approximately 16 gallons per minute (gpm) for soil with a hydraulic conductivity of 620 feet/day, a saturated aquifer thickness of 6 feet, and a cone of depression of approximately 200 radial feet. Oil/water separators and holding tanks would separate and store the hydrocarbon product, respectively. A portion of the estimated 7,400 gallons of floating product would be recovered. The length of time to recover the floating product, and the quantity of recovered product, is difficult to estimate because of the complex interaction of multi-phase flow, capillary and sorption processes, soil heterogeneity, and uncertainty regarding hydraulic and geochemical properties of soil at the site. However, given a 200-foot-radial cone of depression with an average 0.01 feet/foot gradient, gasoline would flow by advection (gravity) from the outer portions of the radius to the center in approximately 100 days. Additional floating product would flow from upgradient areas to the recovery point over a span of approximately 200 days, and additional product would be released over time as groundwater flushes through soil pores releasing adsorbed petroleum hydrocarbon. For purposes of this FS, Alternative 1 groundwater depression system with product recovery is assumed to operate for 24 months and would recover about 10 percent of the estimated floating product (approximately 740 gallons). Recovered product would be appropriately disposed or recycled off-site.

Groundwater removed would have concentrations of petroleum hydrocarbons requiring treatment before disposal. Treatment would be conducted through air-stripping and/or activated carbon adsorption. Assuming groundwater depression pump(s) operate for 730 days at 16 gpm and recover dissolved gasoline-range petroleum hydrocarbons averaging 10,000 µg/kg, approximately 640 kilogram (kg) (1,408 pounds or 225 gallons) of petroleum hydrocarbons would be generated during groundwater recovery. This mass of petroleum hydrocarbons would be captured using liquid-phase granular activated carbon (GAC) adsorption requiring approximately 5 tons of carbon over a two year period. Treated groundwater would be discharged through irrigation or permitted discharge. This alternative does not consider reuse of treated groundwater for hydraulic control.

Other than the dissolved contaminants removed during groundwater extraction, dissolved contaminants within the contaminant plume would be allowed to passively (naturally) attenuate. Low dissolved oxygen concentration, negative oxygen reduction potential (ORP), and decreasing contaminant concentration observed during the RI indicate that biological oxidation of dissolved contaminants is occurring. Long-term performance monitoring would be conducted to monitor groundwater geochemical conditions and contaminant attenuation.

6.2. Remedial Alternative 2: Source Area SVE/BV, Product Removal, Hydraulic Control, and Natural Attenuation

Similar to Alternative 1, Remedial Alternative 2 involves continued operation of the soil vapor extraction SVE/BV system that was installed in 2012 as an interim action to remediate vadose zone soil present at the Airport Kwik Stop property. The SVE/BV system would be allowed to operate until applicable cleanup standards or other ending criteria have been met.

Floating product located on groundwater near the Cabin Grill would be captured using groundwater depression techniques similar to Alternative 1. The elevation of groundwater in floating product areas would be depressed using pumps installed in one or more extraction wells, creating a capture zone around the well(s). As groundwater is depressed, floating product would remain within the created capture zone and would be removed by either the groundwater depression pumps or by product removal pumps. Oil/water separators and holding tanks would separate and store the hydrocarbon product, respectively. Recovered product would be appropriately disposed or recycled off-site.

LNAPL removal would be enhanced by applying a vacuum to the extraction well(s). This would create a negative pressure zone near the well screen and within the dewatered portion of the cone of depression. Residual LNAPL would be volatized and removed from the ground. Also, the applied vacuum would bring oxygen into the cone of depression increasing the rate of biological degradation. Gases discharged from the vacuum unit would require evaluation for treatment using activated carbon, catalytic oxidation, or thermal methods.

Recovered groundwater would be treated through air-stripping and/or activated carbon adsorption and re-injected at strategically-placed locations to optimize recovery of product through hydraulic control. Potentially, re-injection could be perpendicular to the long-axis of groundwater flow to funnel the plume and increase gradient toward recovery wells. Alternatively, re-injection could occur up-gradient to increase groundwater gradient towards the recovery well(s). Re-injection for hydraulic control would shorten the time required to move floating product toward the recovery well(s), increase efficiency of removal, and subsequently reduce the mass of contaminants within the dissolved plume. Time reductions and efficiency improvements over Alternative 1 would vary depending on placement and number of reinjection wells. For comparison under this FS, this alternative would operate for 18 months, and recover approximately 20 percent of the estimated LNAPL (approximately 1,500 gallons). Recovered product would be appropriately disposed or recycled off-site.

Dissolved contaminants within the contaminant plume would be allowed to naturally attenuate. Because of the time reduction and increased efficiency of LNAPL removal in Alternative 2, natural attenuation of dissolved contaminants would be completed sooner than with Alternative 1. Long-term performance monitoring would be conducted to monitor groundwater geochemical conditions and contaminant attenuation.

6.3. Remedial Alternative 3: Source Area Excavation, Product Removal, Hydraulic Control, and Chemical Oxygenation

Remedial Alternative 3 includes excavation of heavily contaminated soil at the Airport Kwik Stop property. Soil would be excavated at site areas where concentrations of petroleum hydrocarbons exceed about 10,000 mg/kg to an estimated depth of approximately 25 feet. This alternative would likely require demolition of the Airport Kwik Stop building and shoring of sidewalls to preserve the structural integrity of Highway 31 and Greenhouse Road road-prisms. Approximately 660 cubic yards of soil would be removed for off-site disposal and/or treatment. The excavation would be filled with clean soil.

Floating product located on groundwater near the Cabin Grill would be captured using vacuum-enhanced groundwater depression techniques similar to Alternative 2. Recovered groundwater would be treated through air-stripping and/or activated carbon adsorption and re-injected for hydraulic control similar to Alternative 2.

Remedial Alternative 3 would remediate the dissolved contaminant plume using ISCO. Chemical oxidation would be conducted by injecting Fenton's reaction chemicals including H_2O_2 and Fe, or a similar oxygenation system. Injection would be performed concurrent and following removal of floating product, possibly metered into groundwater using the hydraulic control re-injection wells and floating LNAPL extraction well(s) for injection of the oxygenation chemicals. Alternatively, the chemicals could be pulse injected using direct-push drilling equipment. For comparison under this FS, this component is estimated to occur concurrently with the groundwater control system, lasting approximately two years. Chemical injection would be conducted until pre-determined performance criteria are met, followed by natural attenuation to complete degradation of groundwater contaminants through biological oxidation. Long-term performance monitoring would be conducted to monitor groundwater contaminant reduction. For comparison under this FS, this component of Alternative 3 is estimated to last approximately four years.

6.4. Remedial Alternative 4: Source Area SVE/BV, Product Removal, Hydraulic Control, and Chemical Oxygenation

Remedial Alternative 4 is a hybrid of Alternative 2 and Alternative 3, utilizing the vadose zone soil treatment strategy of Alternative 2 and the groundwater treatment strategy of Alternative 3.

Source zone contaminated vadose zone soil at the Airport Kwik Stop would continue to be treated using the existing SVE/BV system. The system would continue to operate until applicable cleanup standards or other ending criteria have been met similar to Alternative 2. For comparison purposes under this FS, the estimated time frame for continued operation of the SVE/BV system is 2½ years.

Floating product on groundwater near the Cabin Grill would be captured using vacuum-enhanced groundwater depression techniques, similar to Alternatives 2 and 3. Additionally, ISCO techniques would be utilized to augment the groundwater cleanup. Oxidants could be metered into re-injected groundwater, or pulse injected into direct-push borings. The time frame for groundwater treatment is the same as for Alternative 3.

7.0 EVALUATION CRITERIA

This section presents a description of the threshold requirements for cleanup actions under MTCA and the additional criteria used in this FS to evaluate the cleanup action alternatives.

7.1. Threshold Requirements

Cleanup actions performed under MTCA must comply with several basic requirements. Cleanup action alternatives that do not comply with these criteria are not considered suitable cleanup actions. As provided in WAC 173-340-360(2)(a), the four threshold requirements for cleanup actions must:

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws; and
- Provide for compliance monitoring.

7.1.1. Protection of Human Health and the Environment

The results of cleanup actions performed under MTCA must ensure that both human health and the environment are protected.

7.1.2. Compliance with Cleanup Standards

Compliance with cleanup standards requires, in part, that cleanup levels are met at the applicable points of compliance in a reasonable period of time.

7.1.3. Compliance with Applicable State and Federal Laws

Cleanup actions conducted under MTCA must comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines to be relevant and appropriate as described in WAC 173-340-710.

