Archibald Street Community Gardens
28 Archibald Street
Burlington, Vermont

SMS Site #2014-4471
KAS Job #509130312

CORRECTIVE ACTION PLAN / ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES

September 26, 2014

Prepared For:

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PROFESSIONAL ENGINEER'S REVIEW

I have reviewed the Corrective Action Plan for the 28 Archibald property located in Burlington, Vermont, State of Vermont Department of Environmental Conservation Site #2014-4471, prepared by KAS, Inc. on September 26, 2014.

EXECUTIVE SUMMARY

This Corrective Action Plan (CAP) addresses human health risk and contaminant migration issues posed by subsurface contamination reported beneath the 28 Archibald Street property ("corrective action area" and "Site") in the City of Burlington, Chittenden County, Vermont. The current plan for the property is to maintain the current use as a community garden. No structures suitable for habitation exist on the property and no new construction of buildings is planned. A new water supply, for irrigation purposes, is planned for the Site.

This CAP contains a summary of the results of environmental testing and risk assessment in and near the corrective action area, and also contains qualitative technical and cost analyses of potentially applicable technologies to address the estimated human health risk posed by the contamination. Based on the qualitative technical and cost analyses, a remedial technology is specified and a design is presented.

The corrective action area was investigated for environmental impacts, from December 2013 to February 2014, as part of the Brownfields Phase II Environmental Site Assessment (ESA). A summary of the environmental studies performed during that time is included in this CAP. Soils on the property contain levels of Polycyclic Aromatic Hydrocarbons (PAHs), arsenic, and lead above regulatory standards. Tetrachloroethylene (PCE), a volatile organic contaminant (VOC), was reported above regulatory standards in soil gas on the property.

Oak Creek, Inc. (OCI) conducted a risk assessment for the continued use of the community garden with contamination levels found during the Phase II ESA. Provided that the high concentration of lead near sample location SB-3 is removed, OCI concluded that there is no risk of harm to health to individuals using the community garden.

An evaluation of the contamination data and OCI's risk assessment resulted in recommendations to physically isolate lead contaminated soils above regulatory standards from direct human exposure and to impose an institutional control to limit the uses and future development of the property. The principal remedial technology examined in the CAP is the limited excavation of soil and installation of soil caps to isolate the contaminated soils. The bases of this recommendation are its ability to isolate contaminated soil from direct human exposure while minimizing contaminated sediment transport and implementation costs.

I. INTRODUCTION

This document is a Corrective Action Plan (CAP) as defined by the Vermont Department of Environmental Conservation (DEC) and an Analysis of Brownfields Cleanup Alternatives (ABCA) as defined by the United States Environmental Protection Agency (EPA), to address human health risk and contaminant migration issues posed by subsurface contamination reported at the 28 Archibald property, in the City of Burlington, Chittenden County, Vermont ("corrective action area"). A Site Location Map is included in Appendix A. This CAP was prepared by KAS, Inc. (KAS) for the Chittenden County Regional Planning Commission (CCRPC), for approval by the DEC. The contents of this CAP have been prepared in accordance with the DEC *Corrective Action Guidance*[1].

This CAP was prepared to address the Brownfields Phase II Environmental Site Assessment (ESA) in March 2014, revised May 2014, and to facilitate the transfer of the property. The City of Burlington (bona fide prospective purchaser and document user) is conducting due diligence to facilitate its acquisition of the property. The property is currently owned by the Visiting Nurse Association of Chittenden and Grand Isle Counties and is used as a community garden. Several raised garden beds are present on the property. The only structure on the property is a small garden shed which houses gardening tools. The current plan for the property is to maintain the current use as a community garden. No structures are proposed for construction on the property. A new water supply line is planned for the property.

This CAP contains a summary of the results of environmental testing and risk assessment at the Site, and also contains a qualitative technical and cost analysis of potentially applicable technologies to address the estimated human health risk posed by the contamination. Based on the qualitative technical and cost analysis, remedial technologies are specified and conceptual designs of the recommended corrective actions are presented.

II. SITE BACKGROUND

A. Description

The property is comprised of a 0.17 acre parcel of land located at 28 Archibald Street in the City of Burlington, Vermont. A Site Location Map and Site Map are included in Appendix A. The property is currently used as a community garden. No structures suitable for habitation exist on the property. One small garden shed is located on the eastern portion of the property.

The property was developed circa 1941 and was used as an automotive sales and service facility and gasoline filling station. The property continued to be used as an automobile sales and service facility until the mid-1990s. In 2004, the City of Burlington Planning & Zoning office issued a demolition permit for the on-site building. In 2008, the community garden was established.

[1] VTDEC

KAS conducted a Phase I ESA in October 2013. The Phase I ESA revealed three Recognized Environmental Conditions (RECs):

1. The historic use of the property as an automotive sales and repair shop with a filling station and floor drains.
2. The underground storage tanks (USTs) that were reportedly removed from the property in 1977 without an environmental assessment report available to document their condition.
3. The presence of nearby State Listed Hazardous Waste Sites with documented concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in excess of regulatory standards.

A geophysical investigation was performed on the property on December 4, 2013 to look for closed in place USTs on the property. All accessible portions of the property were scanned using ground penetrating radar (GPR). No metallic signatures associated with USTs were noted. Some anomalies were noted during the scanning including possible concrete footings, small metallic objects, and utility lines. Soil conditions at the Site were conductive for GPR and a clear image was obtained down to approximately 10 feet below grade. Access to portions of the property was impeded by the raised garden beds. However, some evidence of USTs would likely have been identified given their size.

KAS completed a Brownfields Phase II ESA that was documented in a report dated March 10, 2104 and revised May 7, 2014. The Phase II ESA provided the following conclusions:

1. Soils on the Site contained levels of PAHs, arsenic, and lead in excess of the residential Soil Screening Values (SSV); and
2. VOCs were detected in each of the soil gas samples. None of the concentrations exceeded the Vermont Investigation and Remediation of Contaminated Properties Procedure (IROCP) shallow soil gas standards except for tetrachloroethylene (PCE) concentrations in SG-2 and SG-3. No sources of PCE are known to exist on the property.

KAS updated the Phase I ESA in September 2014. Based on the findings which included a review of the Phase II ESA data, the following RECs were determined:

1. The historic use of the property as an automotive sales and repair shop with floor drains, and a gasoline filling station which has resulted in subsurface contamination.
2. The presence of nearby State Listed Hazardous Waste Sites with documented concentrations of PCE and PAHs in excess of regulatory standards.

Based on the Phase II site investigation, it appears that arsenic and PAH contamination is present throughout the property. PAH and lead contamination appear to be limited to the shallow soils. The PAH concentrations are indicative of urban fill and may be attributed in part due to historic Site use as an automotive repair and gasoline filling station and/or atmospheric outfall from non-point sources. Arsenic concentrations are within the normal background range for soils in Vermont and not believed to be indicative of anthropogenic contamination. Concentrations of lead above SSV was limited to sample location SB-3, which may be from past surface spills that occurred when the Site operated as a gasoline filling station. Since there are no building structures on the property, PCE vapors is not considered a potential concern for Site users. However, further investigation of PCE vapors in neighboring residences may be warranted.

Additional investigation of PCE beyond the property boundaries is not addressed in this CAP.

Given the Phase II ESA findings, Oak Creek Inc. (OCI) was retained by the City of Burlington to provide an evaluation of risk associated with the continued use of the community garden. Individual users of the Site were considered to be gardeners, visitors, families including children, maintenance workers, and construction/utility workers. The risk evaluation focused on PAHs and priority pollutant metals at levels detected during the Phase II ESA but assumed that the shallow soils (2-3 feet in depth) did not contain lead in excess of 250 mg/kg (e.g., soils within the vicinity of SB-3 at 880 mg/kg have been removed from the property). Human consumption of plants that have accumulated residual contamination was not included in the risk evaluation because it was assumed that all plants would be contained in appropriately constructed raised garden beds made with appropriately treated wood or other inert material, filled with clean soils, and include a barrier to prevent plant roots from entering the shallow soils beneath the raised beds. Furthermore, OCI noted in the Letter of Understanding dated April 11, 2014 that while some contaminants (e.g., PAH compounds) can accumulate in produce grown in contaminated soils, VOCs are not known to accumulate in produce and therefore are unlikely to pose a risk of harm to human health through that exposure pathway. Therefore, exposure pathways through which individuals using the Site are potentially exposed to residual contamination in soils were assumed to be limited to accidental or incidental ingestion of soil and dermal contact with soil. OCI's risk evaluation concluded that there is no risk of harm to health to individuals using the Site as a community garden, provided that soils with high lead concentrations near SB-3 is excavated (Appendix B).

B. Environmental Setting

The property is located at 28 Archibald Street in Burlington, Vermont. It is approximately 0.17 acres in area and is currently used as a community garden and populated with a number of raised garden beds. The property is located within a densely developed area of north Burlington with single family dwellings, multi-unit housing, and light commercial enterprises located in the immediate vicinity.

The topography on the property is flat. The groundwater flow direction beneath the property is most likely toward the west based on the surface topography, the location of surface waters, and other environmental assessments conducted near the property. The depth to groundwater and predicted flow direction were not confirmed during the Phase II ESA. Previous investigations performed on a nearby Brownfields Site (102 Archibald Street) revealed groundwater in the vicinity of the Site at approximately 75 to 150 feet below grade.[2]

Water and sewer lines that served the former building are presumed to be on the property. However, KAS did not find any documents outlining the location of the utility connections. During the GPR investigation a sewer line was identified to run perpendicular to Walnut Street which may have been connected to the former building. Several subsurface utility corridors, including municipal water, sewer and stormwater lines, and natural gas lines run along Archibald and Walnut Street.

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[2] Phase II Environmental Site Assessment Report. Griffin International, Inc. October 2002.

Bedrock beneath the property was not encountered in any of the soil borings on record for this property. Bedrock in the vicinity of the property consists of the Lower Cambrian Dunham Dolostone of the Vermont Valley Sequence and Middlebury Synclinorium according to the Vermont Natural Resource Atlas.[3] The depth to bedrock beneath the property is not known. The overburden deposits in the area of the property are mapped as Champlain Sea deposited pebbly marine sand according to the Vermont Natural Resource Atlas.

C. Statement of the Problem

Historic use of the corrective action area and the possible use of urban fill on the property have resulted in subsurface contamination. Investigations conducted as part of the Brownfields Phase II ESA have defined the nature and extent of the contamination.

Generally, soils within the corrective action area are contaminated with levels of PAHs, arsenic, and lead in excess of the residential SSVs. VOCs were detected in soil gas but none exceeded the Vermont IROCP shallow soil gas standards except for PCE. No sources of PCE are currently known to exist on the property. The PCE may be from the historic use of the property as an auto sales and repair shop or potentially from other State Listed Hazardous Waste Sites with documented PCE contamination, which are located within the area vicinity. Since there is no structure suitable for habitation on the property, and no new buildings are planned as part of the future use of the property, vapors emanating from the ground surface would quickly diffuse and disperse into the ambient air.

D. Compilation of Contaminant Data

KAS compiled and plotted soil and groundwater contaminant concentration data for the corrective action area to gauge the extent of the contaminated area in need of remediation. Copies of the Contamination Maps are included in Appendix D. A tabular presentation of the contaminant data is included in Appendix E.

E. Sensitive Receptor Risk Assessment

A sensitive receptor risk assessment of the area surrounding the Site was conducted during the 2013/2014 Brownfields Phase II investigation. Based on the observations determined in the Phase II investigation, a determination of the potential risk to identified receptors was made based on proximity to contaminant plumes and contaminant concentration levels.

Buildings in the Vicinity

No VOCs above regulatory standards were detected in the soil samples on the property. However, concentrations of PCE in soil gas samples exceeded regulatory screening levels. Although the subject property does not contain any structures other than a small garden shed, adjoining properties contain buildings with basements. Given the levels of PCE detected in the soil gas, there is the potential for buildings on adjoining properties to be impacted with PCE vapors. Although no clear source of PCE on the property was found, PCE may be from the historic use of the property as an auto repair shop or potentially

[3] State of Vermont Department of Natural Resources Natural Resource Atlas.

from other State Listed Hazardous Waste Sites with documented PCE contamination, which are located within the area vicinity.

Utility Corridors

Several subsurface utility corridors, including municipal water, sewer, stormwater, and natural gas lines exist in the vicinity of the Site. The utility lines run along Archibald and Walnut Street. Given the concentrations of PCE found in the soil gas samples, the utilities may be at risk from soil vapor contamination. Additionally, soils in the utility trenches may contain elevated concentrations of PAHs and metals and should be handled as such.

The property was once served by municipal water and sewer during its past use as an automotive sales and service facility and gasoline filling station. KAS did not find any documents outlining the location of the utility connections. However, during the GPR investigation a sewer line was identified to run perpendicular to Walnut Street that may have been connected to the former building.

Installation of a new water service is planned for the Site. Since excavation would be required in order to connect with the existing municipal water line, precautionary measures should be taken during intrusive site work, as outlined in Section IV.

Wetlands and Surface Water Bodies

No potential jurisdictional wetlands were observed in the immediate vicinity (Site and abutters) of the Site. The nearest surface water body is the Winooski river, located approximately 2,000 feet to the east. Lake Champlain is located approximately 1 mile to the west. The surface water bodies are not believed to be impacted from contamination from the Site due to the immobile nature of the contaminants and the distance from the water bodies.

Public Water Supplies

The Site and surrounding area is served by a municipal water system. The closest known water supply well is located approximately 900 feet to the west of the property according to the DEC’s on line water supply well locator. The supply well is not believed to be impacted from contamination from the Site due to the immobile nature of the contaminants and the distance from the water bodies.

F. Risk Factor Definition and Analysis

This section of the CAP defines risk factors present as a result of the environmental findings presented above, and presents analysis of the risk factors based on the proposed uses of the Site.

Planned Development

No change in the use of the property as a community garden is expected in the foreseeable future and no new buildings are planned as part of the property development. A new municipal water supply line for the community garden is planned.

Categories of Risk

Individuals and families, including young children, who visit or work on the raised garden beds, may be exposed to contamination in the shallow soils. Similarly, maintenance workers maintaining the community garden property are at risk for exposure. Construction/utility workers, whose activities include excavation to maintain, install or repair utilities in support of the gardens, may also be at risk for exposure.

Routes of Potential Exposure

Human exposure to contaminants can theoretically occur via the following pathways: inhalation of vapors or contaminated dust; ingestion of soil and/or liquids; absorption via dermal contact; and, injection of contaminants. However, the nature and occurrence of contamination at this Site discounts most of these potential exposure pathways as explained below. The residual potential exposure pathways to be addressed at this Site are: inhalation of dust and vapors; dermal contact with contaminated soil; and ingestion of contaminated soil. These residual exposure pathways will be effectively addressed with appropriate construction management techniques, engineering and institutional controls as is described in Section IV.

Inhalation Pathway

Inhalation of vapors and/or dust constitutes the inhalation pathway. Inhalation of dust containing VOCs, PAHs, TPH, arsenic and/or lead is a potential route of exposure and will be addressed via construction practices outlined in Section IV. Implementation of the engineering and institutional controls outlined in Section IV will prevent inhalation of the contaminants after the construction is complete.

Ingestion Pathway

Ingestion of PAH, TPH, arsenic and/or lead contaminated soil is a potential route of exposure. During excavation, intrusive activities will be conducted under the jurisdiction of a Health and Safety Plan (HASP) as defined by 40 CFR Part 1910.120 for hazardous sites. The HASP will contain detailed instructions on worker conduct within the contaminated area including ingestion issues. All intrusive work within the contaminated area will take place under the supervision of the Site Safety Officer (SSO) who will be responsible for training workers about HASP requirements and for enforcing those requirements. The engineering and institutional controls described in Section IV will address ingestion issues following construction.

Absorption Pathway

Absorption of PAH, TPH, arsenic and/or lead through direct contact with skin is a potential route of exposure. In order to minimize human health risk during construction, the HASP will contain provisions relating to personal protective equipment (PPE) designed to minimize dermal contact, likely in the form of protective clothing to cover exposed skin. Potential risk to human health posed by long-term uses following construction will be addressed by the measures outlined in Section IV.

Injection Pathway

Injection of PAHs, TPH, arsenic and/or lead into the body due to contamination at this Site during construction is not likely as long as the HASP provisions are followed. Measures to minimize dermal contact will also be effective at minimization of injection potential. Potential risk to human health posed by long-term uses following construction will be addressed by the measures outlined in Section IV.