7.1.4. Provision for Compliance Monitoring

The cleanup action must provide for compliance monitoring in accordance with WAC 173-340-410. Compliance monitoring consists of protection monitoring, performance monitoring and confirmational monitoring. Protection monitoring is conducted to confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of a cleanup action. Performance monitoring is conducted to confirm that the cleanup action has attained cleanup standards and, if appropriate, remediation levels or other performance standards. Confirmational monitoring (groundwater and/or soil) is conducted to confirm the long-term effectiveness of the cleanup action once cleanup standards and, if appropriate, remediation levels or other performance standards have been attained.

7.2. Other MTCA Requirements

Under MTCA, when selecting from the alternatives that meet the minimum requirements described above, the alternatives shall be further evaluated against the following additional criteria:

- Use permanent solutions to the maximum extent practicable [WAC 173-340-360(2)(b)(i)]. MTCA requires that when selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall use permanent solutions to the maximum extent practicable [WAC 173-340-360(2)(b)(i)]. MTCA specifies that the permanence of these qualifying alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives using a "disproportionate cost analysis" in accordance with WAC 173-340-360(3)(e). The criteria for conducting this analysis are described in "Section 7.3" below.

- Provide a reasonable restoration time frame [WAC 173-340-360(2)(b)(ii)]. In accordance with WAC 173-340-360(2)(b)(ii), MTCA places a preference on those cleanup action alternatives that, while equivalent in other respects, can be implemented in a shorter period of time. MTCA includes a summary of factors to be considered in evaluating whether a cleanup action provides for a reasonable restoration time frame [WAC 173-340-360(4)(b)]. These factors include: (1) potential risks posed to human health and the environment; (2) practicability of achieving a shorter restoration time frame; (3) current site use and associated resources that are, or might be, affected by releases to the site; (4) potential future site uses, and associated resources that are, or might be, affected by releases to the site; (5) availability of alternative water supplies; (6) likely effectiveness and reliability of institutional controls; (7) ability to control and monitor migration of hazardous substances at the site; (8) toxicity of the hazardous substances at the site; and (9) natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

  The alternatives presented herein consider potential risks posed to human health and the environment, practicality of achieving a reasonable restoration time frame, and current and potential future land uses, ability to control and monitor migration of hazardous substances at the site, toxicity of hazardous substances and natural attenuation processes.

- With regard to availability of alternative water supplies, it might be possible to drill and install deeper wells to replace impacted domestic water wells and current carbon treatment systems. Deeper wells would draw water from a deeper confined aquifer believed to underlie the upper impacted shallow aquifer and an intermediate aquitard of silt and clay. Based on review of the geologic literature and available water well reports in the site vicinity, the clay aquitard underlying the upper unconfined aquifer could be several hundred feet thick. Drilling of deeper wells would require appropriate design and construction techniques to prevent cross-contamination of the upper unconfined and lower confined aquifers. However, the presence of a lower confined aquifer at the site is not confirmed, and if present, the available yield and water quality of the lower aquifer at the site also is not known. While technically feasible, drilling and installing deeper wells might require funding sources other than those available for site cleanup, and therefore, was not included as a component in the analysis of alternatives. Furthermore, while providing a different water supply does reduce the ingestion of groundwater risk, it does not address the existing contaminant plume in groundwater nor fully eliminate the ingestion of groundwater pathway.

- Consideration of Public Concerns [WAC 173-340-360(2)(b)(iii)]. Ecology will consider public comments submitted during the public comment period for the RI/FS. This preliminary selection is subject to further public review and comment when the proposed remedy is published in the draft CAP.

7.3. MTCA Disproportionate Cost Analysis

The MTCA disproportionate cost analysis (DCA) is used to evaluate which of the alternatives that meet the threshold requirements are permanent to the maximum extent practicable. This analysis involves comparing the costs and benefits of alternatives and selecting the alternative with incremental costs that are not disproportionate to the incremental benefits. The evaluation criteria for the disproportionate cost analysis are specified in WAC 173-340-360(2) and WAC 173-340-360(3), and include protectiveness, permanence, cost, long-term effectiveness, management of short-term risks, implementability and consideration of public concerns.

7.3.1. Protectiveness

The overall protectiveness of a cleanup action alternative is evaluated based on several factors including overall reduction in risks to human health and the environment, time to reduce the risk (and meet MTCA cleanup criteria), and on-site and off-site risks resulting from implementing the alternative.

7.3.2. Permanence

MTCA specifies that when selecting a cleanup action alternative, preference shall be given to actions that are "permanent solutions to the maximum extent practicable." Evaluation criteria include the degree to which the alternative permanently reduces the toxicity, mobility or mass of hazardous substances; the effectiveness of the alternative in destroying the hazardous substances; the reduction or elimination of hazardous substance releases and sources of releases; the degree of irreversibility of waste treatment processes; and the characteristics and quantity of treatment residuals generated.

7.3.3. Cost

The analysis of cleanup action alternative costs under MTCA includes all costs associated with implementing an alternative including design, construction, long-term monitoring and institutional controls. Costs are intended to be comparable among different alternatives to assist in the overall analysis of relative costs and benefits of the alternatives. The costs to implement an alternative include the cost of construction, the net present value of any long-term costs and agency oversight costs. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs and the cost of maintaining institutional controls. Unit costs used to develop overall remediation costs for this FS were derived using a combination of professional judgment and our experience with recent similar projects in the same general area as the site, and construction and materials cost estimates solicited from applicable vendors and contractors. The cost estimates are "order of magnitude" in scale and will be further defined during completion of the Engineering Design Report (EDR) which will be prepared following finalization of the CAP and Scope of Work.

7.3.4. Long-Term Effectiveness

Long-term effectiveness is a parameter that expresses the degree of certainty that the alternative will be successful in maintaining compliance with cleanup standards over the long-term performance of the cleanup action. The MTCA regulations contain a specific preference ranking for different types of technologies that will be considered as part of the comparative analysis. Ranking criteria, in descending preference, includes technologies such as reuse/recycling, treatment, immobilization/solidification, disposal in an engineered, lined, and monitored facility, on-site isolation/containment with attendant engineered controls, and institutional controls and monitoring.

7.3.5. Management of Short-term Risks

Evaluation of this criterion considers the relative magnitude and complexity of actions required to maintain protection of human health and the environment during implementation of the cleanup action. Cleanup actions carry short-term risks such as potential mobilization of contaminants during construction or safety risks typical of large construction projects. Some short-term risks can be managed through best practices during project design and construction, while other risks are inherent to project alternatives and can offset the long-term benefits of an alternative.

7.3.6. Implementability

Implementability is an overall metric expressing the relative difficulty and uncertainty of implementing the cleanup action. Evaluation of implementability includes consideration of technical factors such as the availability of mature technologies and experienced contractors to accomplish the cleanup work. It also includes administrative factors associated with permitting and completing the cleanup.

7.3.7. Consideration of Public Concerns

The public involvement process under MTCA is used to identify potential public concerns regarding cleanup action alternatives. The extent to which an alternative addresses those concerns is considered as part of the evaluation process. This includes concerns raised by individuals, community groups, local governments, tribes, federal and state agencies, and other organizations that may have an interest in or knowledge of the Site. In particular, public concerns for this Site generally would be associated with environmental issues and cleanup action performance, which are addressed under other criteria such as protectiveness and permanence. Furthermore, the public comment periods will address concerns that might not have been addressed and will be included as part of the final FS, should the comments be appropriate for the site.

7.4. Other Criteria

In addition to satisfying MTCA required remedial objectives discussed in this document, the selected remedy should consider the following:

Transportation. State Highway 31 is a major vehicle corridor that supports community, recreational, business and governmental activity in northern Pend Oreille County and connects to a major border crossing route between the United States and Canada. Also, the Ione Airport is located adjacent to the site to the south. The Ione Airport is important for regional transportation and governmental operations. Impacts of short and long term disruptions of transportation will be considered when selecting the cleanup action.

8.0 EVALUATION AND COMPARISON OF CLEANUP ALTERNATIVES

This section provides an evaluation and comparative analysis of cleanup action alternatives developed for the Site. The alternatives are evaluated with respect to the MTCA evaluation criteria described in "Section 7.0" and then compared to each other relative to its expected performance under each criterion. The components of the four remedial alternatives are described above in "Sections 5.0 and 6.0", and are summarized in Table 3. Detailed evaluation of the alternatives is presented in Evaluation of Cleanup Action Alternatives, Table 4, and the results of the evaluation are summarized in Summary of MTCA Evaluation and Ranking of Cleanup Action Alternatives, Table 5.

8.1. Threshold Requirements

All of the alternatives developed in this FS meet each of the four MTCA threshold requirements described for cleanup actions: protection of human health and the environment, compliance with cleanup standards, compliance with applicable state and federal regulations and provision for compliance monitoring.

All four alternatives are considered permanent remedies. Alternative 2 ranks higher as a permanent solution to the maximum extent practicable and is thus the most permanent solution and forms the baseline cleanup action alternative [WAC 173-340-350(8)(c)(ii)(A) and 173-340-360(3)(e)(ii)(B)]. Alternative 4 ranks slightly below Alternative 2 principally because of anticipated public concern and permitting/implementation requirements regarding injection of chemical oxidants into groundwater.

Alternative 1 is a more permanent solution than Alternative 3, because Alternative 1 has fewer short-term risks, is more implementable, is likely to be more accepted by the public, and has a lower cost.

8.2. MTCA Disproportionate Cost Analysis

As discussed in "Section 7.0", the MTCA analysis of disproportionate costs is used to determine which cleanup alternative meets threshold requirements and is permanent to the maximum extent practicable. The remedial Alternatives were ranked relative to each other based on the relative benefits ranking factors of the DCA. Using a numeric scoring scale of 1 (lowest) to 3 (highest) and the methodology described above and in Table 4, each individual criterion is evaluated based on how it applies to each alternative. Note that numeric scoring is not weighted. Table 5 presents the analysis of these results, including the summation of the resulting scores for each alternative and the determination of disproportionate cost.

8.2.1. Protectiveness

Remedial Alternative 4 achieves the highest level of protectiveness of the alternatives as a result of achieving restoration in a reasonable time frame with the least-short term risks. Alternative 2 also achieves restoration in a reasonable time frame (slightly larger than Alternative 4), also with the least short-term risks. Alternative 3 achieves restoration in the shortest time-frame, but with higher short-term risks. Subsequently, Alternative 3 is ranked as the third most protective.

8.2.2. Permanence

Remedial Alternative 3 achieves a high level of permanence through excavation and off-site disposal of the heavily contaminated soil at the Airport Kwik Stop property, and actively treats other media posing risks to human health and the environment. Alternatives 4 and 2 have the second and third highest ranking, respectively, for permanence.

8.2.3. Cost

For purposes of this evaluation, higher cost equates to lower scoring. Remedial Alternative 1 is the lowest cost alternative and is ranked highest, and Alternative 2 is ranked second. Alternative 4 is ranked third. Alternative 3 is ranked lowest as it has the highest cost.

Each remedial alternative is a combination of cleanup action components. Summary of Cleanup Action Component and Alternative Costs, Table 6 provides a summary of estimated costs associated with each remedial alternative. Cost estimates for each cleanup action component are provided in the following tables:

- Component Cost Estimate - Soil Vapor Extraction/Bioventing and On-Site Groundwater Monitoring, Table 7.
- Component Cost Estimate - Excavation of Heavily Contaminated Soil and On-Site Groundwater Monitoring, Table 8.
- Component Cost Estimate - Groundwater Depression for Floating Product Removal, Table 9.
- Component Cost Estimate - Enhanced Groundwater Depression for Floating Product Removal, Table 10.
- Component Cost Estimate - Natural Attenuation and Off-Site Groundwater Monitoring, Table 11.
- Component Cost Estimate - In-Situ Chemical Oxidation and Off-Site Groundwater Monitoring, Table 12.

8.2.4. Long-Term Effectiveness

Long-term effectiveness is measured using specific remedial technology preferences proscribed under MTCA. Alternative 1 is ranked highest because the alternative relies primarily on destruction and detoxification. Alternatives 3 and 4 are ranked second because of their alternative component of in-situ chemical oxidation. Without it, Alternative 3 would be ranked lowest because of its use of off-site excavation and off-site disposal, a low preference remedial technology under MTCA.

8.2.5. Management of Short-Term Risks

The relative difference between short-term risks associated with Remedial Alternatives 1, 2 and 4 are low. While Alternative 1 has less construction and maintenance requirements, the increased construction- and maintenance-related risks associated with injection well installation and operation with Alternatives 2 and 4 are easily managed through engineering and work practice controls. Alternative 2 reduces the duration of short-term risks and is therefore ranked highest. Alternative 4 is ranked second because of potential risks associated with handling and injecting chemical oxidants, which offset reduced remediation time frame. Alternative 3 is clearly the lowest ranked in this category because of high short-term risks associated with remedial excavation, transportation, drilling, and injection of in-situ chemical oxidation chemicals.

8.2.6. Technical and Administrative Implementability

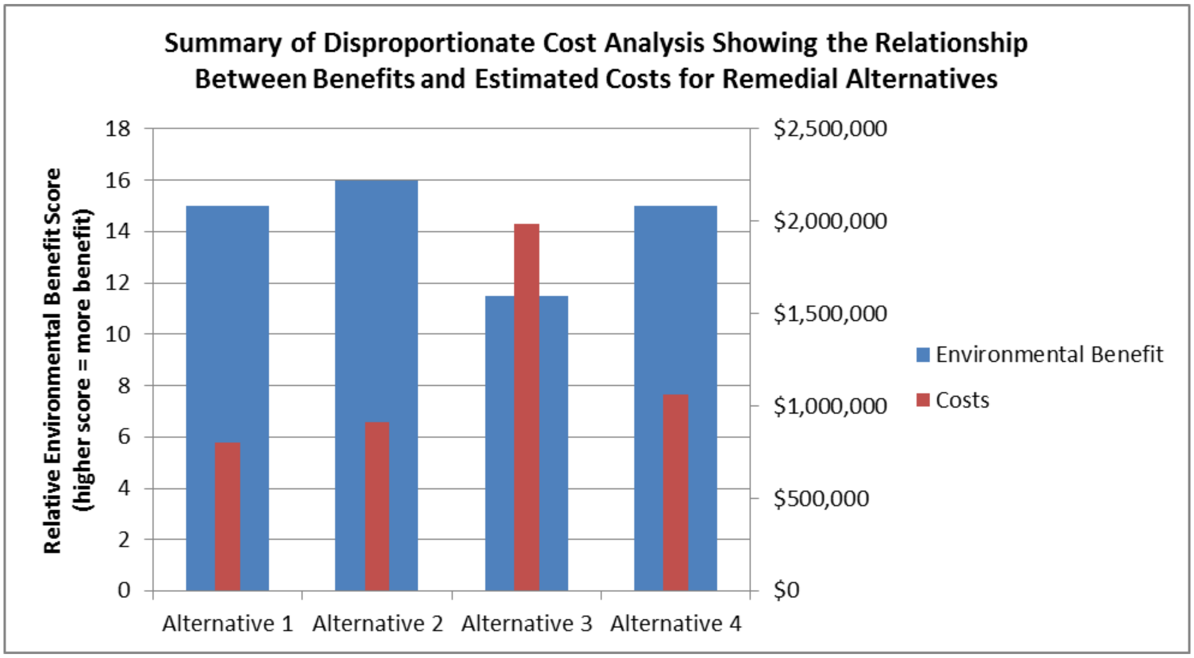
Alternative 1 ranks highest for implementability, since it is the simplest alternative to implement. Alternative 3 relies on relatively complex technical remedial components such as demolition of structures, shoring, hydrogeologic control, and injection of in-situ chemical oxidants. As such, Alternative 3 is ranked lowest for technical and administrative implementability. Alternatives 2 and 4 are ranked between Alternative 1 and 3, with Alternative 4 being more difficult than Alternative 2 based on likely permitting requirements related to injection of chemical oxidants into the groundwater.

8.2.7. Consideration of Public Concerns

The remedial alternatives proposed for the Site are generally expected to be acceptable to the public. Alternative 2 is expected to address public concerns to the greatest extent since it is generally non-disruptive and has a shorter restoration time frame than Alternative 1. While there is potential for Alternative 3 to benefit the local economy through increased short-term construction jobs and service and supply sales, potential negative effects outweigh the benefits. Potential negative effects of Alternative 3 includes traffic disruptions of Highway 31, the airport, and adjacent roadways; demolition of the Airport Kwik Stop, a local landmark; and injection of in-situ chemical oxidants into local groundwater. Alternative 4 is expected to be less receptive to the public because of the use of chemical oxidants.