G. Impacted Third Parties

There are no known current impacted third parties at this time. Interested third parties for this Site include the City of Burlington, the State of Vermont, and United States Environmental Protection Agency.

III. REMEDIAL TECHNOLOGY OPTIONS

Subsurface shallow soil is the main media to be remediated at the Site. The proposed remedy for detected contamination on the Site must primarily isolate contaminated soils from direct human exposure. A second objective of the corrective action is to isolate residual contaminated soils from possible physical transport and dispersion. The following is a description of the remedial technologies examined during the preparation of this CAP.

Soil Option A: Limited Excavation and Disposal of Contaminated Soil and Deeded Restriction

This option focuses on elevated lead contamination in excess of regulatory standards, and specifies that soils around SB-3 (approximate 10 square foot area) be excavated and properly disposed of off-site. Assuming a depth of three feet, a total estimated soil volume would be 11 cubic yards. This option is based on the OCI risk assessment in which OCI concluded that there is no risk of harm to health for users of the community garden who may be exposed to the level of contamination found in the Phase II ESA investigation, provided that the high lead contaminated soils near SB-3 are removed from the Site and that consumable plantings are within appropriately constructed raised garden beds.

Prior to excavation and disposal of the soils, it will be necessary to collect one waste characterization sample. Given the contaminants that have been detected in the soil and the characterization as "urban fill" the waste characterization sample must be tested for a wide range of analytes including: VOCs., SVOCs, TPH, PCBs, metals, pH, ignitability, reactivity, pesticides, and herbicides. The waste characterization sample will consist of a composite sample collected several weeks prior to excavation activities from within the 10 square foot excavation area.

Following excavation activities one confirmation sample will be collected from the bottom of the excavation to confirm that impacted soils have been removed. The confirmation sample will be tested for PAHs and metals only. Following sample collection the excavation will be filled with clean backfill, graded out to approximately original grade, and compacted. Compaction will consist of mechanically compressing with the excavation equipment. Other site restoration includes installation of clean fill, topsoil, seed and mulch.

A deed restriction would be crafted and filed with the City of Burlington and the DEC notifying researchers of the existence of residual contaminated soil on the property and of the need to get permission before excavation and other subsurface uses. The deed restriction should prohibit development and limit future Site use to that of a community garden. Furthermore, the deed restrictions should restrict the growing of produce for human consumption to appropriately constructed raised garden beds made with appropriately treated wood or other inert material, filled with clean soils, and include a barrier to prevent plant roots from entering the shallow soils beneath the raised beds.

Cost Estimate: Information derived from investigations conducted on-site along with current prices for excavation equipment and necessary construction supervision and coordination were used to estimate the total cost range for a soil excavation effort. The cost for this option is approximately $13,653 (Appendix C).

Advantages: The advantage of limited excavation is the cost. With the elevated lead contaminated soils removed, according to the OCI Risk Evaluation Report, there is no risk of harm and health to individuals and families visiting the community garden, to maintenance workers employed full time to care for the community garden or construction/utility workers performing routine maintenance and/or emergency repair work on utility lines beneath or adjacent to the community garden property.

Disadvantages: This option relies on deeded restriction prohibiting the development of the property, appropriately constructing raised garden beds, and prohibiting the growth, and harvesting of produce in areas of the Site outside the raised garden beds.

Soil Option B: Site-wide Excavation and Disposal of Contaminated Soil

This option address site-wide lead and PAH contamination and specifies that shallow soils across the entire property be excavated, transported and disposed of at a licensed treatment and disposal facility. The principal steps in performing this option would include: excavation and loading of contaminated soils (including confirmatory soil sampling and analysis for disposal facility characterization); transportation and disposal of contaminated soil; surveying of the extent of the excavation to create a permanent record of the work; and installation of clean fill, topsoil, seed and mulch.

A conservative interpretation of the currently available soil data indicates that the estimated volume of soil to be excavated and removed from the Site is 634 cubic yards. At an estimated soil density of 1.5 tons per cubic yard, the estimated range of disposal tonnage is 951 tons.

Similar to Option A, it will be necessary to collect a waste characterization sample prior to excavation and disposal of the soils. Given the contaminants that have been detected in the soil and the characterization as "urban fill" the waste characterization sample must be tested for a wide range of analytes including: VOCs., SVOCs, TPH, PCBs, metals, pH, ignitability, reactivity, pesticides, and herbicides. The waste characterization sample will consist of a composite sample collected several weeks prior to excavation activities from within the approximate 10 square foot excavation area.

Following excavation activities two confirmation samples will be collected from the bottom of the excavation to confirm that impacted soils have been removed. The confirmation samples will be tested for PAHs and metals only. Following sample collection the excavation will be filled with clean backfill, graded out to approximately original grade, and compacted. Compaction will consist of mechanically compressing with the excavation equipment. Other site restoration includes installation of clean fill, topsoil, seed and mulch.

Cost Estimate: Information derived from investigations conducted on Site along with current prices for excavation equipment and necessary construction supervision and coordination were used to estimate the total cost range for a soil excavation effort. The cost for this option is approximately $107,749 (Appendix C).

Advantages: The advantages of excavating all soils with contaminant concentrations in excess of the applicable guidelines is that these soils are permanently removed from the Site, no longer pose a risk to Site users, and would not require further on-site management.

Disadvantages: The largest disadvantage for this option is the cost.

Soil Option C: Installation of a Site-wide Protective Soil Cap

This option specifies that a protective soil barrier will be placed over contaminated soils. The principal steps in performing this option would include: excavation and removal of one foot of soil, grading of contaminated soils to accommodate the soil cap; placement of a warning membrane (geotextile) over contaminated soils; installation of a soil/gravel barrier over the geotextile; and implementation of an institutional control (deed restriction filed in the City of Burlington land records).

No excess soil would be excavated, removed, or disposed of under this option. Geotextile will be installed over the regraded contaminated soil and one foot of clean soil will be placed over the filter fabric.

A deed restriction would be crafted and filed with the City of Burlington and the DEC notifying researchers of the existence of residual contaminated soil on the property and of the need to get permission before excavation and other subsurface uses. However, since this soil would be isolated from public exposure no signage would be necessary and the above grade use of the property would be essentially unrestricted.

Cost Estimate: Information derived from investigations conducted on Site along with current prices for excavation equipment and necessary construction supervision and coordination were used to estimate the total cost range for a soil/gravel barrier. This information is contained in Appendix B, and it indicates that the budgetary cost for this option is approximately $60,039.

Advantages: The advantage of Option C is that contaminated soils will be isolated from casual and direct human contact with a clean soil barrier. Human health concerns will be addressed by this option.

Disadvantages: The disadvantages of Option C are that it would not result in removal of all contaminated soils from beneath the corrective action area and future notification and management efforts would continue to be needed to minimize human exposure during construction and erosion scenarios. Short term human exposure to contaminated soil to site workers would be necessary during excavation and testing.

IV. PROPOSED REMEDIAL DESIGN

KAS recommends that Option A be incorporated into the plan for the Site as discussed in Section III. This option would protect human health and the environment and meet the objectives for corrective action at this Site. The cost for Option B and C presented in Section III is prohibitive to the use of the Site. The total cost for Option A is estimated at $13,653, the details of which are provided in Appendix C.

The potential exposure pathways to be addressed at this Site are: inhalation of dust; dermal contact with contaminated soil; and, ingestion of contaminated soil. During intrusive site work in the contaminated portion of the Site resulting in exposed soils will take place under the authority of the HASP in accordance with OSHA requirements 29 CFR 1910 as implemented and enforced by the SSO. These measures are the accepted mechanism for compliance with federal regulations regarding worker safety and health, and will effectively address concerns related to ingestion, absorption and injection of contamination during construction. Additionally, dust control, engineering and institutional controls will be implemented to reduce risk to minimal levels.

A. Contaminated Soil Transportation and Disposal

A qualified environmental consultant will oversee the excavation of the contaminated soil within the corrective action area. The qualified environmental consultant will provide guidance on the proper handling and placement of the contaminated soils if they are encountered. Contaminated soils will be excavated and transported off-site in accordance with this CAP. Soils will be transported by a licensed Vermont Solid Waste Hauler and treated or disposed of at an appropriate disposal facility. No contaminated soils will be stockpiled on-site.

B. Dust Control

Generation of dust from the contaminated area will be addressed as follows to minimize the inhalation pathway during construction. All excavated surfaces will be wetted as needed to minimize dust. Calcium chloride may also be used to control dust on exposed excavation surfaces. No contaminated soil will be stockpiled on Site long-term. The soils will be wetted before being direct loaded onto the transport vehicles and covered. Visible emissions of dust from the Site or from transport vehicles will not be permitted.

Personal air monitoring should be conducted for individuals expected to be subject to the maximum exposure during excavation activities. If during the air monitoring, OSHA/NIOSH levels are exceeded the work should be stopped immediately and additional measures should be implemented to suppress the dust.

C. Soil Excavation/Removal Plan

Due to the limited size of the excavation, a soil erosion control plan is not deemed necessary.

D. Isolation Barrier Construction

No construction of structures or buildings is anticipated; therefore, isolation barrier construction is not required.

E. Institutional Control

Upon implementation of the corrective action outlined in this document, a deed restriction will be filed with the City of Burlington land records to notify interested parties of the resulting restrictions on Site activity. The deed restriction will include a summary of the contamination at the Site, mitigation efforts taken, and future Site use restrictions. Appropriate signage will be installed indicating that no unauthorized excavation is to occur in this area.

F. Construction Details and Sequence

KAS has outlined the excavation area based on the soil boring results. The excavation area is shown in the Site Map in Appendix A.

The construction events include surveying and staking out the areas of excavating, excavating contaminated soils and site restoration. Clean soil will be backfilled to a minimum thickness of 3 feet and to approximate finish grade. Seed, mulch and fertilizer will be applied as soon as topsoil installation is complete.

G. Future Management Issues

The recommended remedial measures will not eliminate all contamination from the corrective action area. Thus, future consideration will need to be paid to management of contaminated soils. These will include limitations on excavation in the contaminated area, and a Deed Restriction in the City land records informing searchers of the existence of contamination within the corrective action area. Persons working beneath the ground surface should be made aware of the contamination and necessary precautions including HASP compliance.

Installation of a new water supply at the property will require subsurface work. Therefore, the handling of contaminated soils, as well as measures to reduce exposure risks, as detailed in this section should be followed.

V. PERMITTING, MONITORING AND REPORTING

A. Health and Safety Plan (HASP)

A HASP will be required for the soil excavation and disposal activities. A 40-hour OSHA 1910.120 trained personnel must be appointed as the Site Safety Officer with a backup also designated. A copy of the HASP will be kept on-Site and will be available to other parties upon request.

B. Permits / Approvals

The following permits are likely needed to accomplish the work as described above. These are identified below.

- Dig Safe
- DEC Approval

C. Contractors and Sub-Contractors

Depending upon contractor availability, the following is a partial list of potential contractors:

Excavation and Site Restoration		
Engineers Construction Inc	Contact: Ken Pidgeon Williston, VT 05495	(802) 863-6389
Hendee Excavating	Contact: Pat Hendee Starksboro, VT 05487	(802) 453-2329
Environmental Product and Services	Contact: Kate Keogh Williston, VT 05495	(802) 862-1212
ENPRO Services of Vermont, Inc	Contact: Scott Buckley Williston, VT 05495	(802) 860-1200
Waste Disposal Facilities		
ESMI	Contact: Mike Phelps Louden, NH 03307	(800) 950-7645
New England Waste Services of Vermont	Airport Road Coventry, VT 05825	(802) 334-5795
Laboratories		
Eastern Analytical, Inc	Contact: Kathleen Noonan Concord, NH 03301	(603) 228-0525
Endyne, Inc	Contact: Mark Fausel Williston, VT 05495	(802) 879-4333
EMSL, Inc	Contact: Ellen Podell Cinnaminson, New Jersey	(800) 220-3675

D. System and Site Monitoring

Persons working beneath the ground surface should be made aware of the contamination and necessary precautions including HASP compliance.

E. Reporting

Following the completion of soil excavation and disposal, a summary report should be completed to document that proper procedures were followed. The summary report should provide a description of all activities completed and contain testing data and confirmation sampling results as applicable to the task.

F. Schedule

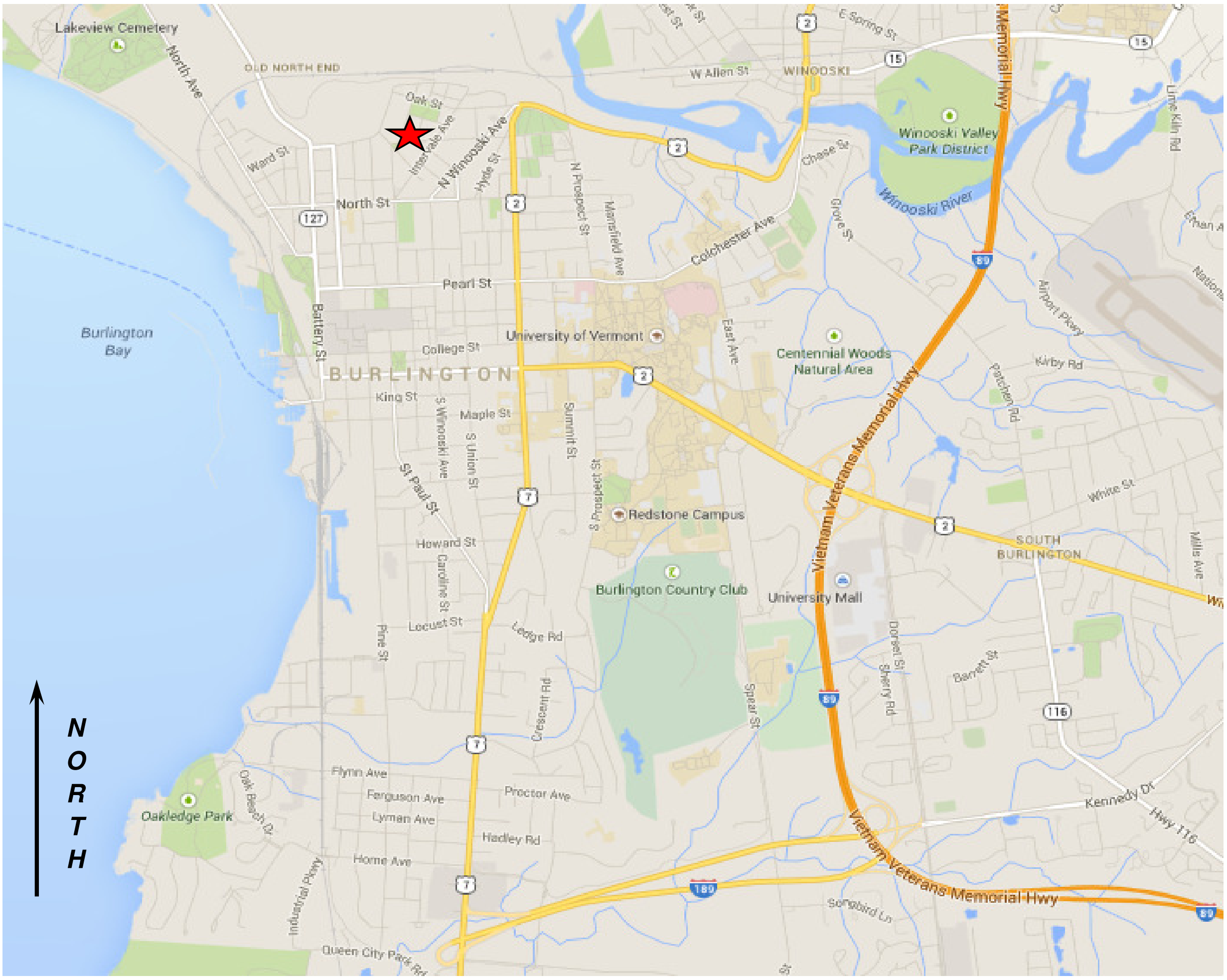
Work may begin on this project following DEC approval, the required public comment period, and acquisition of all required excavation approvals. Waste characterization samples need to be collected at least three weeks prior to the time planned for excavation in order to receive results and authorization from the landfill prior to transport. The excavation, transport, disposal, and confirmation sampling can occur all in one day.

Time to complete the above tasks assumes fair weather and good access; frozen ground or unfavorable weather conditions could lengthen the time periods.