8.2.8. DCA Summary

Using the scoring criteria described in "Section 8.2" and the analysis outlined in "Sections 8.2.1 through 8.2.7", Alternative 2 ranked highest with a score of 16.0. Alternative 1 and Alternative 4 tied for second with a score of 15.0. Alternative 3 ranked lowest with a score of 11.5. The incremental benefits of permanence relative to cost are presented in the following figure:



9.0 CONCLUSIONS

All four alternatives meet the MTCA threshold criteria. Based on the DCA, remedial Alternative 2 is the preferred alternative. Alternative 2 provides more permanence measured as environmental benefit, compared to Alternative 1 with only a small incremental cost increase. The increased cost of Alternative 3 does not provide a higher measure of environmental benefit over Alternatives 1 and 2 as measured using the DCA criteria provided by MTCA. Alternative 4 provides slightly less environmental benefit at a higher cost than Alternative 2.

10.0 REFERENCES

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GeoEngineers, Inc. "Remedial Investigation Report, Airport Kwik Stop Site, Ione, Washington" File No. 0504-058-02, January 29, 2013.

TABLES

GeoEngineers

Table 3

Summary of Cleanup Action Alternatives

Airport Kwik Stop Site
Ione, Washington

Alternative	Media and Remedial Components							
	On-Site Soil, Vapor, and Groundwater		Floating LNAPL on Groundwater				Dissolved GRPH in	
	SVE/BV[1,2]	Excavation and Offsite Disposal of Heavily Contaminated Soil[2]	Groundwater Depression for Hydraulic Control	Reinjection of Treated Groundwater for Enhanced Hydraulic Control	Vacuum Extraction	NAPL Removal and Offsite Disposal/Recycling	Natural Attenuation	In-Situ Chemical Oxidation
Alternative 1	X		X			X	X	
Alternative 2	X		X	X	X	X	X	
Alternative 3		X	X	X	X	X		X
Alternative 4	X		X	X	X	X		X

Notes:

[1]SVE/BV: Soil vapor extraction/bio-venting

[2]Includes on-site groundwater monitoring

https://projects.geoengineers.com/sites/0050405802/Draft/FS/[Airport Kwik Stop FS Tables.xlsx]Table 3

Table 4

Evaluation of Cleanup Action Alternatives

Airport Kwik Stop Site
Ione, Washington

	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Alternatives Descriptions	Heavily contaminated soil area at the Airport Kwik Stop property would be remediated using the existing SVE/BV system. Floating LNAPL on groundwater near the Cabin Grill would be recovered using groundwater depression pump(s) that would create a cone-of-depression that would cause the LNAPL to flow to extraction well(s). Extracted groundwater would be treated and discharged under permit. Contaminants dissolved in groundwater at the site would be allowed to naturally attenuate.		Heavily contaminated soil areas at the Airport Kwik Stop property would be treated using the existing SVE/BV system. Floating LNAPL on groundwater would be recovered using groundwater depresssion similar to Alternative 1 but would be enhanced by reinjecting treated groundwater for hydraulic control and by applying a vacuum to extraction well(s). Contaminants dissolved in groundwater at the site would be allowed to naturally attenuate.		Heavily contaminated soil at the Airport Kwik Stop property would be excavated and transported off-site to an appropriate disposal facility. This would likely require demolition of existing site structures and shoring of sidewalls along adjacent roadways. Floating LNAPL would be recovered using groundwater depression, reinjection for hydraulic control, and vacuum methods similar to Alternative 2. Contaminants dissolved in groundwater would be treated in-situ (in-place) using chemical oxidants injected into and upgradient of affected groundwater areas.		Heavily contaminated soil areas at the Airport Kwik Stop property would be treated using the existing SVE/BV system. Floating LNAPL on groundwater would be recovered using groundwater depresssion similar to Alternative 1 but would be enhanced by reinjecting treated groundwater for hydraulic control and by applying a vacuum to extraction well(s). Contaminants dissolved in groundwater would be treated in-situ (in-place) using chemical oxidants injected into and upgradient of affected groundwater areas.	
Relative Average Ranking (see Table 5)	15.0		16.0		11.5		15.0	
Alternative Ranking Under MTCA								
1. Compliance with MTCA Threshold Criteria								
Protection of Human Health and the Environment	Yes- alternative will protect human health and the environment		Yes - Alternative will protect human health and the environment.		Yes - Alternative will protect human health and the environment.		Yes - Alternative will protect human health and the environment.	
Compliance with Cleanup Standards	Yes - contaminated soil and groundwater will be remediated to the extent feasible.		Yes - contaminated soil and groundwater will be remediated to the extent feasible.		Yes - contaminated soil and groundwater will be remediated to the extent feasible.		Yes - contaminated soil and groundwater will be remediated to the extent feasible.	
Compliance with Applicable State and Federal Regulations	Yes - Alternative complies with applicable state and federal regulations		Yes - Alternative complies with applicable state and federal regulations		Yes - Alternative complies with applicable state and federal regulations		Yes - Alternative complies with applicable state and federal regulations	
Provision for Compliance Monitoring	Yes - Alternative includes provision for compliance monitoring		Yes - Alternative includes provision for compliance monitoring		Yes - Alternative includes provision for compliance monitoring		Yes - Alternative includes provision for compliance monitoring	
2. Restoration Time Frame								
	Estimated restoration time frame: Heavily contaminated soil: 2.5 years Floating LNAPL: 2 years Dissolved groundwater contaminants: 7 years Compliance monitoring: 7 years		Estimated restoration time frame: Heavily contaminated soil: 2.5 years Floating LNAPL: 1.5 years Dissolved groundwater contaminants: 5 years Compliance monitoring: 6 years		Estimated restoration time frame: Heavily contaminated soil: 1 year Floating LNAPL: 1.5 years Dissolved groundwater contaminants: 2 years Compliance monitoring: 4 years		Estimated restoration time frame: Heavily contaminated soil: 1 year Floating LNAPL: 1.5 years Dissolved groundwater contaminants: 2 years Compliance monitoring: 4 years	
		Score		**Score**		**Score**		**Score**
3. Disproportionate Cost Analysis - Relative Benefits Ranking (Scored from 1-lowest								
Protectiveness	Achieves lowest ranking of protectiveness because this alternative has the longest duration of the considered alternatives.	1	Second Highest-ranked because this alternative meets cleanup criteria slightly sooner than Alternative 2 and has the least short-term risks.	2.5	Medium-ranked because this alternative includes excavation, transportation, and off-site disposal which increases short-term risk and requires off-site management of remedial wastes.	2	Highest-ranked because this alternative meets cleanup criteria slightly sooner than Alternative2 and has the least short-term risks.	3
Permanence	This alternative is ranked the lowest of the three alternatives for permanance because it relies mostly on passive methods of contaminant removal.	1	Medium-ranked because this alternative provides increased activity toward remediation of floating LNAPL over Alternative 1.	2	Highest-ranked for permanance because this alternative includes excavation and off-site removal of heavily contaminated soil, and provides active remediation of dissolved groundwater contamination.	3	Second highest-ranked for permanance because this alternative provides active remediation of dissolved groundwater contamination coupled with SVE/BV for source area remediation .	2.5
Cost	This alternative is ranked the highest of the three alternatives for cost because it is the lowest cost alternative.	3	Medium-ranked for cost.	2	This alternative is the highest cost and subsequently ranked lowest.	1	This alternative is the second highest cost and subsequently ranked second lowest.	1.5
Long-Term Effectiveness	This alternative utilizes destruction and detoxification as a primary method of cleanup, with the lowest application of reuse or recycling of the alternatives considered.	3	This alternative increases the application of reuse or recycling over Alternative 1 through increased recovery of floating LNAPL.	1.5	This alternative is ranked higher than Alternative 2 because it increases application of destruction or detoxification through in-situ chemical oxidation. However, one half a point is deducted because it relies on excavation and off-site disposal of heavily contaminated soil.	2.5	This alternative is ranked higher than Alternative 2 because it increases application of destruction or detoxification through in-situ chemical oxidation.	2.5