Appendix A

PLANS

1) Site Location Map
2) Site Map



★ **SUBJECT PROPERTY**

KAS Job Number *509130312*

Source: http://www.googlemaps.com/

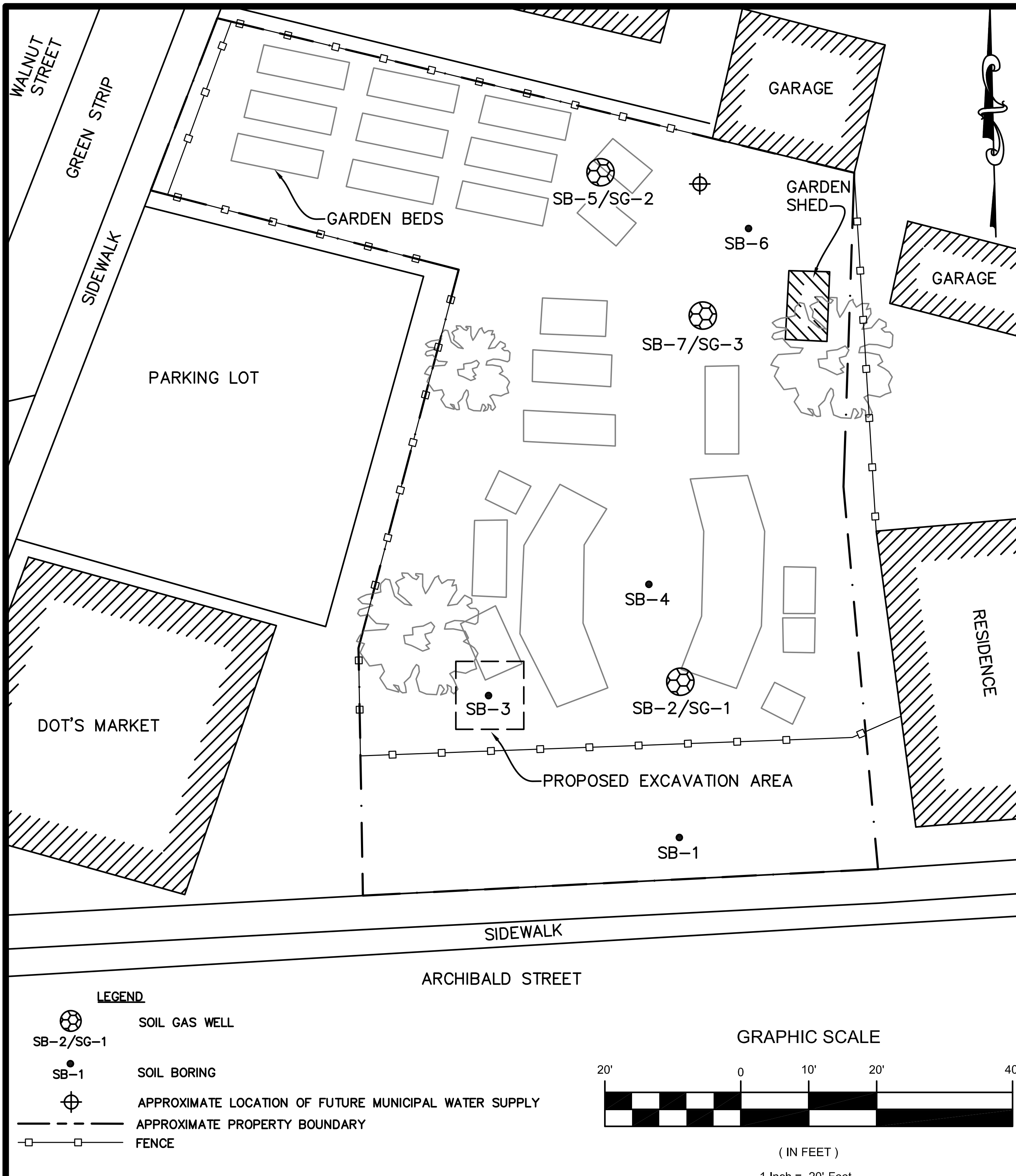
kas

28 Archibald Street

Burlington, Vermont

Site Location map

Date: 09/22/14	Drawing No. 0	Scale: NTS	By: CS



NOTE: BASE MAP DEVELOPED FROM KAS, INC. FIELD MEASUREMENTS ON 1/30/14 AND FROM GOOGLE MAPS SATELLITE IMAGERY.

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28 ARCHIBALD STREET BURLINGTON, VERMONT

SITE MAP WITH PROPOSED EXCAVATION AREA

DATE: 9/26/14	DWG #: 1	SCALE: 1"=20'	DRN.: TB	APP.: CS

Appendix B

OCI RISK EVALUATION

OAK CREEK
Toxicology &
Risk Assessment Consulting

August 27, 2014

Dan Cahill, CPRP
Land Steward
Burlington Parks, Recreation & Waterfront
City of Burlington
645 Pine Street
Burlington, VT 05401

Via Electronic Mail

Re: Risk Evaluation
Community Gardens
28 Archibald Street
Burlington, Vermont.

Dear Mr. Cahill:

OAK CREEK Inc. (OCI) was retained by the City of Burlington to provide a focused evaluation of risk associated with the continued use of the community garden located at 28 Archibald Street in Burlington, Vermont. This risk evaluation assumes a deeded restriction will be implemented to prohibit development of the Site for any other use and which will stipulate acceptable and unacceptable Site uses and activities. The purpose of this risk evaluation is to provide the City of Burlington and the Chittenden County Regional Planning Commission (CCRPC) with information concerning the relative risk to the health of people using the community garden.

Please review the attached risk characterization report and call me with any concern or question you have concerning the report.

Sincerely,

James S. Smith, Jr. (electronic signature)

James S. Smith, Jr., Ph.D.
President & Toxicologist
Principal Scientist

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TECHINCAL APPROACH

OCI conducted an evaluation of the human health risk associated with use of the community gardens located at 28 Archibald Street in Burlington, Vermont. This risk evaluation relies on information developed by KAS Environmental Science and Engineering (KAS) and reported within their Brownfields Phase II Environmental Site Assessment Report (dated March 10, 2014) (KAS 2014). This risk evaluation assumes implementation of a deeded restriction, or other deeded conveyance, limiting future Site use to that of a community garden and prohibiting development or use of any area of the Site as a children's play area, day care, school, or other similar use. Furthermore, the implemented deeded restriction shall restrict the growing of produce for human consumption to appropriately constructed raised garden beds. An appropriately constructed and raised garden bed is one constructed from appropriately treated wood or inert structural materials, filled with clean soils, with a barrier to prevent plant roots from entering shallow soils beneath the garden. Finally, OCI assumed that soils associated with SB-3 (2 to 3 feet in depth), which were shown to contain lead at a concentration of 880 mg/kg, have been removed from the Site for off-site treatment and/or disposal and that no other Site soils contain lead concentrations exceeding 250 mg/kg.

Purpose

The purpose of this risk evaluation is to determine whether persons using the community gardens at the subject Site have an increased risk of harm to their health resulting from residual contaminates existing in Site soils. The result of this work may direct or determine what response actions or additional deeded restrictions, if any, may be necessary for mitigating health risks at the Site.

The State of Vermont's, Agency of Natural Resources, *Investigation And Remediation Of Contaminated Properties Procedure* or IROCP (VT DEC 2012), stipulates that risk evaluations follow standard US EPA risk assessment methodology and that human health risk assessments must be approved by the Vermont Department of Health (VDH). KAS obtained VDH approval for this Site specific risk evaluation of the community gardens located at 28 Archibald Street in Burlington, Vermont.

HUMAN HEALTH RISK CHARACTERIZATION

The characterization of human health risk integrates five separate components: hazard identification, dose response assessment, exposure assessment, risk characterization, and uncertainty analysis. In addition, several preliminary steps are required in a focused characterization of human health risk. The most important of these is the development of an appropriate Conceptual Site Model or CSM. The CSM and other preliminary steps necessary for a focused risk evaluation of the subject Site are described below.

Conceptual Site Model

The SMS requires a Conceptual Site Model or CSM be developed as an initial part of preparing a Site Investigation (SI) work plan (VT DEC 2013). The CSM is an important tool for defining the potential for receptor exposure (U.S. EPA 1989). Specifically, the CSM identifies all potential or suspected sources of release, types and concentrations of contaminants detected in media, all potentially impacted media, potential exposure pathways, and potentially exposed receptors. The CSM for the community gardens (i.e., the subject Site) is based on the description of the Site provided by KAS (KAS 2014) and relies on implementation of a deeded restriction prohibiting a change in its current use as a community garden and specifying the nature of the raised garden beds that are to be used by people gardening at the Site. Furthermore, the CSM assumes that soils associated with SB-3 (2 to 3 feet in depth), which were shown to contain lead at a concentration of 880 mg/kg, have been removed from the Site for off-site treatment and/or disposal.

Land Use: According to KAS (KAS 2014), the subject property is located at 28 Archibald Street in Burlington, Vermont (Site). It is approximately 0.17 acreas in area and currently used as a community garden, which is populated by a number of raised garden beds. The Site is located within a densely developed area of north Burlington with single family dwellings, multi-unit housing, and light commercial enterprises located in the immediate vicinity. No structures suitable for human habitation exist on the property. A small garden shed is located on the eastern portion of the property.

From 1941 to the mid 1990s, the Site was used as an automobile sales and service facility and gasoline filling station. Underground Storage Tanks (USTs) assocaited with this former use were reported to have been removed from the site in 1977, but no environmental assessment report documeting their condition is available (KAS 2014). The Site has since been converted into a community garden for use by the public. Its use as a community garden is not expected or planned to change in the future.

According to KAS, the topography of the site is flat with a slight slope to the west with groundwater flow assumed to follow site topography to the west (KAS 2014). KAS did not confirm the direction of groundwater flow nor its depth, but report groundwater depth is greater than 70 feet below the ground surface (ft bgs) at nearby properties.

KAS assessment of environmental conditions at the Site included advancement of 7 soil borings (i.e., SB-1 through 7) to a depth of 20 ft bgs in January of 2014. Soil boring SB-3 was only advanced to a depth of 15 ft bgs due to bore-hole cave-in. Groundwater was not encountered during drilling. Soil borings SB-2, 5, and 7 were completed as soil gas wells. During the advancement soil borings, soil samples were collected and screened for the presence of volatile organic contaminates (VOCs) using a photoionization detector (PID). No soils were found to have PID readings above background and none were observed to have odors or staining. Within each of the borings, soil samples were collected from 0 to 2 ft bgs, except for SB-3. At SB-3 soils were collected from 2 to 3 ft bgs because of frost. Additional soil samples were collected from SB-3 and 7 at a depth of 8 to 10 ft bgs, with a duplicate soil sample collected from SB-3 at a depth of 8 to 10 ft bgs.

Analytical analysis of soil samples did not detect any VOCs by EPA Method 8260B or polychlorinated biphenyls (PCBs) by EPA Method 8082. Other than arsenic, which was detected in soils at concentrations exceeding applicable VT DEC Soil Screening Values (SSVs), no metals were detected in Site soils in excess of their applicable SSVs. KAS noted that the concentration of arsenic in Site soils is within the normal background range for Vermont soils (KAS 2014).

Regional Physical Setting: KAS reports that the subject Site is approximately 235 ft above sea level and has undergone extensive depositional and erosional processes through relatively recent glacial events (KAS 2014). Sandy materials (Champlain Sea deposited pebbly marine sand) deposited over broader silts and clays underlie the property. Geological logs for soil borings, advanced on the property to a depth of 20 ft, consist of well graded sands with varying amounts of silt. All soils encountered during the advancement of soil borings consisted primarily of well graded sand with varying amounts of silt and gravel. Soils collected from borings SB-3, 4, 6, and 7 showed evidence of fill materials, including coal fragments.

Previous investigations at 102 Archibald Street suggest that groundwater resides at a depth of 75 to 150 ft bgs. Bedrock in the vicinity likely consists of Lower Cambrian Dunham Dolostone of the Vermont Valley Sequence and Middlebury Synclinorium. The depth to bedrock beneath the Site is not known.

Potential Risks and Potential Receptors: Currently, the Site is used as the location of a community garden. This use is not expected to change in the foreseeable future and implementation of a deeded restriction will ensure that the Site is not developed for, or used for, any other purpose.

Several subsurface utility corridors, including municipal water, sewer, storm water, and natural gas lines are located in the vicinity of the Site. These utility lines generally run along Archibald and Walnut Streets.

Given the continued use of the Site as a community garden, OCI assumed that potential receptors would include individuals and families visiting the Site to garden, maintenance workers caring for the Site (e.g., mowing, landscaping, etc.), and construction/utility workers engaged in the routine maintenance and/or emergency repair of utility lines at or near the Site.

Exposure pathways through which these receptors are potentially exposed to residual contamination in Site soils are limited to the accidental or incidental ingestion of soil and dermal contact with soil. For persons visiting the Site to work in the raised garden beds, their contact with residual soil contamination is limited to shallow soils outside of the raised garden beds. Although the soils within the raised garden beds are “clean,” people who are gardening or visiting the Site, including small children, might reasonably sit, rest, or play on the ground adjacent to the raised garden beds, and thereby contact shallow soils containing contamination remaining at the Site. Similarly, maintenance workers performing routine tasks at the community garden property are also only expected to contact residual contamination residing in shallow soils. In contrast, construction/utility workers may become involved in excavation activities necessary to maintain and/or repair utilities that result in them contacting residual contaminates in soils at greater depths.

Implementation of a deeded restriction, or other deeded conveyance, shall limit the growing of produce for human consumption to appropriately constructed raised garden beds. An appropriately constructed raised garden bed is one made with appropriately treated wood or other inert material, filled with clean soil, with a barrier preventing plant roots from accessing soils beneath the garden beds. Additionally, the deeded restriction shall prohibit any change in Site use from that of a community garden. This will eliminate the potential future development of the Site for a purpose not considered in this risk evaluation.

The subject property and the surrounding area are serviced by a municipal water supply system, with the closest known water supply well located more than 900 feet distant and west of the Site. This well is not known to be impacted by contamination from the Site.

KAS notes that there are no jurisdictional wetlands in the immediate vicinity of the Site (KAS 2014). The nearest surface water body is the Winooski river. It is located approximately 2,000 ft to the east. Another surface water body, Lake Champlain, is located approximately 1 mile to the west. Neither surface water body is known to be impacted by contamination from the Site.

Data Quality Evaluation: KAS performed data validation on the available laboratory analytical data reported in the Phase II investigation (Appendix F; KAS 2014). Representative soil samples were collected in an appropriate manner and analyzed for a variety of volatile and semi-volatile organic compounds and priority pollutant metals. Although the results of these analyses were identified by the laboratory with certain limitations, they were accepted with few qualifications. Laboratory qualifications included high method detection limits (MDLs) for 1,2,3-trichloropropane and vinyl chloride in soil vapors. These MDLs exceed the applicable residential Sub-slab Soil Screening Values (SSVs). The lack of related VOC detections in Site soils, however, suggests that these VOCs are not present above SSVs collected from the Site (KAS 2014).

Data Gaps & Needs: The currently available analytical data is sufficient for the conduct of this risk evaluation.

Conditions Affecting Exposure Pathways and Transport Mechanisms: In this risk evaluation the only contaminated environmental media to which people are likely to have contact are Site soils. There is no apparent contamination of groundwater beneath the Site and no mechanism by which people might contact groundwater more than 75 ft bgs. Furthermore, although chlorinated VOCs have been detected in soil vapors collected from borings at the Site, there is no evidence of these VOCs in Site soils. Furthermore, because there is no structure at the Site into which these VOC vapors might infiltrate, there is not potential for VOC vapors to infiltrate indoor air and accumulate in indoor air spaces. Because vapors emanating from the ground surface are quickly diffused and dispersed into outdoor air, it is very unlikely that persons using the community garden would be exposed to an amount of chlorinated VOCs that would pose a risk of harm to human health.

How Data Will Be Used to Modify the Conceptual Site Model: The CSM is initially used to help guide the development of the SI work plan. It helps to ensure that the SI will be conducted in an efficient manner and develop the information necessary to provide the SMS with a comprehensive understanding of site conditions and contaminant fate and transport. As the SI generates Site specific data, the CSM is refined to reflect the growing knowledge and understanding of the Site. The revised CSM in turn is used to iteratively refine the SI work plan to focus SI resources in directions that will best characterize contaminant fate and transport and possible risk to human health and the environment. As the SI nears completion and the CSM is finalized, the CSM provides context for, and helps guide, long term Site decisions.

In the conduct of this risk evaluation, OCI assumed that a substantial portion of the SI has been completed for the Site and that the CSM, partially through implementation of a deeded restriction, can be defined with respect to both current and future Site use as a community garden. The purpose of this risk evaluation, therefore, is to identify remaining CoPC in environmental media, define potential exposure pathways by which people using the community gardens may be exposed, and conservatively estimate the cancer and non-cancer health risk to people using the Site.

Sources, Types, and Concentrations of CoPC in Site-Media: Laboratory analysis of Site soils did not detect VOCs or polychlorinated biphenyls (PCBs) above laboratory detection limits. Target polycyclic aromatic hydrocarbon (PAH) compounds were detected above the laboratory detection limits and above their applicable residential soil screening values (SSVs) in shallow soil samples. KAS reported that the PAH contamination in shallow soils is consistent with that associated with urban fill, but also recognized that it may also be associated with historical use of the Site as the location of an automobile repair and gasoline filling station (KAS 2014). Analytical analysis also detected priority pollutant metals in shallow soils. The concentration of arsenic in Site soils generally exceeds its residential SSV, but at concentrations that are within the normal background range for Vermont soils (KAS 2014). Lead was detected at one location at a concentration exceeding the residential SSV (SB-3), but soils at this location will be excavated for offsite treatment and disposal. No other priority pollutant metal was detected at a concentration exceeding its applicable residential SSV.

Sampling and analysis of soil vapors collected from shallow soils detected several VOCs. These included ethanol and isopropyl alcohol from SG-1, and acetone, ethanol, isopropyl alcohol, and tetrachloroethylene or perchloroethylene (PCE) in SG-2 and SG-3. Only PCE was detected at concentrations exceeding applicable regulatory limits. There is, however, no known source of PCE on the property and no PCE was found in soil samples collected from the property. KAS speculates that PCE in soil gas may source from an off-site location. There is no structure on Site into which PCE might infiltrate indoor air. Furthermore, the release of soil vapors to outdoor ambient air is unlikely, because of diffusion and dispersion (i.e., wind), likely to accumulate in such concentrations so as to pose an inhalation risk to human receptors. Consequently, the only environmental media potentially impacted by historical release of contaminates at the Site are soils.

Preliminary Steps in Risk Characterization

Several other preliminary steps need to be considered in the performance of a risk evaluation. These steps include the identification of current and future Site uses, the establishment of background levels, and the determination of any assumptions regarding the use of deeded restrictions, or other conveyances, designed or intended to mitigate potential receptor exposure.

Identify Current and Reasonably Foreseeable Use of the Site

This risk evaluation considers the current and future use of the subject Site as a community garden. Implementation and maintenance of a deeded restriction, or other deeded conveyance, is required to limit potential future use of the subject Site to just that considered in this risk evaluation. Namely, that the subject Site will remain a community garden, that no portion of the Site will be set aside for use as a children's play area, school, daycare, or other similar use, and that the planting, growth, and harvesting of produce will be restricted to appropriately constructed and raised garden beds. Finally, current and future Site uses assume the excavation and removal of soils associated with SB-3, which were found to contain high concentrations of lead, for offsite treatment and disposal.

Under such restrictions, OCI expects that persons using the subject Site (i.e., receptors) will be limited to individuals and families who are gardening and/or visiting the Site and that their exposure will be limited to residual contamination remaining in surface soils between 0 and 3 feet below the ground surface (ft bgs). The receptors of specific interest in this group are young children who accompany parents, guardians, or other adults to the community garden. While young children might become involved in gardening, OCI assumes that they principally play in areas of the community garden other than within the raised garden beds. Additional receptors of interest include maintenance and construction/utility workers. OCI assumed that maintenance workers contact residual contamination in shallow Site soils during routine work such as landscaping, mowing, and other such activities. While it seems unlikely that any one individual would need to work fulltime at this community garden, OCI assumes that this is the case (i.e., that a maintenance worker works 8 hours a day, 5 days a week, 350 days a year for 25 years at this community garden). Finally, OCI assumes that construction/utility workers contact Site soils at all depths at any location across the Site during routine maintenance and/or emergency repair of existing utility lines. Unlike, individuals and families who might use the community gardens for as many as 30 years, or maintenance workers who might be employed to maintain the community gardens over a period of 25 years, construction/utility workers are only assumed to have fleeting contact with Site soils over a 1 year period.

Established Background

KAS identified soil arsenic concentrations as being consistent with natural arsenic concentrations in Vermont soils (KAS 2014). Additionally, KAS noted that the concentration of PAH compounds in Site soils appears to be consistent with that typically encountered in urban environments (KAS 2014). As such, arsenic and PAH compounds might be eliminated from the risk evaluation because their concentrations are typical of ubiquitous background. However, in order to provide a robust and conservative estimate of the potential for human health risk at the community garden, OCI retained these compounds of potential concern (CoPC) for consideration in this risk evaluation.

Assumptions Concerning Site Activity and Use

This risk evaluation relies on the implementation of a deeded restriction, or other deeded conveyance, that prohibits any change of future Site use and limits potential receptor exposures to only those considered in this risk characterization. Namely, exposures potentially associated only with the use of the Site as a community garden. To that end, the deeded restriction shall ensure that the subject Site will remain a community garden in perpetuity and that no portion of the Site will be set aside for use as a children's play area, school, daycare, or similar use. Furthermore, the implemented deeded restriction shall prohibit the planting, growth, and harvesting of produce outside of raised garden beds, while specifying the nature of an appropriately constructed raised garden bed. This risk evaluation also assumes that the soils associated with the high soil lead concentration detected at SB-3 have been excavated and removed for offsite treatment and disposal.

Characterization of Human Health Risk

The characterization of human health risk integrates five separate components: hazard identification, dose response assessment, exposure assessment, risk characterization, and uncertainty analysis. Each of these components is described below in the following appropriately labeled sections.

Hazard Identification

Hazard identification describes the nature of a substance that causes it to be of regulatory concern and identifies the effects of substances determined to cause adverse effects in humans (U.S. EPA 1989). The U.S. EPA has characterized substances, commonly encountered at hazardous waste sites, as to whether they are likely to have carcinogenic and/or non-carcinogenic effects in humans. The relative hazard of each CoPC is fully discussed by the U.S. EPA (U.S. EPA 2005, 2014a,b) and will not be further addressed within this risk characterization outside of Table 8 (Appendix B). The following sections identify CoPC carried forward through this risk evaluation.

Identification of Contaminants of Potential Concern

Every contaminant detected in shallow soils, between 0 and 3 ft bgs, is tentatively identified as a contaminant of potential concern (CoPC) and is considered for inclusion within this risk evaluation. Specific CoPC identified for consideration in this risk evaluation include the following:

Target PAH compounds

- Acenaphthene
- Acenaphthylene
- Anthracene
- Benz[a]anthracene
- Benzo[a]pyrene
- Benzo[b]fluoranthene
- Benzo[g,h,i]perylene
- Benzo[k]fluoranthene
- Chrysene
- Dibenz[a,h]anthracene
- Fluoranthene
- Fluorene
- Indeno[1,2,3-c,d]pyrene
- 2-Methylnaphthalene
- Naphthalene
- Phenanthrene
- Pyrene

Priority Pollutant Metals

- Antimony
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

Elimination of Contaminants of Potential Concern

OCI may eliminate CoPC from consideration in this risk evaluation if they meet any one of the following criteria (US EPA 1992).

- Present at low frequency of detection and in low concentrations;
- Present at levels which are consistent with "background" concentrations for the area and there is no evidence that their presence is related to activities at the site;
- Present as a field or laboratory contaminant (e.g., acetone, 2-butanone, methylene chloride, toluene, and phthalate esters).

OCI did not eliminate any CoPC from further consideration in this risk evaluation based on these criteria. KAS reported that the concentration of soil arsenic at the Site is consistent with that known to exist naturally in Vermont soils (KAS 2014). Additionally, KAS reported that the concentrations of PAH compounds in Site soils are also consistent with that typically associated with soils found in an urban environment. Regardless, OCI did not eliminate these CoPC from further consideration in this risk evaluation.

Dose Response/Toxicity Assessment

Dose-response or Toxicity Assessment describes the observed effects in humans and/or laboratory animals that are associated with a particular exposure to a CoPC (USEPA 1989). U.S. EPA obtains this information from published literature describing epidemiological or toxicological studies involving the CoPC of interest. U.S. EPA uses this information to characterize the relationship between the dose of the CoPC and the incidence of adverse effects in exposed populations (U.S. EPA 2005, 2014a,b).

U.S. EPA indicates the carcinogenic potency of a compound, consumed or contacted by the skin, using an oral-cancer slope factor (CSF_O). The CSF_O is expressed as the reciprocal of standard intake units of milligrams per kilogram body weight per day or 1/(mg/kg-bw/day) or $(mg/kg\text{-}day)^{-1}$. For non-carcinogenic effects, U.S. EPA derives a chronic oral reference dose (RfD) for use in estimating non-cancer risk posed by a compound consumed or contacted by the skin. The RfD is defined as the highest dose deemed unlikely to cause adverse effects when administered over a lifetime of exposure (U.S. EPA 2014a). The RfD is typically given units of milligrams of a chemical per kilogram body weight per day (mg/kg-day).

Receptor- and Pathway-Specific Adjustment of Toxicity Values

U.S. EPA guidance (Appendix 1A, U.S. EPA 1997) suggests correction of CSF toxicity values to reflect the characteristics of the exposed population (U.S. EPA 1997, 2011). U.S. EPA derives CSF toxicity values assuming a default average adult body weight of 70 kg. Children <1 to 6 years of age, however, are typically assumed to have a default average body weight of only 15 pounds. As a consequence of this difference in body weight and expected CoPC toxicity, the U.S. EPA suggests an adjustment of the CSF to reflect the lower body weight of children. Consistent with applicable U.S. EPA guidance, OCI calculates an appropriate adjustment factor equivalent to the cube root of the quotient of the child's body weight (i.e., 15 kg) over the default average adult body weight of 70 kg used to derive the CSF. For children <1 and 6 years of age, the adjustment factor is equivalent to 0.60 of the CSF. Table 8 (Appendix B) lists un-adjusted CSF values for Site-related CoPC (RAIS 2014; U.S. EPA 2014a,b). Prior to use in this risk evaluation, however, OCI adjusted each CoPC-specific CSF used to estimate excess lifetime cancer risk (ELCR) in children.

U.S. EPA's derivation of each CoPC-specific chronic oral reference dose (RfD) reflect the expected non-cancer toxicity over a lifetime of exposure (i.e., a chronic exposure period). Chronic oral RfD's are not necessarily appropriate for use in estimating non-cancer health risk over shorter exposure periods. When characterizing non-cancer health risks for less than lifetime exposures (i.e., subchronic exposures), it is typical to adjust the RfD upwards by a factor of 10 to account for the less than lifetime exposure of receptors. Construction/utility workers have less than lifetime exposures, which are often associated with a lower incidence and lesser severity of non-cancer effects. Although the U.S. EPA's Integrated Risk Information System (IRIS) does not provide RfD values specific for less than lifetime exposures, RAIS publishes subchronic toxicity values for use by the U.S. EPA and others in risk evaluation. For many CoPC, the RAIS given subchronic RfD is the same as the chronic RfD derived by the U.S. EPA. For construction/utility workers, OCI used the RAIS subchronic RfD values (Table 8; Appendix B) to estimate non-cancer risk over this receptor groups less than lifetime exposure.

Source of Toxicity Values

In this risk characterization, OCI specifically relied on CoPC-specific toxicity values obtained from RAIS (RAIS 2014). RAIS CoPC-specific toxicity information includes values from U.S. EPA's IRIS database (U.S. EPA 2014a,b) and those published in U.S. EPA's Health and Environmental Assessment Summary Table (HEAST), as well as provisional toxicity values determined by U.S. EPA program offices for use at specific Superfund sites (U.S. EPA 2014a,b).

Generally, it is considered inappropriate to use an RfD to characterize the risk of harm posed by lead (ATSDR 1993; U.S. EPA 1994a,b, 1996, 1999, 2001, 2005a). The EPA has not developed a reference dose (RfD) for inorganic lead, or "*lead and compounds*," because some of the health effects associated with lead exposure occur at blood lead levels so low as to be essentially without a threshold (U.S. EPA 2005a, 2014a). Although considered inappropriate, OCI uses the RfD derived for lead by the Massachusetts Department of Environmental Protection (MassDEP) (MassDEP 2012). MassDEP uses their lead RfD to provide an estimate of the potential health risk to exposed human receptors. Such use, while still inappropriate, does allow for a simple comparison of estimated health risks posed by all CoPC to which a receptor is exposed. OCIs use if the MassDEP RfD for lead is ONLY for comparison purposes.

In this risk evaluation, OCI used the more appropriate U.S. EPA All Ages Lead Model (AALM) to estimate health risk posed by soil lead. The use of the AALM to evaluate health risk posed by lead in Site soils is conducted separately from the risk evaluation and is reported in the Section entitled Risk Characterization. The health risk results of the AALM are often difficult to interpret in relation to the relative risk posed by other CoPC present at the Site. For such a comparison, OCI used the MassDEP RfD for lead within this risk evaluation.

Identify Applicable and Suitably Analogous Standards

There are no applicable and suitably analogous regulatory standards (ARARS) identified for soils.

Exposure Assessment

Exposure assessment involves identifying potential routes of exposure; characterizing the populations exposed; and determining the magnitude, frequency, duration, and extent of exposure to CoPC in Site media (U.S. EPA 1989, 1991, 1992, 1997, 2001, 2005b, 2008, 2011). OCI divides exposure assessment into several sections, which include discussion of exposure profiles and scenarios, assumptions relating to the selection of exposure parameters, selection of exposure points, determination of exposure point concentrations (EPCs), and the calculation of quantitative estimates of exposure. Each of these are discussed in the appropriately labeled sections below.

Exposure Profiles

An exposure profile is a narrative description of the assumed potential for receptor exposure to CoPC at the Site. OCI developed an exposure profile for each potential human receptor given the Sites current and continued use as a community garden. Exposure profiles are described in Table 7 (Appendix B). Potential receptors at the Site include individuals and families, (including young children) who are visiting and gardening at the Site. Other potential receptors at the Site include maintenance and construction/utility workers. Consistent with cancer risk assessment guidelines (U.S. EPA 2005b), OCI assumed that individuals visiting the community gardens could be divided into age-specific categories of <1 to 6 years of age (i.e., young children) and adults 7 to 31 years of age. OCI assumed that maintenance and construction/utility workers are adults between 18 and 45 years of age, inclusive.

Exposure Parameters

For individuals visiting and working in the raised beds of the community gardens, OCI assumed default exposure parameters consistent with that recommended by the U.S. EPA for resident adults and children (U.S. EPA 2008, 2011). For maintenance and construction/utility workers, OCI used default exposure parameters obtained from U.S. EPA guidance (U.S. EPA 2002, 2004, 2011). For simplicity, OCI assumed that construction and utility workers could be combined into one receptor group (i.e., the construction/utility worker receptor group). Typically, construction workers are assumed to have more frequent and longer contact with contaminated soils than a utility worker performing routine maintenance or emergency repair of utility lines. As a result, an evaluation of construction worker risk can be considered protective of utility worker health risk (i.e., a construction workers health risk will typically be greater than that determined for a utility worker). Consequently, finding that there is no significant risk of harm to construction worker health also suggests that there is no risk of harm to utility worker health. OCI describes the parameters used to estimate receptor exposure (i.e., intake) from Site media below and within Tables 6, 7, and 9.

Exposure Times:

People Visiting the Community Garden: OCI assumed that people living near the community garden (i.e., persons with unfettered access to the garden) might visit the garden at any time during the year. U.S. EPA typically assumes that residents are home 350 days a year, and that they vacation away from home 15 days each year. This exposure frequency (EF) of 350 days a year is a standard default value recommended for use by the U.S. EPA.

According to the most recent U.S. EPA Exposure Factors Handbook (U.S. EPA 2011), the 95^{th} percentile of time that adults spend working with soil in a garden is 40 hours each month. This is equivalent to 480 hours a year (12 months), or 1.32 hours a day (365 days a year). The 95^{th} percentile reflects the fact that of all adults working with soils in a garden, 95 out of 100 would spend as much as or less than 40 hours a month, working with soils in a garden. As a 95^{th} percentile, the time an adult spends working in garden soils reflects a reasonable maximum exposure (RME) of this receptor. The use of an RME exposure parameter in the estimation of exposure is meant to be inclusive of most all of the people performing that activity.