	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Management of Short-Term Risks	This alternative is ranked in the middle because construction-based risks to human health are lower than Alternative 4.	2	Alternative 2 is ranked highest because short-term risks related to construction are low, and short-term environmental risks are addressed in a shorter time frame than Alternative 1.	3	Alternative 3 is ranked lowest because of high short-term human health risks associated with remedial excavation and transportation, drilling, and in-situ chemical handling.	1	Alternative 4 is ranked highest second highest because of short-term risks related to construction are low, however, one-half point is deducted becuase of human health risks associated with in-situ chemical handling.	2.5
Technical and Administrative Implementability	This alternative is the easiest technically and administratively to implement, assuming that groundwater extracted during operation of the groundwater depression system can be readily discharged.	3	Alternative 2 would be more difficult to implement than Alternative 1 because of additional access required for reinjection well installation, additional underground injection control (UIC) permitting, and anticillary engineering/hydrogeological studies.	2	This alternative would be the most difficult to implement because of increased permitting associated with heavily contaminated soil excavation adjacent to the WSDOT right-of-way and increased UIC permitting associated with in-situ chemical oxidation operations.	1	This alternative would be more difficult to implement than Alternative 2 becauce of additional permitting associated with in-situ chemical oxididation operations, but less difficult than Alternative 3	1.5
Consideration of Public Concerns	This alternative is ranked medium because the public would be less likely to accept a longer restoration timeframe.	2	This alternative in ranked highest as it is expected to best consider public concerns.	3	This alternative is ranked lowest because the public might consider the Airport Kwik Stop building a landmark and not accept demolition of structures. Distruptions in highway traffic and airport access during excavation activities might negatively affect tourist and commerce-related traffic. Also, the public might have concerns about injection of in-situ chemical oxidants into groundwater. Note these concerns are considered to out-weigh potential economic benefits of temporary local construction jobs.	1	This alternative is ranked seond lowest because the public might have concerns about injection of in-situ chemical oxidants into groundwater. Note these concerns are considered to out-weigh potential economic benefits of temporary local construction jobs.	1.5

Table 5

Summary of MTCA Evaluation and Ranking of Cleanup Action Alternatives

Airport Kwik Stop Site
Ione, Washington

	Alternative 1 Source Area SVE/BV, Floating Product Capture, Dissolved Contaminant Natural Attenuation	Alternative 2 Source Area SVE/BV, Enhanced Floating Product Capture, Dissolved Contaminant Natural Attenuation	Alternative 3 Source Area Excavation, Enhanced Floating Product Capture, Dissolved Contaminant In-Situ Chemical Oxidation	Alternative 4 Source Area SVE/BV, Enhanced Floating Product Capture, Dissolved Contaminant In-Situ Chemical Oxidation
Alternative Ranking Under MTCA				
1. Compliance with MTCA Threshold Criteria[1]	**Yes**	**Yes**	**Yes**	**Yes**
2. Restoration Time Frame	This alternative relies largely on passive and natural contaminant degradation processes. SVE/BV source removal is expected to complete remediation of heavily contaminated soil areas within approximately 2.5 years. Removal of mobile floating LNAPL is expected to be complete within approximately 2 years. Natural attenuation of dissolved contaminants is expected to occur over approximately 6 to 7 years, with on-site compliance monitoring to 5 years and off-site to about 7 years. Ranking = 7 to 8 years	This alternative increases rate and efficiency of LNAPL removal over Alternative 1. SVE/BV source removal is expected to complete remediation of heavily contaminated soil areas within approximately 2.5 years. Removal of mobile floating LNAPL is expected to be complete within approximately 1.5 years. Natural attenuation of dissolved contaminants is expected to occur over approximately 5 to 6 years. with on-site compliance monitoring to 5 years and off-site to about 6 years. Ranking = 6 to 7 years	Alternative 3 relies on physical removal of the heavily contaminated soil source area in the first year, enhanced removal of floating LNAPL in about 1.5 years, and injection of chemical oxidants into groundwater to accelerate degradation of dissolved contaminant mass in about 2 years, with on-site compliance monitoring to 3 years and off-site to 4 years. Ranking = 3 to 4 years	Alternative 4 relies is a hybrid between Alternative 2 and Alternative 3, relying on continued operation of the SVE/BV system to remove the heavily contaminated soil source area within approximately 2.5 years, enhanced removal of floating LNAPL in about 1.5 years, and injection of chemical oxidants into groundwater to accelerate degradation of dissolved contaminant mass in about 2 years, with on-site compliance monitoring to 3 years and off-site to 4 years. Ranking = 3 to 4 years
3. Reasonable Restoration Timeframe?	Yes	Yes	Yes	Yes
4. Disproportionate Cost Analysis Ranking[2]				
Protectiveness	1	2.5	2	3
Permanence	1	2	3	2.5
Cost[3]	3	2	1	1.5
Long-Term Effectiveness	3	1.5	2.5	2.5
Management of Short-Term Risks	2	3	1	2.5
Technical and Administrative Implementability	3	2	1	1.5
Consideration of Public Concerns	2	3	1	1.5
Total Score	15.0	16.0	11.5	15.0
5. Disproportionate Cost Analysis				
Probable Remedy Cost (+25%/-25%)	$804,700	$912,371	$1,985,700	$1,064,200
Costs Disproportionate to Incremental Benefits	No	No	Yes	No
Practicability of Remedy	Practicable	Practicable	Least Practicable	Practicable
Remedy Permanent to Maximum Extent Practicable	Yes	Yes	Yes	Yes
Overall Alternative Ranking	3rd	1st	4th	2nd

Notes:

[1]WAC 173-340-360(2)(a)

[2]Alternatives are ranked against each other, 1 being low to 3 being high

[3]Low cost is a benefit

Table 6

Summary of Cleanup Action Component and Alternative Costs

Airport Kwik Stop Site

Ione, Washington

Alternative	Media						Alternative Cost Estimate[8]
	On-Site Soil, Vapor and Groundwater		Floating LNAPL on Groundwater		Dissolved GRPH in Groundwater		
	SVE/BV[1,2]	Excavation and Offsite Disposal of Heavily Contaminated Soil[3]	Groundwater Depression for Hydraulic Control and NAPL Removal and Offsite Disposal/Recycling[4]	Reinjection of Treated Groundwater for Enhanced Hydraulic Control, Vaccuum Extraction, and NAPL Removal and Offsite Disposal/Recycling[5]	Natural Attenuation[6]	In-Situ Chemical Oxidation[7]	
Alternative 1	$241,500		$323,600		$239,600		$804,700
Alternative 2	$241,500			$465,500	$205,371		$912,371
Alternative 3		$1,163,000		$465,500		$357,200	$1,985,700
Alternative 4	$241,500			$465,500		$357,200	$1,064,200

Notes:

[1]SVE/BV: Soil vapor extraction/bio-venting

[2]Refer to Table 7 for detailed cost estimate. Includes on-site groundwater monitoring.

[3]Refer to Table 8 for detailed cost estimate. Includes on-site groundwater monitoring.

[4]Refer to Table 9 for detailed cost estimate

[5]Refer to Table 10 for detailed cost estimate

[6]Refer to Table 11 for detailed cost estimate. Note Alternative 2 is discounted by one less year of monitoring.

[7]Refer to Table 12 for detailed cost estimate

[8]Costs for activites that extend beyond 1 year are presented in net present value (2013 dollars) assuming an inflation rate of 2.5% per year.

https://projects.geoengineers.com/sites/0050405802/Draft/FS/[Airport Kwik Stop FS Tables.xlsx]Table 6

Table 7

Component Cost Estimate - Soil Vapor Extraction/Bioventing and On-Site Groundwater Monitoring

Airport Kwik Stop Site
Ione, Washington

Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Mobilization and Site Preparation						
1	Mobilization/Site Controls/Demobilization	NA[1]	NA	NA	$0	Costs captured in 2012
	Subtotal				**$0**	
Construction						
2	Purchase, place, and start-up equipment	NA[1]	NA	NA	NA	Costs captured in 2012
	Subtotal				**$0**	
Continued Operation of SVE/BV System						
3	SVE annual operation for 2 years	1	2 YRS NPV[1]	$115,000	$115,000	Includes one carbon change out at the end of year 2.
4	BV annual operation for 0.5 years	1	0.5 YRS NPV	$12,000	$12,000	NPV year 3
5	Decommissioning costs	1	LS NPV	$19,000	$19,000	Removal of treatment system and decommission wells in Year 3
	Subtotal				**$146,000**	
On-Site Groundwater Monitoring and Reporting						
6	Perform 4 quarterly monitoring events per year for 5 years	1	5 YRS NPV	$37,000	$37,000	Costs based on actual costs 2012
7	Annual reporting to Ecology for 5 years	1	5 YRS NPV	$37,000	$37,000	
	Subtotal				**$74,000**	
Institutional Controls						
8	Administrative groundwater and land use restrictions.	1	LS	$10,000	$10,000	
	Subtotal				**$10,000**	

Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Engineering Design Report						
9	Design and Permitting	5.0%	%	$230,000	$11,500	Accrued during preparation of EDR
	Subtotal				**$11,500**	
COMPONENT COST ESTIMATE					**$241,500**	

Notes:

[1]NPV: Net present value @ 2 5%/yr

https://projects.geoengineers.com/sites/0050405802/Draft/FS/[Airport Kwik Stop FS Tables.xlsx]Table 7 SVE

Table 8

Component Cost Estimate - Excavation of Heavily Contaminated Soil and On-Site Groundwater Monitoring