According to the U.S. EPA, the seasonal time people spend working with soils in a garden is much less during the winter months than during spring, fall, and summer months. Intuitively, this makes sense since snow and ice can limit accessibility to garden soils during winter months. This suggests that people are unlikely to visit a community garden every day of the year, especially in northern latitudes where snow and ice are a regular part of the winter season. As a result, it seems reasonable to expect that people would visit a community garden fewer days a year, but for a longer period of time than 1.32 hours per day. Consequently, OCI assumed that individuals and families visit to the community garden for 2 hours a day for a total of 240 times a year. This 2 hour a day exposure time (ET) is consistent with the approximate amount of time the U.S. EPA reports that adults and children play in sand/gravel, in grass, or in dirt each day and approaches the U.S. EPA recommended 95^{th} percentile time spent working in soils in a garden (480 hours a year).

Assuming less frequent visits and a longer time spent at the community garden results in a lower estimated exposure to soil contaminates and, thereby, lower estimated health risks. This is because the amount of contaminants that might enter the body through the accidental consumption of soils and dermal contact with soils are provided by the U.S. EPA as daily averages (i.e., milligrams consumed per day and milligrams adhered to skin per day). Regardless, it seems unlikely that people visiting this community garden would do so more than 240 times a year.

It is important to note that the exposure times above reflect a person's frequency and time of contact working in garden soils. The soils within the raised beds of the community garden, however, are not contaminated. Consequently, individuals and families visiting and working in the soils of the raised garden beds are unlikely to have the same intensity of contact with Site surface soils containing residual contamination (i.e., they will not be planting, digging, and weeding in shallow Site soils). Intuitively, while the frequency of contact does not change (i.e., the number of days the community garden is visited), the intensity of these people contacting shallow Site soils is likely to be much less than that of the soils in raised garden beds. This is even more true where vegetation, wood chips, or other material, that prevent contact with shallow Site soils. Given these differences in the intensity of contact with soils at the Site, OCI uses a fractional intake (FI) value of 0.5 (50%) to adjust this receptors exposure to reflect the lower intensity of contact with shallow Site soils.

The U.S. EPA also provides information relating to the 95^{th} percentile of time young children spend working with soils in a garden, but these estimates (20 hours each month) are approximately half that assumed for adults. It seems unlikely that a child, <1 to 6 years of age, would visit the community gardens with greater frequency, or for a longer period of time, than that OCI has assumed for the adult visitor. Consequently, OCI assumed children visit the community garden in the company of an adult and therefore visit the community garden with the same frequency and duration (i.e., visiting the community garden 240 times a year for 2 hours each visit). OCI used the following exposure parameters in this risk characterization:

Children Accompanying Adults; Ages <1-6:

- ET = 2 hours/day
- EF = 240 days/year
- ED = 6 years (1-6 years)
- FI = 0.5 (unitless)

Adults Visiting the Community Gardens; Ages 7-31:

- ET = 2 hours/day
- EF = 240 days/year
- ED = 24 years (7-31 years)
- FI = 0.5 (unitless)

Maintenance Workers: OCI assumed that maintenance workers have direct contact with shallow surface soils throughout the Site. OCI assumed that maintenance workers are employed to work ONLY at the community garden and have intimate contact with shallow Site soils during the entire time they are employed. This is an overly conservative assumption given the fact that the surface soils of the community garden are unlikely to be accessible during winter months when they are covered by snow and ice. Furthermore, maintenance activities are unlikely to require intimate contact with surface soils for the entire time of employment at the Site. Consequently, OCI assumed that maintenance workers only have intimate contact with Site soils for half of the days worked at the Site. This assumption is integrated into the exposure equations as a fractional intake (FI) adjustment to exposure (i.e., FI = 0.5 or 50%).

The U.S. EPA default RME condition for worker exposure includes working 250 days year (U.S. EPA 2002, 2004), with exposure occurring during an eight-hour workday, five days each week, over a 25 year period of employment. OCI uses these exposure parameters to estimate potential exposure of maintenance workers to CoPC in shallow Site soils.

Maintenance Workers:

- ET = 8 hours/day
- EF = 250 days/year
- ED = 25 years
- FI = 0.5 (unitless)

Construction/Utility Workers: OCI assumed that construction/utility workers have direct contact with soil throughout the subsurface excavation activities associated with the routine maintenance and/or emergency repair of existing utilities at or near the Site. The U.S. EPA's RME condition for worker exposure assumes that construction/utility workers work an eight-hour workday, five days each week, for a total of 250 days over one year (U.S. EPA 2002, 2004). OCI used these RME exposure parameters to estimate CoPC exposure of construction/utility workers. OCI did not adjust this exposure using a fractional intake (FI) adjustment factor (FI=1 or 100%).

Construction/Utility Workers:

- ET = 8 hours/day
- EF = 250 days/year
- ED = 1 year (365 days/year)
- FI = 1 (unitless)

Ages: Individuals and families visiting and working in soils within the raised garden beds can include young children. Additionally, these individuals and young children may contact shallow Site soils outside of the raised garden beds. OCI evaluated the risk posed by this later potential exposure to young children, less than 1 to 6 years of age, and adults aged 7 to 31 years. OCI evaluated adult maintenance and construction/utility workers between 18 to 45 years of age, inclusive. These age groups are consistent with those suggested for use in U.S. EPA guidance (U.S. EPA 2005b).

Body Weights (BW): U.S. EPA guidance recommends using sex- and age-adjusted mean body weights for different age groups in risk characterization (U.S. EPA 2005b, 2011). For children, the U.S. EPA default average sex- and age-specific body weight is 15 kilograms (kg), while for adults, the U.S. EPA default average sex- and age-specific body weight is 70 kg.

Dermal Contact Surface Area (SA): Guidance from the U.S. EPA (U.S. EPA 2002, 2004, 2011) suggest the total skin surface area (SA) of the RME residential child and adult receptor available for contact with soil is 2,800 cm^2 and 5,700 cm^2, respectively. This same guidance suggests that the total SA for an RME maintenance or construction/utility worker available for contact with soils is 3,300 cm^2. In this risk evaluation, OCI uses these default U.S. EPA RME values to evaluate receptor exposure and risk.

Adherence Factor (AF): U.S. EPA has indicated that very few adherence factors (AF) are available for soil types and body parts (U.S. EPA 1989, 1991, 2004, 2011). Although this is still true, updated U.S. EPA guidance identifies new AF values for use in estimating a receptor's dermal exposure to contaminants in soils (U.S. EPA 2004, 2011). This guidance provides AF values for RME residential adults and children of 0.07 mg/cm^2 and 0.2 mg/cm^2, respectively (U.S. EPA 2004, 2008, 2011). For the RME construction/utility and maintenance workers, this same guidance recommends AF values of 0.3 and 0.1 mg/cm^2, respectively. OCI uses these AF values to estimate dermal uptake of CoPC from soil for these receptor groups.

Ingestion Rates (IR): U.S. EPA risk characterization guidance recommends an ingestion rate of 100 mg/day for RME adults, 200 mg/day for RME children and 330 mg/day for RME maintenance and construction/utility workers (U.S. EPA 2002, 2011).

Fractional Intake (FI): Unitless fractional intake (FI) values can be used to adjust receptor CoPC intake from soils to reflect seasonal differences in soil ingestion rates and seasonal differences in skin surface area available for contact with shallow Site soils. In this risk evaluation, such seasonal differences are generally accounted for in the time of exposure (ED), the days per year each receptor group is assumed to have contact with shallow Site soils.

OCI used an FI to adjust some receptor exposures to CoPC in soils downward. For individuals and families visiting the community garden, OCI used an FI of 0.5 (50%) to reflect the much lower intensity with which they are likely to contact shallow Site soils than is assumed for these same receptors working in garden soils. For maintenance workers, OCI also used an FI of 0.5 (50%) to reflect the fact that maintenance workers were unlikely to spend all of their time at work in intimate contact with shallow Site soils. For construction/utility workers, it seemed inappropriate to assume any reduction in the frequency or intensity of soil contact for a construction/utility worker working in a subsurface excavation at the Site. As a result, OCI did not adjust construction/utility worker exposure by an FI (i.e., FI=1 or 100%).

Averaging Time (AT): The non-cancer effect averaging time (ATn) is used to determine an average daily dose (ADD) for non-carcinogenic CoPC. The ATn is equivalent to the exposure duration (ED) in days (U.S. EPA 1989). The carcinogenic effect averaging time (ATc) is used to determine the lifetime average daily dose (LADD) used in the evaluation of CoPCs that cause carcinogenic effects. The ATc is equivalent to the average human lifetime of 70 years or 25,550 days (U.S. EPA 1989). Although the average human lifespan is somewhat longer (U.S. EPA 1997, 2011), the use of 70 years as the default human lifespan is the same assumption used by U.S. EPA in the derivation of its toxicity values. The 70 year human lifespan is recommended for use in risk evaluations (VT DEC 2012, U.S. EPA 1997, 2011).

Exposure Points

Exposure points are physical locations where exposure of potential receptors is evaluated (U.S. EPA 1989). Exposure points for current and potential future individuals visiting and working with soils in raised garden beds is limited to shallow Site surface soils at the community gardens. As noted earlier, the soils in the raised garden beds are clean, and as such do not pose a risk of harm to health. The soils in the raised garden beds are not, however, the focus of this risk evaluation. OCI conservatively assumed that individuals and families visiting the community garden contact shallow Site surface soils with the same frequency and intensity as they do the soils within the raised garden beds. The intensity of this contact is subsequently adjusted by an FI of 0.5 to reflect the lower intensity contact expected for shallow Site surface soils. The expectation that individuals would contact shallow Site soils with the dame frequency and half the intensity with which they would contact soils while working in a garden is highly conservative. Such conservatism, however, ensures that the resulting risk estimates are not underestimated. Because young children may dig and play in shallow Site soils while adult receptors garden, such conservatism seems appropriate. Exposure points for current and potential future maintenance and construction/utility workers include any location where these receptors might reasonably contact Site soils.

Exposure Media

Exposure media refer to the variety of contaminated environmental media with which receptors may have contact (U.S. EPA 1989). The only exposure media evaluated in this risk characterization are Site soils. Site groundwater is not known to be impacted and resides at a depth greater than 75 ft bgs making receptor contact with groundwater very unlikely. Although soil vapors have been found to contain detectable concentrations of various VOCs, some exceeding applicable standards, there is no building at the subject Site that soil vapors can infiltrate and pose a risk of harm to occupants. Furthermore, through diffusion and dispersion, the release of soil vapors to outdoor ambient air is unlikely to result in air concentrations that pose a significant risk of harm to human health.

Exposure Point Concentrations

OCI provides chemical- and media-specific exposure point concentrations (EPC) in Table 11 (Appendix B). These EPC are determined from the available soil analytical data provided by KAS in their Phase II Report (KAS 2014). Consistent with U.S. EPA guidance (US EPA 1989), OCI derived an EPC for each CoPC detected in Site soils as the mean of all shallow (0 to 3 ft bgs) and all soil analytical data (i.e., all depths). The shallow soil EPC are used to evaluate the health risk of individuals and families visiting the community garden and of maintenance workers caring for the Site. The EPC calculated for all soils is used to assess the health risk of construction/utility workers who might contact soils at any depth between 0 and 15 ft bgs. Because contaminant concentrations appear to diminish with increasing soil depths, the EPC for all soils are generally lower than those derived for shallow soils. OCI describes the derivation of these soil EPC in additional detail in the following sections.

EPC in Site Soils

Analytical soil results (Appendix A; Table 1-4) include 10 soil samples from 7 unique locations collected from the surface of the Site, between 0 and 2 ft bgs (6 samples), with an additional surface soil sample collected from 2 to 3 ft bgs, and the remaining 3 samples collected from a depth of 8 to 10 ft bgs, one of which is a duplicate. The surface soils associated with one of the soil samples (SB-3), was found to contain a high concentration of soil lead and will be removed for offsite treatment and disposal. OCI assumed that maintenance workers and individuals and families visiting the community garden have contact surface soils, but not with soils greater than 3 ft bgs. Since the highest contaminate concentrations were detected in surface soils, these receptors are exposed to the highest average contaminate concentrations measured at the Site. OCI assumed that construction/utility workers may contact Site soils at any depth.

Soil EPCs were determined as the mean of all applicable soil analytical data. OCI calculated the mean of soil analytical data as the mean of both detected and one-half (½) of the method detection limit (MDL) for non-detected CoPC concentrations. OCI reported the standard deviation (SD), the 95th confidence interval (95th CI) on the mean, the maximum (MAX) soil CoPC concentration, and the ratio of the maximum soil concentration to the Site wide average soil concentration (i.e., the hot spot ratio or HSR). The HSR identifies potential hot spot soil CoPC concentrations. Where the HSR exceeds 10, a CoPC is identified as having a potential hot spot soil concentration. Removal of the soil lead contamination associated with SB-3 eliminates a potential hot spot soil lead concentration at the community gardens property. OCI did not identify any other CoPC as having a hot spot soil concentration. OCI calculated an EPC for each CoPC detected at least once above its respective MDL in Site soils.

Quantification of Exposure

OCI determined quantitative exposure estimates in accordance with guidance from U.S. EPA (U.S. EPA 1989, 1991, 1992, 1997, 2002, 2004, 2005b, 2011).

Risk Characterization Calculations Quantifying Intake

OCI used the equations provided in U.S. EPA guidance (U.S. EPA 1989, 1991, 2004, 2005b) to quantify CoPC intake and health risk. In a separate process, OCI used the U.S. EPA's AALM to determine the potential for soil lead to pose a risk of harm to health (U.S. EPA 1994a,b, 2005a). Although considered inappropriate, OCI used the RfD derived by MassDEP for lead so that its relative health risk could be compared to that of other CoPC.

OCI lists exposure parameters used in these calculations in Tables 6, 7, 8, 9 and 10. OCI used the following equations and variables to determine CoPC intake and risk:

Ingestion of Soil:

Equation 1

$$\text{LADD or ADD (mg/kg-day)} = \frac{C_S \times RAF_{SI} \times IR \times FI \times EF \times ED \times CF}{BW \times AT}$$

Dermal Contact with Soil:

Equation 2

$$\text{LADD or ADD (mg/kg-day)} = \frac{C_S \times RAF_{SD} \times SA \times AF \times FI \times EF \times ED \times CF}{BW \times AT}$$

Where:

LADD = lifetime average daily dose (mg/kg-day).
ADD = average daily dose (mg/kg-day).
C_S = concentration of CoPC in soil (mg/kg).
RAF = route- and chemical-specific relative absorption factor (unit less).
RAF_{SI} = soil ingestion RAF.
RAF_{SD} = dermal contact RAF.
IR = ingestion rate (mg/day).
SA = mean age-specific surface contact area (cm^2/event).
AF = skin adherence factor (mg/cm^2).
CF = conversion factor (units as required).
FI = adjusting route- and pathway-specific fractional intake (unit less).
ET = time of exposure (hours/day).
EF = exposure frequency (days/year).
ED = exposure duration (years).
BW = mean age-specific body weight (kg).
AT = effect specific averaging time (day)
ATn and ATc for non-cancer and cancer effects respectively.

OCI calculated a chemical independent dose (CID) for each exposure pathway and receptor group. Non-cancer and cancer health risks are estimated using separate non-cancer, and cancer averaging times (i.e., ATn or ATc, respectively). The calculation of a CID allows for a streamlined approach to the quantification of exposure and risk for each receptor group, exposure pathway, and environmental media considered in the risk evaluation (Tables 6 and 7; Appendix B).

The calculation of receptor-specific non-cancer and cancer health risks integrate chemical-specific information such as CoPC- and route-specific relative absorption factors (RAF), CoPC-specific toxicity values, and other chemical-specific parameters listed in Tables 8, 9 and 10. OCI obtained relative RAF for CoPC from U.S. EPA guidance (U.S. EPA 2004, 2011) and the online Risk Assessment Information System (RAIS), a service sponsored by the U.S. Department of Energy (DOE), Office of Environmental Management, Oak Ridge Operations (ORO) Office through a contract with Bechtel Jacobs Company LLC (RAIS 2014). OCI also obtained CoPC-specific toxicity values, (i.e., CSF, chronic oral RfD and subchronic RfD values) from RAIS (Appendix B. Table 8).

OCI calculated chemical-specific non-cancer and cancer risks for each CoPC, receptor group, and completed exposure pathway in Tables 12 through 19 (Appendix B), with relative risks posed by each CoPC determined in Table 20, and total receptor group health risks determined in Table 21 (Appendix B).

Risk Characterization

The final step in the process of risk characterization, integrates information regarding a CoPC's toxicity and a receptors estimated exposure to quantify potential carcinogenic and non-carcinogenic human health risks. OCI provides quantified risk estimates for each CoPC, receptor class, exposure pathway, and media in Tables 12 through 19 (Appendix B), a summary of the health risk associated with each CoPC in Table 20, and a summary to the total health risk to each receptor group in Table 21 (Appendix B).

Cancer Risk

This risk evaluation conservatively determines an excess lifetime cancer risk (ELCR) to current and potential future individuals visiting the community gardens over 30 years as 7E-06 (7×10^{-6}). This is less than the applicable target risk of 1E-05 (1×10^{-5}). This ELCR assumes that an individual begins his or her exposure as a young child, and that their exposure (i.e., visiting the community gardens) continues for 30 years. Individually, the ELCR for children <1 to 6 years of age is 4.2E-06 while the ELCR for adult visitors is 3.2E-06 (Table 21; Appendix B). Each of these ELCR is below the applicable target risk of 1E-05.

For young children (<1 to 6 years of age) visiting the community garden, the major contributor to their ELCR is arsenic (53%), with the target PAH compounds benzo[a]pyrene (31%), dibenz[a,h]anthracene (6%), benzo[b]fluoranthene (4%), benzo[a]anthracene (3%), and indeno[1,2,3-c,d]pyrene (3%) contributing the remaining risk. No other CoPC contributes significantly (i.e., more than 1 %) to the visiting child's ELCR (Appendix B; Table 20). The exposure pathways contributing most to the child visitors ELCR include the accidental ingestion of soil (83%) and dermal exposure to soils (17%) (Appendix B; Table 21).

For adults (7 to 31 years of age) visiting the community garden, the major contributor to their ELCR is also arsenic (51%), with the target PAH compounds benzo[a]pyrene (33%), dibenz[a,h]anthracene (6%), benzo[b]fluoranthene (4%), benzo[a]anthracene (3%), and indeno[1,2,3-c,d]pyrene (3%) contributing the remaining risk. No other CoPC contributes significantly to the visiting adults' ELCR (Appendix B; Table 20). The exposure pathways contributing most to the adult visitors ELCR include the accidental ingestion of soil (78%) and dermal exposure to soils (22%) an (Appendix B; Table 21).

Taken together, these results indicate that a condition of "No Significant Risk" of harm to human health exists for these receptors visiting the community garden. These results rely on the assumptions made in this risk evaluation. Namely, the implementation of a deeded restriction limiting future use of the Site to that of a community garden and prohibiting gardening outside of the provided raised garden beds.

The ELCR for maintenance and construction/utility workers is 9.4E-07 and 8.6E-07, respectively (Table 21; Appendix B). Both these ELCR are also below the applicable target cancer risk of 1E-05. This result suggests that there is "No Significant Risk" of harm to the health of individuals working at the community gardens.

For maintenance workers, working full time at the community gardens for 25 years, the CoPCs contributing most to their ELCR is arsenic (57%) with the target PAH compounds benzo[a]pyrene (29%), dibenz[a,h]anthracene (6%), benzo[b]fluoranthene (4%), benzo[a]anthracene (3%), and indeno[1,2,3-c,d]pyrene (2%) contributing the remaining cancer risk. No other CoPC contributes significantly to the ELCR of maintenance workers (Appendix B; Table 20). The exposure pathways contributing most to maintenance worker ELCR include the accidental ingestion of soils (94%) and dermal contact with soils (6%) (Appendix B; Table 21).

For construction/utility workers, the CoPCs contributing most to their ELCR are arsenic (53%), with the target PAH compounds benzo[a]pyrene (32%), dibenz[a,h]anthracene (6%), benzo[b]fluoranthene (4%), benzo[a]anthracene (3%), and indeno[1,2,3-c,d]pyrene (3%) contributing the remaining cancer risk. No other CoPC contributes significantly to the ELCR of construction/utility workers (Appendix B; Table 20). The exposure pathways contributing most to the construction/utility worker ELCR include the ingestion of soils (82%) and dermal contact with Site soils (18%) (Appendix B; Table 21).

These results indicate that there is no significant cancer risk to individuals and families visiting the community garden, to maintenance workers caring for the Site, or to construction/utility workers working to maintain and/or repair utilities at or near the Site. These results do rely on implementation of a deeded restriction, or other deeded conveyance, to prohibit any future change in Site use, describe the nature of an appropriately constructed raised garden bed, and prohibit the use of other Site soils for the planting, growth, and harvesting of produce for human consumption.

Non-Cancer Risk

The HI for children and adults visiting the Site are below the applicable target hazard index (HI) of 1 (Table 21). The HI for the child visitor (<1 to 6 years of age) is 0.45, whereas the HI for the adult visitor (7 to 31 years of age) is less than 0.06, both of these HI are also below the applicable target risk of 1. The exposure pathways contributing most to the child visitor HI are accidental ingestion of soils (53%) and dermal contact with Site soils (47%) (Appendix B; Table 21). The exposure pathways contributing most to the adult visitor HI are dermal contact with Site soils (56%) and the accidental ingestion of soils (44%) (Appendix B; Table 21).

Lead poses the greatest non-cancer risk to children and adults. Table 22 presents the relative percent contribution of each CoPC to the child and adult visitor HI. No other CoPC contributes significantly (i.e., more than 1%) to the HI of these receptors (Appendix B; Table 20).

Table 22. Relative Percent Contribution of Each CoPC to Each Receptor HI.

Compound of Potential Concern	**Child Visitors** (<1-6 years)	**Adult Visitors** (7-31)
Metals		
Antimony	7 %	9 %
Arsenic	21 %	18 %
Copper	2 %	2 %
Lead*	63 %	63 %
Nickel	3 %	3%
Zinc	3 %	3%
Total HI	0.45	0.06

NA = Not Applicable.
-- = Less than 1 %.
*Note: The risk posed by lead is only for comparison purposes.

The HI for construction/utility and maintenance workers are 0.3 and 0.09, respectively (Appendix B; Table 21). Both of these HI are well below the applicable target HI of 1. Exposure pathways that contribute most to the HI of the construction/utility worker are dermal contact with soils (59%) and the accidental ingestion of soils (41%). The exposure pathways contributing most to the HI of maintenance workers are the accidental ingestion of Site soils (67%) and dermal contact with Site Soils (33%) (Appendix B; Table 21).

Lead poses the greatest risk to workers at the community gardens. The CoPC contributing most to the construction/utility worker HI include lead (74%), antimony (9%), copper (8%), nickel (3%), zinc (3%), and arsenic (1%) (Appendix B; Table 20). No other CoPC contributes significantly to the HI of construction/utility workers (Appendix B; Table 20). The CoPC contributing most to the maintenance worker HI include lead (80%), copper (7%), antimony (5%), zinc (3%), nickel (2%, and arsenic (2%) (Appendix B; Table 20). No other CoPC contributes significantly to the HI of maintenance workers (Appendix B; Table 20).

It is important to note here that the inclusion of lead in these results is for comparison purposes only. As noted earlier, it is inappropriate to assess lead related health risks using an RfD (ATSDR 1993, U.S. EPA 1994a,b, 2005). OCI included lead in this evaluation ONLY for the purpose of comparing relative non-cancer risks.

These results indicate that there is no significant non-cancer risk to individuals and families visiting the community garden, to maintenance workers caring for the Site, or to construction/utility workers working to maintain and/or repair utilities at or near the Site. These results rely on implementation of a deeded restriction, or other conveyance, to prohibit any future change in Site use, describe the nature of an appropriately constructed raised garden bed, and prohibit the use of other Site soils for the planting, growth, and harvesting of produce for human consumption. Furthermore, these results also rely on the assumption that the soils associated with

SB-3, which were found to contain high concentrations of lead, were excavated and removed for offsite treatment and disposal.

Health Risk Posed by Lead

As noted earlier, it is generally considered inappropriate to use an RfD to characterize the risk of harm posed by lead (ATSDR 1993; U.S. EPA 1994a,b, 1996, 1999, 2001, 2005a). The EPA has not developed a reference dose (RfD) for inorganic lead, or for "*lead and compounds*," because some of the health effects associated with lead exposure occur at blood lead levels so low as to be essentially without a threshold (U.S. EPA 2014a). Although considered inappropriate, OCI used an RfD derived by MassDEP (MassDEP 2012) to provide an estimate of relative non-cancer health risk posed by lead to exposed receptors. Such use, while still inappropriate, allows for a simple comparison of the relative health risks posed by all CoPC to which a receptor is exposed.

To appropriately assess the health risk posed by exposure to lead in community garden soils, OCI used the U.S. EPA's All Ages Lead Model (AALM) (U.S. EPA 2005a). The purpose of the AALM is to provide the risk assessor with a sufficiently complex, multi-compartment biokinetic model for use in predicting, with reasonable accuracy, the tissue concentrations of lead in humans and how lead tissue concentrations change over a lifetime of exposure.

The original model developed for this purpose, the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) met some of these objectives, but was only useful in predicting blood lead concentrations through the age of six. The IEUBK did not provide information on lead tissue concentrations (U.S. EPA 2005a).

The AALM provides an accurate description of the total daily exposure to lead, calculating the amounts of lead absorbed. The model then offers a choice of two biokinetic models to determine how the lead is distributed to the key body tissues. These two models are referred to as the Leggett Model and the O'Flaherty Model.

Technical Approach

The AALM, uses exposure, absorption, and biokinetic information to model the simultaneous distribution of absorbed lead in several major body components and thereby predict, at any point in time, the concentration of lead in these components. The AALM has about 190 parameters with assigned values that can be revised by the modeler. All values for these parameters have default settings (i.e., the default mode), and will produce reasonable results consistent with the default inputs in place. OCI used the AALM in default mode and did not alter any of the input parameters except the average soil lead concentration. A screen shot of the relevant AALM spreadsheet is provided below. Importantly (yellow highlighted cells), none of the estimated blood lead values (mean or 95th percentile) for adults (PbP_{adult}) or unborn children (PbP_{fetal}) exceed the target (PbP_t) blood lead concentration of 10 micrograms per deciliter blood (ug/dL). This indicates that lead remaining in soils at the community gardens (i.e., with the soils associated with SB-3 removed) does not pose a risk of harm to adults or unborn children visiting or working at the Site.

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

Click to Print Values | Click to Print Description | Click to return All inputs to Defaults

Exposure Variable	PbB Equation[1] 1*	PbB Equation[1] 2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1, GSDi = Hom	Using Equation 1, GSDi = Het	Using Equation 2, GSDi = Hom	Using Equation 2, GSDi = Het
PbS	X	X	Soil lead concentration	ug/g or ppm	158.33	158.33	158.33	158.33
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	2.1	2.3	2.1	2.3
PbB_0	X	X	Baseline PbB	ug/dL	1.5	1.7	1.5	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	--	--
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	0.050	0.050
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	--	--	--	0.7	0.7
$AF_{S,D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	219	219	219	219
$AT_{S,D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}			PbB of adult worker, geometric mean	ug/dL	1.7	1.9	1.7	1.9
$PbB_{fetal, 0.95}$			95th percentile PbB among fetuses of adult workers	ug/dL	5.3	6.8	5.3	6.8
PbB_t			Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	10.0	10.0	10.0	10.0
$P(PbB_{fetal} > PbB_t)$			Probability that fetal PbB > PbB_t, assuming lognormal distribution	%	0.6%	1.8%	0.6%	1.8%

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

$$PbB_{adult} = (PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S,D}) + PbB_0$$

$$PbB_{fetal,0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$$

****Equation 2, alternate approach based on Eq. 1, 2, and A-19 in USEPA (1996).**

$$PbB_{adult} = PbS*BKSF*([(IR_{S+D})*AF_S*EF_S*W_S]+[K_{SD}*(IR_{S+D})*(1-W_S)*AF_D*EF_D])/365+PbB_0$$

$$PbB_{fetal,0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$$

Conclusion

This risk evaluation demonstrates that there is “No Significant Risk” of harm to human health posed by residual contamination remaining at the Site of the community gardens. This result relies on implementation of a deeded restriction, or other permanent deeded conveyance, to prohibit a change in future Site use, describes the nature of an appropriately constructed raised garden bed, and prohibits the planting, growth, and harvesting of produce for human consumption in areas outside of the provided raised garden beds. Furthermore, this result relies on the excavation and removal of soils associated with SB-3, which were shown to contain relatively high concentrations of soil lead, for offsite treatment and disposal.

Uncertainty Analysis

OCI performed this risk evaluation in a manner consistent with U.S. EPA guidance (USEPA 1989, 1991, 1992, 1996, 1997, 2001, 2005a,b, 2011, 2014a,b). Use of generic U.S. EPA default exposure factors and conservative assumptions relating to receptor use of the community gardens ensures that this risk evaluation provides a conservative estimate of Site-related human health risk. The use of additional Site- and chemical-specific information, and more reasonable site-specific exposure parameters, would likely further reduce the magnitude of human health risk estimated at this Site.

Four typical areas of uncertainty in risk characterization are media concentrations, transport modeling, exposure assumptions, and toxicity factors.

Media Concentrations: KAS utilized state certified laboratories to determine the concentration of contaminates in environmental media (KAS 2014). Data evaluation noted the use of appropriate analytical methods using quality control and quality assurance protocols to validate the accuracy of contaminant concentrations in environmental media. As such, the resulting analytical data provides a useful basis for determining whether residual contamination in Site soils poses a health risk to receptors using the Site.

Transport Models: OCI did not use a transport model to adjust contaminate concentrations in environmental media. Although VOCs were detected in soil vapor samples collected from the Site, there is no known source of VOCs and no exposure pathway through which receptors visiting the Site would be exposed to significant concentrations of these VOCs in indoor air. Specifically, there is no habitable structure existing on Site for VOC soil vapors to infiltrate indoor air and the release of VOC soil vapors from the ground is unlikely to result in concentrations of VOCs in ambient air that would pose a risk to human health.

Exposure Assumptions & Toxicity Values: OCI used generic U.S. EPA default exposure assumptions, and toxicity values in the conduct of this risk characterization (RAIS 2014; U.S. EPA 1997, 2004, 2011, 2014a, b). The use of generic U.S. EPA default exposure parameters for the RME individual results in an over-prediction of the average health risk associated with receptor use of a Site. The purpose of using the RME condition is to ensure that the resulting risk estimates are inclusive of the vast majority of potentially exposed individuals. In other words, it is unlikely that an individual using the community gardens will experience a greater exposure and risk than that estimated in this risk evaluation.

OCI's assumptions regarding receptor use of the Site add to the level of conservatism inherent in the characterization of health risks. Specifically, OCI assumed that individuals and families (children ages <1 to 6 and adults aged 7 to 31) visited the community gardens 240 times a year, for 2 hours each visit, and that each child and adult contacted shallow Site soils with the same frequency, but half the intensity assumed for such receptors contacting soils in a garden. Furthermore, OCI assumed that these receptors returned to use the community gardens in this same way year after year for 30 years. For maintenance workers, OCI assumed that they are employed full time, 8 hours a day for 250 days a year over a period of 25 years, for the sole purpose of maintaining the community garden (i.e., they have no other location to maintain). OCI also assumed that maintenance workers spent half of their time working at the community gardens in intimate contact with shallow surface soils. For construction/utility workers, OCI assumed that they are involved in an excavation to maintain and/or repairing utility lines, and that that activity occurs for 250 days over a year long period. Each of the RME assumptions used to model these receptors exposures were obtained from U.S. EPA guidance and reflect an upper-bound estimate of exposure. As a result, this risk evaluation likely over-predicts actual exposures and associated health risks to these receptors.

There is significant uncertainty inherent in the derivation of toxicity values. The U.S. EPA biases its estimate of chemical toxicity to protect human health. As a result, the use of U.S. EPA derived toxicity values is unlikely to under predict the potential for a contaminant to cause harm. The conservative nature of these toxicity values is acknowledged by the U.S. EPA, which stipulated that non-cancer toxicity values (e.g., the RfD) likely over estimate contaminant toxicity by an order of magnitude (i.e., 10-times). The U.S. EPA's use of uncertainty factors (UF) totaling several orders of magnitude (i.e., 10- to 100,000-times) in the derivation of RfD values may increase the conservative nature of the RfD by a similar amount. Additionally, the U.S. EPA indicates that CSF values also may over estimate cancer potency for compounds that have no cancer causing potential at all.

This risk evaluation was conducted in a manner consistent with U.S. EPA guidance using conservative generic U.S. EPA default exposure parameters for the RME individual, U.S. EPA derived toxicity values, including RAIS reported subchronic toxicity values, and conservative assumptions regarding receptor use of the community gardens. As a result, this risk evaluation likely over predicts the health risk associated with residual contamination remaining at the subject Site. Importantly, this risk evaluation relies on the implementation of a deeded restriction to prohibit a change in Site use, describe the nature of an appropriately constructed raised garden bed, and prohibit the planting, growth, and harvesting of produce in areas of the Site outside the provided raised garden beds. Furthermore, this risk characterization relies on the excavation and removal of soils associated with the high lead soil concentration detected at SB-3.