Airport Kwik Stop Site
Ione, Washington

Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Mobilization and Site Preparation						
1	Mobilization/Site Controls/Demobilization	1	%	10%	$100,693	10% of construction costs
	Subtotal				**$100,693**	
Construction						
2	Demolition	1	LS	$48,650	$48,650	Demolition of the Kwik Stop Building
3	Abandon 6 wells	6	EA	$500	$3,000	
4	Install 4 groundwater monitoring wells	4	EA	$2,000	$8,000	
5	Shoring	7,500	SQ FT	$100	$750,000	300 feet of shoring 25 feet deep
6	Excavation and staging of contaminated soil	660	BNK CU YDS	$15	$9,900	
7	Backfill and Placement	990	CU YDS	$15	$14,850	Local source, assumes 1.5 tons/bank cubic yards excavated
8	Haul and disposal of contaminated soil	1,485	TON	$65	$96,525	Disposal to Graham Road Landfill @$30/ton. Not taxed.
	Subtotal				**$930,925**	
Abandonment of SVE/BV System						
9	Decommissioning costs	1	LS	$20,000	$20,000	
	Subtotal				**$20,000**	
Groundwater Monitoring and Reporting						
10	Perform 4 quarterly monitoring events per year for 3 years	1	3 YRS NPV	$23,000	$23,000	Costs based on actual costs 2012
11	Annual reporting to Ecology	1	3 YRS NPV	$23,000	$23,000	
	Subtotal				**$46,000**	
Institutional Controls						
12	Administrative groundwater and land use restrictions.	1	LS	$10,000	$10,000	
	Subtotal				**$10,000**	

Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Engineering Design Report						
13	Design and Permitting	5%	%	$1,107,618	$55,381	Percentage of construction costs; includes WSDOT permitting and access
	Subtotal				**$55,381**	
COMPONENT COST ESTIMATE					**$1,163,000**	

Notes:

[1]NPV: Net present value @ 2 5%/yr

Table 9

Component Cost Estimate - Groundwater Depression for Floating Product Removal

Airport Kwik Stop Site

Ione, Washington

Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Mobilization and Site Preparation						
1	Mobilization/Site Access/Demobilization	1	LS	$20,000	$20,000	
	Subtotal				**$20,000**	
Construction of Groundwater Depression System						
3	Drill two 40 ft deep 4-inch diameter extraction wells	2	EA	$15,000	$30,000	
4	Purchase and installation of groundwater extraction system	1	EA	$12,000	$12,000	
5	Purchase and installation of oil/water separator with tank	1	EA	$10,000	$10,000	
6	Purchase and installation of groundwater treatment system	1	EA	$15,000	$15,000	
7	Plumbing and electrical	1	LS	$15,000	$15,000	Local source
8	Disposal of IDW	5	DRUMS	$315	$1,575	Transport and disposal to Graham Road Landfill
	Subtotal				**$83,575**	
O&M of Groundwater Depression System						
9	Product Disposal	740	GAL	$3.0	$2,220	Assumes recovery of 20% of the estimated LNAPL
10	Operation Costs, 2 years	1	2 YRS NPV[1]	$111,000	$111,000	Includes well and equipment maintenance labor and ODCs, electricity, and discharge sampling
11	Quarterly Performance Reporting	1	2 YRS NPV	$31,000	$31,000	Includes well and equipment maintenance labor and ODCs, electricity, and discharge sampling
	Subtotal				**$144,220**	
Institutional Controls						
12	Adminstrative goundwater and land use restrictions.	1	LS	$10,000	$10,000	
	Subtotal				**$10,000**	

Engineering Design Report						
13	Design and Permitting	1	LS	$65,800	$65,800	10% of project costs plus additional $40,000 for aquifer testing to optimize design and permitting of discharge
	Subtotal				**$65,800**	
COMPONENT COST ESTIMATE					**$323,600**	

Notes:

[1]NPV: Net present value @ 2 5%/yr

https://projects.geoengineers.com/sites/0050405802/Draft/FS/[Airport Kwik Stop FS Tables.xlsx]Table 9 GW Dep

Table 10

Component Cost Estimate - Enhanced Groundwater Depression for Floating Product Removal

Airport Kwik Stop Site

Ione, Washington

Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Mobilization and Site Preparation						
1	Mobilization/Site Access/Demobilization	1	LS	$40,000	$40,000	
	Subtotal				**$40,000**	
Construction of Groundwater Depression System						
2	Drill two 40 ft deep 4-inch diameter extraction wells	2	EA	$15,000	$30,000	
3	Drill two 40 ft deep 4-inch diameter injection wells	2	EA	$15,000	$30,000	
4	Purchase and installation of groundwater extraction system	1	EA	$12,000	$12,000	
5	Purchase and installation of oil/water separator with tank	1	EA	$10,000	$10,000	
6	Purchase and installation of groundwater treatment system	1	EA	$15,000	$15,000	
7	Purchase and installation of vacuum system	1	EA	$10,000	$10,000	
8	Purchase and installation of vapor treatment system	1	EA	$15,000	$15,000	
9	Plumbing and electrical	1	LS	$20,000	$20,000	Local source
10	Disposal of IDW	10	DRUMS	$173	$1,725	Transport and disposal to Graham Road Landfill
	Subtotal				**$143,725**	
O&M of Groundwater Depression System						
11	Product Disposal	1,480	GAL	$3.0	$4,440	Assumes recovery of 30% of the estimated LNAPL
12	Operation Costs	1	1.5 YRS NPV[1]	$169,000	$169,000	Includes well and equipment maintenance labor and ODCs, GAC, electricity, and discharge sampling
13	Quarterly Performance Reporting	1	1.5 YRS NPV	$24,000	$24,000	
	Subtotal				**$197,440**	
Institutional Controls						
14	Administrative groundwater and land use restrictions.	1	LS	$10,000	$10,000	
	Subtotal				**$10,000**	

Engineering Design Report						
15	Design and Permitting	1	LS	$74,300	$74,300	10% of project cost plus additional $40,000 for aquifer testing to optimize design and permitting of discharge
	Subtotal				**$74,300**	
COMPONENT COST ESTIMATE					**$465,500**	

Notes:

[1]NPV: Net present value @ 2 5%/yr

https://projects.geoengineers.com/sites/0050405802/Draft/FS/[Airport Kwik Stop FS Tables.xlsx]Table 10 GW Dep+Cntrl

Table 11

Component Cost Estimate - Natural Attenuation and Off-Site Groundwater Monitoring

Airport Kwik Stop Site
Ione, Washington

Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Site Preparation						
1	Install additional monitoring wells	2	EA	$2,000.00	$4,000	
	Subtotal				**$4,000**	
Groundwater Monitoring and Reporting						
2	Perform 4 quarterly monitoring events per year for 7 years	1	7 YRS NPV[1]	$115,000	$115,000	
3	Annual reporting to Ecology for 7 years	1	7 YRS NPV	$102,000	$102,000	
	Subtotal				**$217,000**	
Institutional Controls						
4	Adminstrative groundwater and land use restrictions.	1	LS	$10,000	$10,000	
	Subtotal				**$10,000**	
End of Monitoring Well Abandonment						
5	Abandon monitoring wells year 8	21	EA	$500	$8,618	Net Present Value
	Subtotal				**$8,618**	
COMPONENT COST ESTIMATE					**$239,600**	

Notes:

[1]NPV: Net present value @ 2 5%/yr

https://projects.geoengineers.com/sites/0050405802/Draft/FS/[Airport Kwik Stop FS Tables.xlsx]Table 11 NatAten

Table 12

Component Cost Estimate - In-Situ Chemical Oxidation and Off-Site Groundwater Monitoring