2.7 Conclusion

This risk evaluation demonstrates that there is no risk of harm to health to individuals and families visiting the community garden, to maintenance workers employed full time to care for the community garden, or to construction/utility workers performing routine maintenance and/or emergency repair work on utility lines beneath or adjacent to the community garden property. This result relies on the implementation of a deeded restriction prohibiting a change in Site use, describing the nature of an appropriately constructed raised garden bed, and prohibiting the planting, growth, and harvesting of produce in areas of the Site in areas other than the provided raised garden beds. Finally, OCI assumed that soils associated with SB-3 (2 to 3 feet in depth), which were shown to contain lead at a concentration of 880 mg/kg, have been removed from the Site for off-site treatment and/or disposal and that no other Site soils contain lead concentrations exceeding 250 mg/kg.

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APPENDIX A. ANALYTICAL DATA TABLES

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TABLE 1. Soil Sampling VOC Data Summary
28 Archibald Street
Burlington, Vermont
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Soil Sample Sample Depth (ft.) PID reading (ppm) Sample Date	SB-1 (0-2) 1 0.0 1/30/14	SB-2 (0-2) 1 0.0 1/30/14	SB-3 (2-3) 2 0.0 1/30/14	SB-3 (8-10) 9 0.0 1/30/14	SB-4 (0-2) 1 0.0 1/30/14	SB-5 (0-2) 1 0.0 1/30/14	SB-6 (0-2) 1 0.0 1/30/14	SB-7 (0-2) 1 0.0 1/30/14	SB-7 (8-10) 9 0.0 1/30/14	Duplicate 9 0.0 1/30/14	IROCP SSV Residential	VDH Values
VOCs, EPA Method 8260b (mg/kg)												
Benzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.1	6.24
Toluene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	5,000	NA
Ethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	5.4	NA
mp-Xylene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3,400	NA
o-Xylene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3,800	NA
MTBE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	43	NA
1,3,5-trimethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	780	NA
1,2,4-trimethylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	62	NA
Naphthalene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3.6	1070
isoPropylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NA	NA
n-Propylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NA	NA
tert-Butylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	7,800	NA
sec-Butylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	7,800	NA
p-Isopropyltoluene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	NA	NA
1,4-Dichlorobenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.4	NA
1,2-Dichlorobenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1,900	NA
n-Butylbenzene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3,900	NA
Tetrachloroethene (PCE)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	22	0.800
Trichloroethene (TCE)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.91	0.860
1,1-Dichloroethane	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3.3	NA
cis-1,2-Dichloroethene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	160	673
trans-1,2-Dichloroethene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	150	135
1,2,3-Trichloropropane	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.005	NA
Chloroform	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.29	NA
Styrene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	6,300	NA
Vinyl Chloride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.08	NA
Total Reported VOCs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-

Soil Sample	Summary Statistics All Soils							Summary Statistics Shallow Soils (0-3 ft)						
	Sample n	Detected d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR	Sample n	Detected d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR
VOCs, EPA Method 8260b (mg/kg)														
Benzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Toluene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Ethylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
mp-Xylene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
o-Xylene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
MTBE	10	0	–	--	--	–	–	7	0	–	--	--	–	–
1,3,5-trimethylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
1,2,4-trimethylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Naphthalene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
isoPropylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
n-Propylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
tert-Butylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
sec-Butylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
p-Isopropyltoluene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
1,4-Dichlorobenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
1,2-Dichlorobenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
n-Butylbenzene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Tetrachloroethene (PCE)	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Trichloroethene (TCE)	10	0	–	--	--	–	–	7	0	–	--	--	–	–
1,1-Dichloroethane	10	0	–	--	--	–	–	7	0	–	--	--	–	–
cis-1,2-Dichloroethene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
trans-1,2-Dichloroethene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
1,2,3-Trichloropropane	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Chloroform	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Styrene	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Vinyl Chloride	10	0	–	--	--	–	–	7	0	–	--	--	–	–
Total Reported VOCs	0	0	–	--	--	–	–	0	0	–	--	--	–	–

NOTES:
All values reported in mg/kg, dry, unless otherwise indicated.
IROCP = April 2012 Investigation and Remediation of Contaminated Properties document.
SSV= Soil Screening Values from Appendix A of the IROCP with RSL updates from November 2013
ND<xx = Not Detected< Applicable Detection Limit
Results reported above detection limits are indicated in bold
Detection limits and reported concentrations above the residential SSV are shaded.
NA = No IROCP SSV available
VDH = Vermont Department of Health Soil Screening Values

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TABLE 2. Soil Sampling PAH Data Summary
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Burlington, Vermont
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Soil Sample Sample Depth (ft.) PID reading (ppm) Sample Date	SB-1 (0-2) 0-2 0.0 1/30/14	SB-2 (0-2) 0-2 0.0 1/30/14	SB-3 (2-3) 0-2 0.0 1/30/14	SB-3 (8-10) 8-10 0.0 1/30/14	SB-4 (0-2) 0-2 0.0 1/30/14	SB-5 (0-2) 0-2 0.0 1/30/14	SB-6 (0-2) 0-2 0.0 1/30/14	SB-7 (0-2) 0-2 0.0 1/30/14	SB-7 (8-10) 8-10 0.0 1/30/14	Duplicate 8-10 0.0 1/30/14
PAHs, EPA Method 8270 (mg/kg)										
Acenaphthene	0.018	<0.008	0.73	<0.007	0.0097	<0.007	0.045	<0.008	<0.007	<0.007
Acenaphthylene	0.22	0.16	0.280	0.012	0.077	0.039	0.091	0.020	<0.007	0.0087
Anthracene	0.15	0.089	0.88	<0.007	0.073	0.027	0.24	0.016	<0.007	<0.007
Benzo(a)anthracene	0.65	0.40	1.6	<0.007	0.26	0.082	0.82	0.081	<0.007	<0.007
Benzo(a)pyrene	0.71	0.48	1.5	<0.007	0.31	0.098	0.87	0.091	<0.007	<0.007
Benzo(b)fluoranthene	0.98	0.62	1.9	<0.007	0.40	0.015	1.1	0.13	<0.007	0.0079
Benzo(g,h,i)perylene	0.66	0.41	1.1	0.012	0.25	0.091	0.67	0.068	<0.007	0.012
Benzo(k)fluoranthene	0.35	0.23	0.67	<0.007	0.14	0.046	0.33	0.045	<0.007	<0.007
Chrysene	0.73	0.46	1.6	<0.007	0.30	0.12	0.89	0.097	<0.007	<0.007
Dibenzo(a,h)anthracene	0.15	0.097	0.28	<0.007	0.064	0.022	0.15	0.015	<0.007	<0.007
Fluoranthene	1.2	0.65	3.1	0.016	0.50	0.20	1.7	0.17	<0.007	0.019
Fluorene	0.028	0.018	0.48	<0.007	0.015	0.0073	0.060	<0.008	<0.007	<0.007
Indeno(1,2,3-cd)pyrene	0.65	0.44	1.1	<0.007	0.26	0.093	0.67	0.068	<0.007	<0.007
2-Methylnaphthalene	0.017	0.016	0.34	0.012	0.0082	<0.007	0.016	<0.008	<0.007	0.0082
Naphthalene	0.036	0.029	0.57	<0.007	0.017	<0.007	0.039	<0.008	<0.007	<0.007
Phenanthrene	0.43	0.20	2.7	0.013	0.24	0.11	1.1	0.069	<0.007	0.013
Pyrene	1.1	0.63	2.8	0.019	0.46	0.18	1.7	0.15	<0.007	0.022
Total Reported PAHs	8.1	4.93	21.6	0.084	3.38	1.13	10.5	1.02	ND	0.091

Soil Sample	IROCP SSV Residential	VDH Values	Summary Statistics All Soils: Samples n	Detections d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR	Summary Statistics Shallow Soils (0-3 ft): Samples n	Detections d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR
Acenaphthene	3400	NA	10	4	0.082	0.228	0.244	0.73	8.9	7	4	0.116	0.271	0.346	0.73	6.3
Acenaphthylene	NA	NA	10	9	0.091	0.098	0.160	0.28	3.1	7	7	0.127	0.097	0.209	0.28	2.2
Anthracene	17000	NA	10	7	0.149	0.268	0.339	0.88	5.9	7	7	0.211	0.305	0.469	0.88	4.2
Benzo(a)anthracene	0.15	NA	10	7	0.390	0.513	0.754	1.6	4.1	7	7	0.556	0.537	1.011	1.6	2.9
Benzo(a)pyrene	0.015	0.01	10	7	0.407	0.494	0.757	1.5	3.7	7	7	0.580	0.500	1.004	1.5	2.6
Benzo(b)fluoranthene	0.15	NA	10	8	0.516	0.639	0.969	1.9	3.7	7	7	0.735	0.653	1.288	1.9	2.6
Benzo(g,h,i)perylene	NA	NA	10	9	0.328	0.375	0.593	1.1	3.4	7	7	0.464	0.372	0.779	1.1	2.4
Benzo(k)fluoranthene	1.5	NA	10	7	0.182	0.217	0.336	0.67	3.7	7	7	0.259	0.219	0.444	0.67	2.6
Chrysene	15	NA	10	7	0.421	0.521	0.790	1.6	3.8	7	7	0.600	0.531	1.050	1.6	2.7
Dibenzo(a,h)anthracene	0.015	NA	10	7	0.079	0.092	0.144	0.28	3.6	7	7	0.111	0.092	0.189	0.28	2.5
Fluoranthene	2300	NA	10	9	0.756	0.998	1.463	3.1	4.1	7	7	1.074	1.049	1.963	3.1	2.9
Fluorene	2300	NA	10	6	0.062	0.148	0.167	0.48	7.7	7	6	0.087	0.174	0.235	0.48	5.5
Indeno(1,2,3-cd)pyrene	0.15	NA	10	7	0.329	0.376	0.596	1.1	3.3	7	7	0.469	0.369	0.782	1.1	2.3
2-Methylnaphthalene	230	NA	10	7	0.043	0.105	0.117	0.34	7.9	7	5	0.058	0.125	0.163	0.34	5.9
Naphthalene	3.6	1070	10	5	0.071	0.176	0.196	0.57	8.0	7	5	0.100	0.208	0.276	0.57	5.7
Phenanthrene	NA	NA	10	9	0.49	0.84	1.09	2.7	5.5	7	7	0.69	0.95	1.50	2.7	3.9
Pyrene	1700	NA	10	9	0.71	0.92	1.36	2.8	4.0	7	7	1.00	0.96	1.82	2.8	2.8
Total Reported PAHs	-	-	9	9	5.649	7.019	######	21.63	3.8	7	7	7.238	7.241	######	21.63	3.0

NOTES:
All values reported in mg/kg, dry, unless otherwise indicated.
IROCP = April 2012 Investigation and Remediation of Contaminated Properties document.
SSV= Soil Screening Values from Appendix A of the IROCP with RSL updates from November 2013
NDxxx = Not Detected< Detection Limit
Results reported above detection limits are indicated in bold
Detection limits and reported concentrations above the residential SSV are shaded.
NA = No IROCP SSV available
VDH = Vermont Department of Health Soil Screening Values

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TABLE 3. Soil Sampling Metals Data Summary
28 Archibald Street
Burlington, Vermont
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Soil Sample / Sample Depth (ft.) / PID reading (ppm) / Sample Date	SB-1 (0-2) 0-2 0.0 1/30/14	SB-2 (0-2) 0-2 0.0 1/30/14	SB-3 (2-3) 0-2 0.0 1/30/14	SB-3 (8-10) 8-10 0.0 1/30/14	SB-4 (0-2) 0-2 0.0 1/30/14	SB-5 (0-2) 0-2 0.0 1/30/14	SB-6 (0-2) 0-2 0.0 1/30/14	SB-7 (0-2) 0-2 0.0 1/30/14	SB-7 (8-10) 8-10 0.0 1/30/14	Duplicate 8-10 0.0 1/30/14	IROCP SSV Residential	VDH Values
TOTAL METALS (mg/kg, dry)												
Antimony	**0.9**	**1.6**	**2.1**	<0.5	**1.1**	<0.5	**0.6**	**0.5**	<0.5	<0.5	31	NA
Arsenic	5.2	7.0	6.8	2.6	5.4	4.8	6.5	6.3	3.7	5.1	0.61	NA
Beryllium	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	160	NA
Cadmium	**2.0**	**0.9**	**1.6**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	70	34.5
Chromium (total)	**20**	**21**	**27**	**8.5**	**18**	**14**	**20**	**24**	**11**	**11**	NA	NA
Copper	**14**	**24**	**28**	**6.8**	**16.0**	**12**	**16**	**18**	**7.2**	**8.3**	3,100	NA
Lead	**200**	**209**	**880**	**7.0**	**160**	**91**	**160**	**130**	**3.7**	**12**	400	NA
Mercury	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	10	NA
Nickel	**18**	**18**	**21**	**13**	**17**	**15**	**17**	**21**	**16**	**15**	1,500	NA
Selenium	<0.5	<0.5	**0.6**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	390	NA
Silver	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	390	NA
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.78	NA
Zinc	**240**	**240**	**670**	**29**	**140**	**81**	**120**	**150**	**28**	**30**	23,000	NA

	Summary Statistics All Soils							Summary Statistics Shallow Soils (0-3 ft)						
Soil Sample	Sample n	Detected d	MEAN (mg/kg)	SD (mg/kg)	95th Cl (mg/kg)	MAX (mg/kg)	HSR	Sample n	Detected d	MEAN (mg/kg)	SD (mg/kg)	95th Cl (mg/kg)	MAX (mg/kg)	HSR
Antimony	10	6	0.8	0.6	1.2	2.1	2.7	7	4	1.0	0.7	1.6	2.1	2.1
Arsenic	10	10	5.3	1.4	6.3	7	1.3	7	7	6.0	0.9	6.7	7.0	1.2
Beryllium	10	1	0.3	0.2	0.4	0.8	2.6	7	1	0.3	0.2	0.5	0.8	2.4
Cadmium	10	3	0.6	0.7	1.1	2	3.2	7	2	0.8	0.7	1.4	1.6	2.0
Chromium (total)	10	10	17.5	6.1	21.8	27	1.5	7	7	20.6	4.2	24.1	27	1.3
Copper	10	10	15.0	7.0	20.0	28	1.9	7	7	18.3	5.7	23.1	28.0	1.5
Lead	9	9	108.1	83.0	170.1	209	1.9	6	6	158.3	43.9	198.5	209	1.3
Mercury	10	2	0.1	0.02	0.1	0.1	1.7	7	2	0.1	0.02	0.1	0.1	1.6
Nickel	10	10	17.1	2.6	18.9	21	1.2	7	7	18.1	2.2	20.0	21	1.2
Selenium	10	1	0.3	0.1	0.4	0.6	2.1	7	1	0.3	0.1	0.4	0.6	2.0
Silver	10	0	–	–	–	–	–	7	0	–	–	–	–	–
Thallium	10	0	–	–	–	–	–	7	0	–	–	–	–	–
Zinc	10	10	172.8	191.8	308.7	670	3.9	7	7	234.4	201.0	404.7	670	2.9

NOTES:
All values reported in mg/kg, dry, unless otherwise indicated.
ROCP = April 2012 Investigation and Remediation of Contaminated Properties document.
SSV= Soil Screening Values from Appendix A of the IROCP with RSL updates from November 2013
ND<xx = Not Detected< Detection Limit
Results reported above detection limits are indicated in bold
Detection limits and reported concentrations above the residential SSV are shaded.
Shaded values exceed the applicable IROCP SSv for Residents.
NA = No IROCP SSV available
VDH = Vermont Department of Health Soil Screening Values
Shaded value is removed from the Stats.