Airport Kwik Stop Site

Ione, Washington

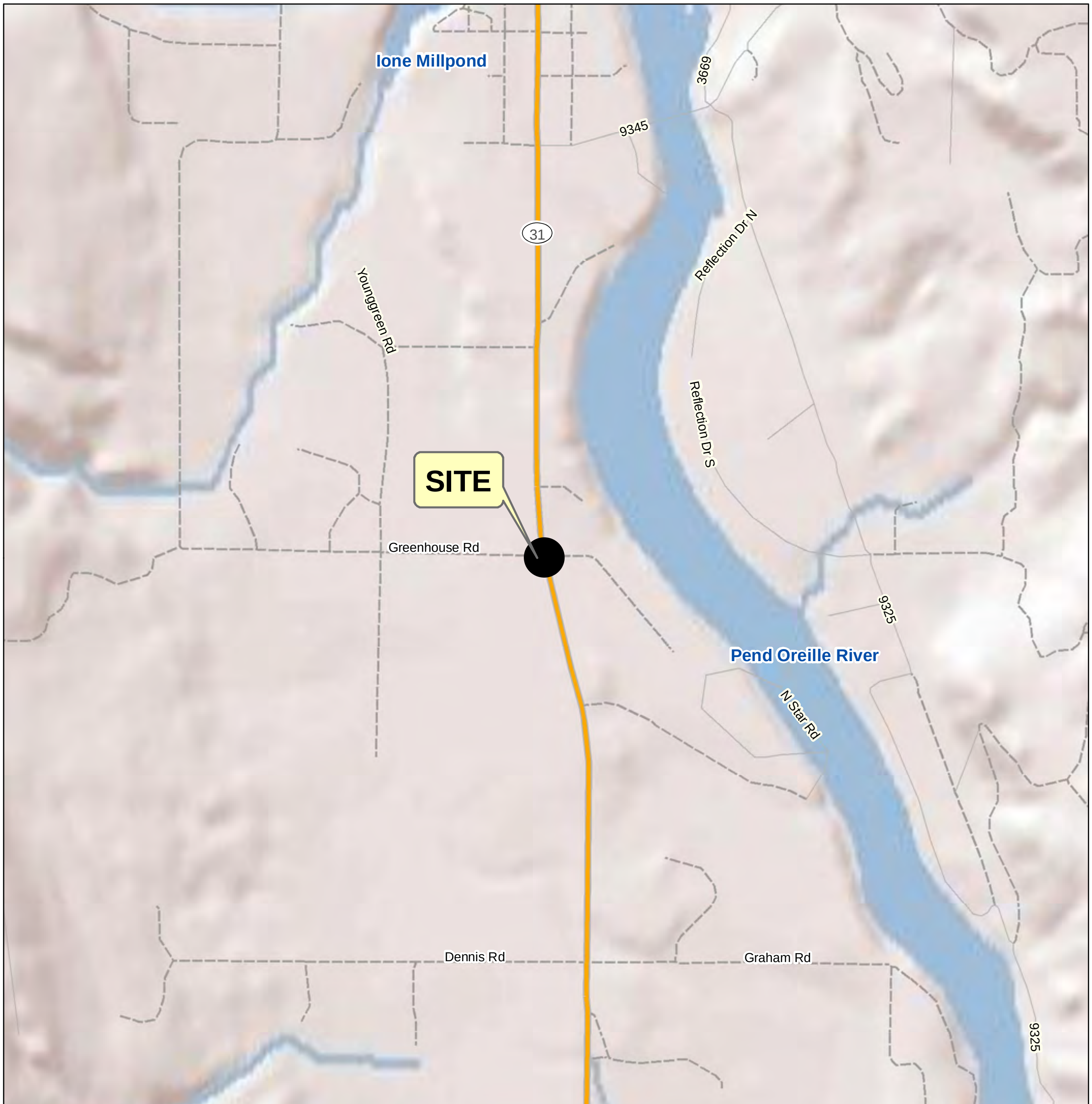
Item No.	Description	Plan Quantity	Unit	Unit Price	Amount (2013$)	Notes
Mobilization and Site Preparation						
1	Mobilization/Site Access/Demobilization	1	LS	$10,000	$10,000	
	Subtotal				**$10,000**	
Construction of Monitoring and Oxidation Chemical Injection System						
2	Installation of additional monitoring wells	2	EA	$2,000	$4,000	
3	Installation of injection wells	2	EA	$3,000	$6,000	
4	Purchase and installation of chemical injection system	1	EA	$10,000	$10,000	Assumes metered injection; pulse injection costs would be similar (four applications at $2500/application)
5	Plumbing and electrical	1	LS	$10,000	$10,000	Local source
6	Disposal of IDW	5	DRUMS	$315	$1,575	Transport and disposal to Graham Road Landfill
	Subtotal				**$31,575**	
O&M of Chemical Injection System						
7	Operation Costs for 2 years	1	2 YRS NPV[1]	$0	$92,000	Includes well and equipment maintenance labor and ODCs, electricity
8	ISCO Chemicals	5,000	GALS	$25	$125,000	
	Subtotal				**$125,000**	
Groundwater Monitoring and Reporting						
9	Perform 4 quarterly monitoring events per year for 4 years	1	4 YRS NPV	$68,000	$68,000	
10	Quarterly reporting to Ecology for 4 years	1	4 YRS NPV	$61,000	$61,000	
	Subtotal				**$129,000**	
Institutional Controls						
11	Adminstrative groundwater and land use restrictions.	1	LS	$10,000	$10,000	
	Subtotal				**$10,000**	
End of Monitoring Well Abandonment						
12	Abandon monitoring wells year 5	21	EA	$500	$9,000	Net Present Value
	Subtotal				**$9,000**	
Engineering Design Report						
13	Design and Permitting	1	LS	$42,658	$42,658	10% of project costs plus additional aquifer testing to optimize design
	Subtotal				**$42,658**	
COMPONENT COST ESTIMATE					**$357,200**	

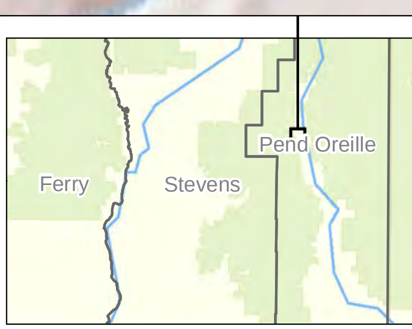
Notes:

[1]NPV: Net present value @ 2 5%/yr

https://projects.geoengineers.com/sites/0050405802/Draft/FS/[Airport Kwik Stop FS Tables.xlsx]Table 12 ISCO

FIGURES





N
W E
S

2,000 0 2,000
Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Sources: ESRI Data & Maps, Street Maps 2008.
Projection: NAD 1983, UTM Zone 11 North.

Vicinity Map

Airport Kwik Stop Site
Ione, Washington

GeoEngineers

Figure 1

Office: SPO Path:W:\Spokane\Projects\0\0504058\GIS\050405802_VM_F1.mxd Map Revised: 4/5/2012 CRC

Legend

Ⓦ Approximate Location of Existing Water Well

Property Boundary

Reference: Bing Maps aerial from ESRI, Online Data Resource Center.
Parcel boundaries digitized from Pend Oreille County GIS,
https://gis.pendoreilleco.org/pocgisweb/map.html

N W E S

250 0 250

Feet

Notes:
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2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Site Plan

Airport Kwik Stop Site
Ione, Washington

GeoEngineers

Figure 2

Map Revised: April 12, 2013

Path: W:\Spokane\Projects\0\0504058\GIS\050405802_SitePlan_PropertyBoundary_FS.mxd

OfficeLocation: SPO

Legend

- MW-1 — Approximate Location of Monitoring Well
- W — Approximate Location of Existing Water Well
- MP-1 — Approximate Location of 2" Monitoring Point
- Approximate Extent of Floating LNAPL Area
- Approximate Extent of Heavily Contaminated Soil Area
- Estimated Approximate Extent of Dissolved Contaminant Area (as of February 2013)

Note: Due to the transient nature of concentrations of dissolved contaminants measured in groundwater samples from area monitoring wells and domestic water wells, the extent of the plume shown on this figure is approximate, and likely varies seasonally, from year to year.

N W E S

200 0 200

Feet

Map Revised: April 12, 2013

Path: P:\0\0504058\GIS\0504058\02_Feasibility_Study_Remediation_Component_Site_Feb2013.mxd

OfficeLocation: SPO

Reference: Bing Maps aerial from ESRI, Online Data Resource Center.
ESRI Data & Maps, Street Maps 2008

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Elevations are referenced in NAVD 88.
4. The equivalent (true) groundwater elevation at MW-5 as showing calculated to account for the presence of the free product using the following equation: GW = SG X T + IE; where GW = equivalent groundwater elevation SG = specific gravity of free product (0.75) for gasoline; T = thickness of product measured in well using oil/water interface probe; IE =elevation of water/product interface measured in the well.
5. NA=Not Analyzed

Exploration Locations and Feasibility Study Remediation Component Site Areas

Airport Kwik Stop Site
Ione, Washington

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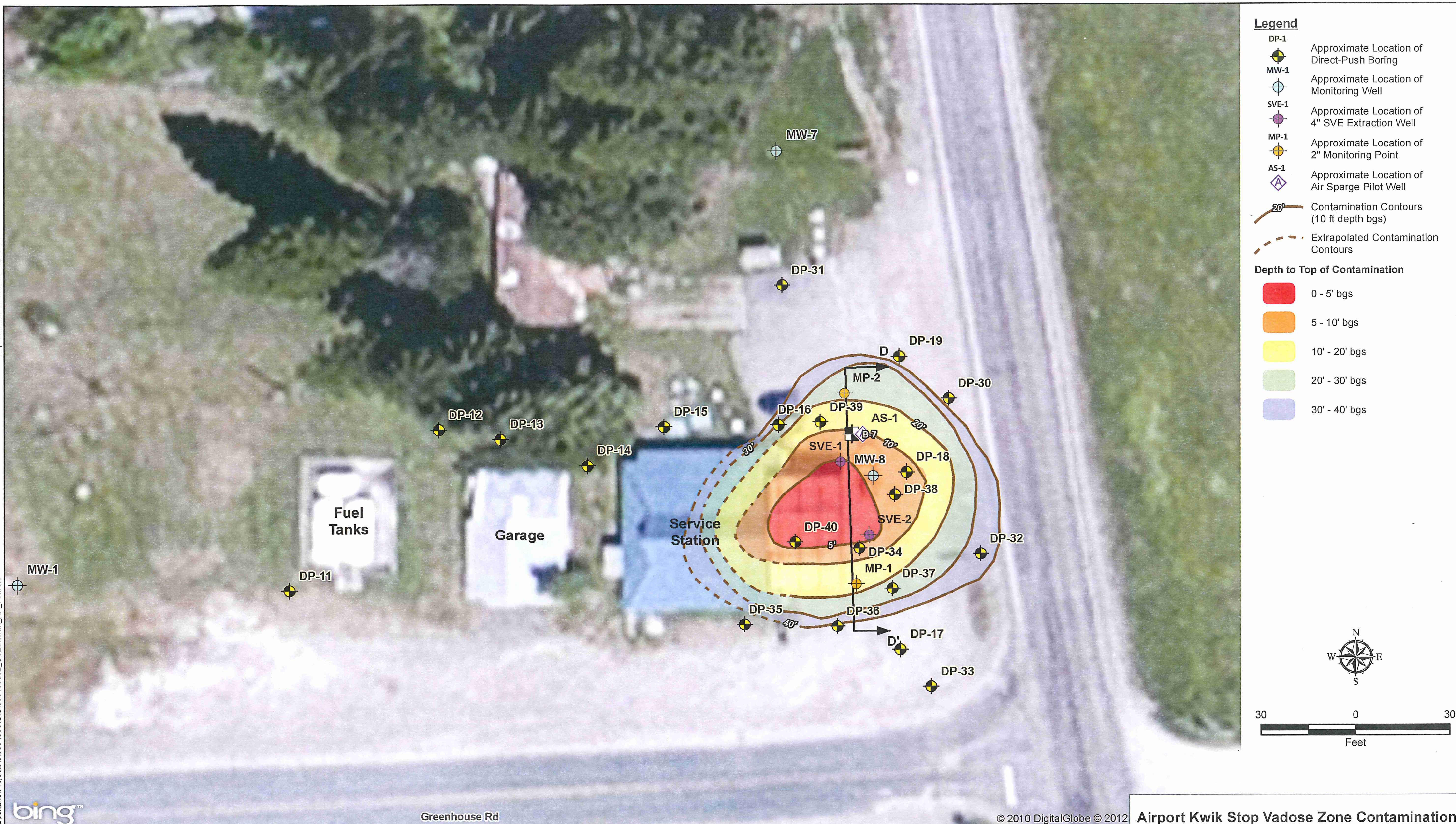
Figure 3



Map Revised: December 20, 2012

Path: W:\Spokane\Projects\0\0504058\GIS\050405802_SVEInterim_AP_F9.mxd

OfficeLocation: SPO

Reference: Bing Maps aerial from ESRI, Online Data Resource Center.
ESRI Data & Maps, Street Maps 2008

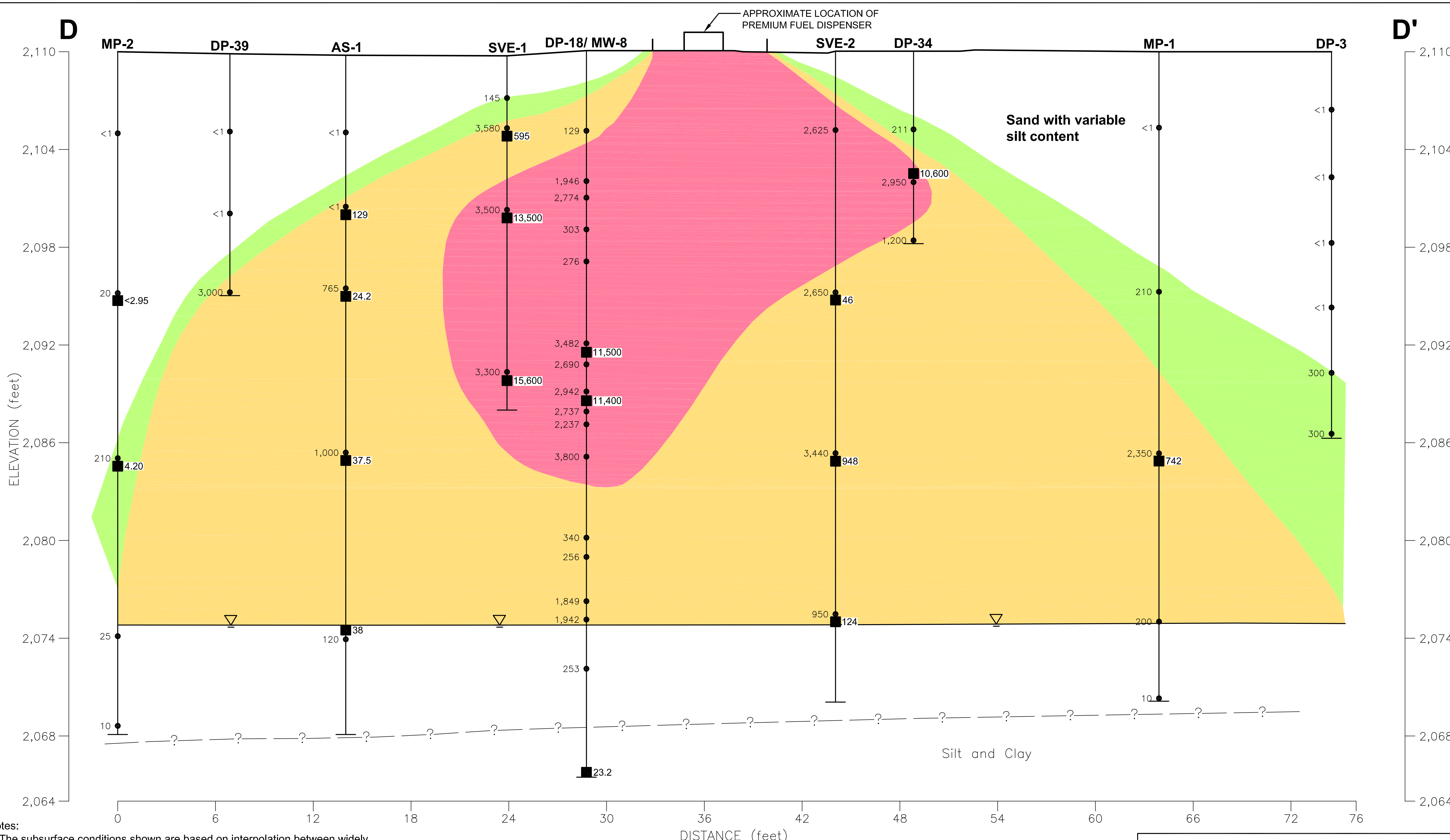
Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Airport Kwik Stop Vadose Zone Contamination

Airport Kwik Stop Site
Ione, Washington

GeoEngineers

Figure 4



Notes:

1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 3 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Legend

- 595 — GRPH concentration (mg/kg) from laboratory analytical testing
- 1,000 — Headspace vapor concentration (ppm) from PID
- Estimated zone of GRPH present at concentrations less than 100 mg/kg
- Estimated zone of GRPH present at concentrations greater than 100 mg/kg
- Estimated zone of GRPH present at concentrations greater than 10,000 mg/kg

6 0 6
Horizontal Scale in Feet

6 0 6
Vertical Scale in Feet
Vertical Exaggeration: 1X

Cross Section D-D'

Airport Kwik Stop Site
Ione, Washington

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Figure 5

SPOK:DRL : SCY

P:\0\0504058\02\CAD\050405802_F4 FS.dwg\TAB:F10 modified on May 30, 2013 - 1:57pm

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