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Table 4. Soil Sampling TPH and PCB Data Summary
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Burlington, Vermont
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Soil Sample Sample Depth (ft.) PID reading (ppm) Sample Date	SB-1 (0-2) 0-2 0.0 1/30/14	SB-2 (0-2) 0-2 0.0 1/30/14	SB-3 (2-3) 0-2 0.0 1/30/14	SB-3 (8-10) 8-10 0.0 1/30/14	SB-4 (0-2) 0-2 0.0 1/30/14	SB-5 (0-2) 0-2 0.0 1/30/14	SB-6 (0-2) 0-2 0.0 1/30/14	SB-7 (0-2) 0-2 0.0 1/30/14	SB-7 (8-10) 8-10 0.0 1/30/14	Duplicate 8-10 0.0 1/30/14	IROCP SSV Residential		Summary Statistics All Soils Sample n	tectio d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR	Summary Statistics Shallow Soils (0-3 ft) ample n	tectio d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR
TPH, EPA Method 8100																										
TPH (mg/kg, dry)	**98**	**81**	**160**	<20	**74**	**36**	**83**	**25**	<20	<20	200.		10	7	58.7	49.3	93.7	160	2.7	7	5	79.6	44.2	117.0	160	2.0

Soil Sample Sample Depth (ft.) PID reading (ppm) Sample Date	SB-1 (0-2) 0-2 0.0 1/30/14	SB-2 (0-2) 0-2 0.0 1/30/14	SB-3 (2-3) 0-2 0.0 1/30/14	SB-3 (8-10) 8-10 0.0 1/30/14	SB-4 (0-2) 0-2 0.0 1/30/14	SB-5 (0-2) 0-2 0.0 1/30/14	SB-6 (0-2) 0-2 0.0 1/30/14	SB-7 (0-2) 0-2 0.0 1/30/14	SB-7 (8-10) 8-10 0.0 1/30/14	Duplicate 8-10 0.0 1/30/14	IROCP SSV Residential (mg/kg)	VDH Value (mg/kg)	Summary Statistics All Soils ample n	tectio d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR	Summary Statistics Shallow Soils (0-3 ft) ample n	tectio d	MEAN (mg/kg)	SD (mg/kg)	95th CI (mg/kg)	MAX (mg/kg)	HSR
PCBs, EPA Method 8082																										
Aroclor 1221	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.14	-	10	0	–	–	–	--	–	7	0	–	–	–	–	–
Aroclor 1242	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.22	-	10	0	–	–	–	--	–	7	0	–	–	–	–	–
Aroclor 1254	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.22	-	10	0	–	–	–	--	–	7	0	–	–	–	–	–
Aroclor 1061	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	3.9	-	10	0	–	–	–	--	–	7	0	–	–	–	–	–
Aroclor 1232	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.14	-	10	0	–	–	–	--	–	7	0	–	–	–	–	–
Aroclor 1248	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.22	-	10	0	–	–	–	--	–	7	0	–	–	–	–	–
Aroclor 1260	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.22	-	10	0	–	–	–	--	–	7	0	–	–	–	–	–
Total PCBs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		0.12	0	0	–	–	–	--	–	0	0	–	–	–	–	–

NOTES:
All values reported in mg/kg, dry, unless otherwise indicated.
ROCP = April 2012 Investigation and Remediation of Contaminated Properties document.
SSV = Soil Screening Values from Appendix A of the ROCP with RSL updates from November 2013
ND<xx = Not Detected< Detection Limit
Results reported above detection limits are indicated in bold
Detection limits and reported concentrations above the residential SSV are shaded.

APPENDIX B. RISK EVALUTION TABLES

TABLE 5. COMPOUNDS OF POTENTIAL CONCERN IDENTIFIED IN SOIL

Class	Compound		CASRN
Semi-Volatile Organic Compounds			
	Acenaphthene		83-32-9
	Acenaphthylene		208-96-8
	Anthracene		120-12-7
	Benz[a]anthracene		56-55-3
	Benzo[a]pyrene		50-32-8
	Benzo[b]fluoranthene		205-99-2
	Benzo[g,h,i]perylene		191-24-2
	Benzo[k]fluoranthene		207-08-9
	Chrysene		218-01-9
	Dibenz[a,h]anthracene		53-70-3
	Fluoranthene		206-44-0
	Fluorene		86-73-7
	Indeno[1,2,3-c,d]pyrene		193-39-5
	2-Methylnaphthalene		91-57-6
	Naphthalene		91-20-3
	Phenanthrene		85-01-8
	Pyrene		129-00-0
Metals			
	Antimony	(tetraoxide)	1332-81-6
	Arsenic	(Inorganic)	7440-38-2
	Beryllium	and compounds	7440-41-7
	Cadmium	(diet)	7440-43-9
	Chromium	(total)	7440-47-3
	Copper		7440-50-8
	Lead	and compounds	7439-92-1
	Mercury	(Inorganic Salts)	0000-07-7
	Nickel	(Soluble Salts)	7440-02-0
	Selenium		7782-49-2
	Silver		7440-22-4
	Thallium	(Soluble Salts)	7440-28-0
	Zinc	and compounds	7440-66-6

TABLE 6. QUANTITATIVE EXPOSURE ESTIMATES

Scenario:		Variable	Units	Value
TABLE 6.1 Incidental Soil Ingestion - Adult Visitor (7 to 31 years)				
Exposure Assumptions:				
	Chemical Concentration in Soil	OHM_{soil}	mg/kg	
	Conversion Factor	CF	kg/mg	1E-06
	Relative Absorption Factor (default=1; or chemical-specific)	RAF	--	--
	Ingestion Rate	IR	mg/day	100
	Fractional Ingestion	FI	unitless	0.5
	Exposure Frequency	EF	days/year	240
	Exposure Duration	ED	years	24
	Body Weight - Adult	BW	kg	70
	Averaging Time - Carcinogenic	AT.c	days	25,550
	Averaging Time - Noncarcinogenic - Adult	AT.n	days	8,760
CID.c	=(CF*IR*FI*EF*ED)/(BW*AT.c)	CID.c	$(day)^{-1}$	1.6E-7
CID.n	=(CF*IR*FI*EF*ED)/(BW*AT.n)	CID.n	$(day)^{-1}$	4.7E-7
TABLE 6.3 Dermal Contact with Soil - Adult Visitor (7 to 31 years)				
Exposure Assumptions:				
	Chemical Concentration in Soil	CS	mg/kg	
	Conversion Factor	CF	kg/mg; day/hour	1E-06
	Skin Surface Area Available for Contact	SA	cm^2/event	5,700
	Soil-to-Skin Adherence Factor	AF	mg/cm^2	0.07
	Relative Absorption Factor (default=1: or chemical specific)	RAF	unitless	--
	Fractional Exposure	FI	unitless	0.5
	Exposure Frequency	EF	days/year	240
	Exposure Duration	ED	years	24
	Body Weight - Adult	BW	kg	70
	Averaging Time - Carcinogenic	AT.c	days	25,550
	Averaging Time - Noncarcinogenic - Adult	AT.n	days	8,760
CID.c	=(CF*SA*AF*FI*EF*ED)/(BW*AT.c)	CID.c	$(day)^{-1}$	6.4E-07
CID.n	=(CF*SA*AF*FI*EF*ED)/(BW.AT.n)	CID.n	$(day)^{-1}$	1.9E-06

TABLE 6. QUANTITATIVE EXPOSURE ESTIMATES

Scenario:			Variable	Units	Value
TABLE 6.2 Incidental Soil Ingestion - Child Visitor (<1 to 6 years)					
	Exposure Assumptions:				
		Chemical Concentration in Soil	OHM_{soil}	mg/kg	
		Conversion Factor	CF	kg/mg	1E-06
		Relative Absorption Factor (default=1; or chemical-specific)	RAF	--	--
		Ingestion Rate (default)	IR	mg/day	200
		Fractional Ingestion	FI	unitless	0.5
		Exposure Frequency	EF	days/year	240
		Exposure Duration	ED	years	6
		Body Weight - Child (mean age-specific)	BW	kg	15
		Averaging Time - Carcinogenic	AT.c	days	25,550
		Averaging Time - Noncarcinogenic - Child	AT.n	days	2,190
	CID.c	=(CF*IR*FI*EF*ED)/(BW*AT.c)	CID.c	$(day)^{-1}$	3.8E-7
	CID.n	=(CF*IR*FI*EF*ED)/(BW*AT.n)	CID.n	$(day)^{-1}$	4.4E-6
TABLE 6.4 Dermal Contact with Soil - Child Visitor (<1 to 6 years)					
	Exposure Assumptions:				
		Chemical Concentration in Soil	CS	mg/kg	
		Conversion Factor	CF	kg/mg; day/hour	1E-06
		Skin Surface Area Available for Contact (mean age-specific)	SA	cm^2/event	2,800
		Soil-to-Skin Adherence Factor	AF	mg/cm^2	0.2
		Relative Absorption Factor (default=1: or chemical specific)	RAF	unitless	--
		Exposure Frequency	FI	unitless	0.5
		Exposure Frequency	EF	days/year	240
		Exposure Duration	ED	years	6
		Body Weight - Child (mean age-specific)	BW	kg	15
		Averaging Time - Carcinogenic	AT.c	days	25,550
		Averaging Time - Noncarcinogenic - Child	AT.n	days	2,190
	CID.c	=(CF*SA*AF*EF*ED)/(BW*AT.c)	CID.c	$(day)^{-1}$	1.1E-06
	CID.n	=(CF*SA*AF*EF*ED)/(BW.AT.n)	CID.n	$(day)^{-1}$	1.2E-05

TABLE 6. QUANTITATIVE EXPOSURE ESTIMATES

Scenario:			Variable	Units	Value
TABLE 6.5 Incidental Soil Ingestion - Construction/Utility Worker					
	Exposure Assumptions:				
		Chemical Concentration in Soil	CS	mg/kg	--
		Conversion Factor	CF	kg/mg	1E-06
		Relative Absorption Factor (default=1; or chemical-specific)	RAF	--	--
		Ingestion Rate	IR	mg/day	330
		Fractional Ingestion	FI	unitless	1
		Exposure Frequency	EF	days/year	250
		Exposure Duration	ED	years	1
		Body Weight - Adult	BW	kg	70
		Averaging Time - Carcinogenic	AT.c	days	25,550
		Averaging Time - Noncarcinogenic - Adult	AT.n	days	365
CID.c	=(CF*IR*FI*EF*ED)/(BW*AT.c)		CID.c	$(day)^{-1}$	4.6E-8
CID.n	=(CF*IR*FI*EF*ED)/(BW*AT.n)		CID.n	$(day)^{-1}$	3.2E-6
TABLE 6.6 Dermal Contact with Soil - Construction/Utility Worker					
	Exposure Assumptions:				
		Chemical Concentration in Soil	CS	mg/kg	--
		Conversion Factor	CF	kg/mg	1E-06
		Skin Surface Area Available for Contact (1 event/day)	SA	cm^2/events	3,300
		Soil-to-Skin Adherence Factor	AF	mg/cm^2	0.3
		Relative Absorption Factor (default=1: or chemical specific)	RAF	unitless	--
		Events each day	FI	events/day	1
		Exposure Frequency	EF	days/year	250
		Exposure Duration	ED	years	1
		Body Weight - Adult	BW	kg	70
		Averaging Time - Carcinogenic	AT.c	days	25,550
		Averaging Time - Noncarcinogenic - Adult	AT.n	days	365
CID.c	=(CF*SA*AF*EF*ED)/(BW*AT.c)		CID.c	$(day)^{-1}$	1.4E-07
CID.n	=(CF*SA*AF*EF*ED)/(BW.AT.n)		CID.n	$(day)^{-1}$	9.7E-06

TABLE 6. QUANTITATIVE EXPOSURE ESTIMATES

Scenario:		Variable	Units	Value
TABLE 6.7 Incidental Soil Ingestion - Maintenance Worker				
Exposure Assumptions:				
	Chemical Concentration in Soil	CS	mg/kg	--
	Conversion Factor	CF	kg/mg	1E-06
	Relative Absorption Factor (default=1; or chemical-specific)	RAF	--	--
	Ingestion Rate	IR	mg/day	330
	Fractional Ingestion	FI	unitless	0.5
	Exposure Frequency	EF	days/year	250
	Exposure Duration	ED	years	25
	Body Weight - Adult	BW	kg	70
	Averaging Time - Carcinogenic	AT.c	days	25,550
	Averaging Time - Noncarcinogenic - Adult	AT.n	days	9,125
CID.c	=(CF*IR*FI*EF*ED)/(BW*AT.c)	CID.c	$(day)^{-1}$	5.8E-7
CID.n	=(CF*IR*FI*EF*ED)/(BW*AT.n)	CID.n	$(day)^{-1}$	1.6E-6
TABLE 6.8 Dermal Contact with Soil - Maintenance Worker				
Exposure Assumptions:				
	Chemical Concentration in Soil	CS	mg/kg	--
	Conversion Factor	CF	kg/mg	1E-06
	Skin Surface Area Available for Contact (1 event/day)	SA	cm^2/events	3,300
	Soil-to-Skin Adherence Factor (Adult Grounds Keeper)	AF	mg/cm^2	0.1
	Relative Absorption Factor (default=1: or chemical specific)	RAF	unitless	--
	Events each day	FI	events/day	0.5
	Exposure Frequency	EF	days/year	250
	Exposure Duration	ED	years	25
	Body Weight - Adult	BW	kg	70
	Averaging Time - Carcinogenic	AT.c	days	27,375
	Averaging Time - Noncarcinogenic - Adult	AT.n	days	9,125
CID.c	=(CF*SA*AF*FI*EF*ED)/(BW*AT.c)	CID.c	$(day)^{-1}$	5.4E-07
CID.n	=(CF*SA*AF*FI*EF*ED)/(BW.AT.n)	CID.n	$(day)^{-1}$	1.6E-06

TABLE 7. SUMMARY of EXPOSURE PARAMETER VALUES

Receptor	Source Medium	Route	Age	Effect	IR mg/day	FI unitless	EF days/year	ED Year	SA cm^2/day	AF mg/cm^2	BW kg	AT.n days	AT.c days	CDI[a] mg/kg-day
Resident	Soil	Ingestion	Child (1-6)	Carc	200	0.50	240	6	--	--	15	--	25,550	3.8E-7
				Nonc	200	0.50	240	6	--	--	15	2,190	--	4.4E-6
			Adult (7-31)	Carc	100	0.50	240	24	--	--	70	--	25,550	1.6E-7
				Nonc	100	0.50	240	24	--	--	70	8,760	--	4.7E-7
		Dermal	Child (1-6)	Carc	--	0.50	240	6	2,800	0.2	15	--	25,550	1.1E-6
				Nonc	--	0.50	240	6	2,800	0.2	15	2,190	--	1.2E-5
			Adult (7-31)	Carc	--	0.50	240	24	5,700	0.07	70	--	25,550	6.4E-7
				Nonc	--	0.50	240	24	5,700	0.07	70	8,760	--	1.9E-6
Construction/Utility Worker	Soil	Ingestion	Adult	Carc	330	--	250	1.0	--	--	70	--	25,550	4.6E-8
				NonC	330	--	250	1.0	--	--	70	365	--	3.2E-6
		Dermal	Adult	Carc	--	1.00	250	1.0	3,300	0.3	70	--	25,550	1.4E-7
				NonC	--	1.00	250	1.0	3,300	0.3	70	365	--	9.7E-6
Maintenance Worker	Soil	Ingestion	Adult	Carc	330	0.50	250	25	--	--	70	--	25,550	5.8E-7
				Nonc	330	0.50	250	25	--	--	70	9,125	--	1.6E-6
		Dermal	Adult	Carc	--	0.50	250	25	3,300	0.1	70	--	25,550	5.4E-7
				Nonc	--	0.50	250	25	3,300	0.1	70	9,125	--	1.6E-6

NOTES:

AF - Soil adherence factor
BW - Body weight
CF - Conversion Factor
ED - Exposure Duration
EF - Exposure Frequency

IR - Ingestion Rate
SA - Contact Surface Area
FI - Fraction Intake
Nonc - Non-carcinogenic effect
Carc - Carcinogenic effect

[a] Chemical dependent intake (CDI) values are exclusive of chemical concentration, K_p, and relative absorption factor (RAF).
Multiply CDI value by chemical-specific concentration in media, chemical specific factors (K_p), and pathway specific RAF.

[b] CDI for the Food Ingestion pathway is estimated in Table 4.2 for food and age specific consumption (MADEP 1995).

TABLE 8. CoPC TOXICITY VALUES

Compounds		CASRN	CSF_{oral} (mg/kg-day)$^{-1}$		Chronic RfD (mg/kg-day)		Subchronic RfD (mg/kg-day)	
Semi-Volatile Organic Compounds								
Acenaphthene		83-32-9	NA		6.00E-02	I	2.00E-01	P
Acenaphthylene		208-96-8	NA		6.00E-02	F	6.00E-01	Z
Anthracene		120-12-7	NA		3.00E-01	I	1.00E+00	P
Benz[a]anthracene		56-55-3	7.30E-01	W	3.00E-02	D	3.00E-01	Z
Benzo[a]pyrene		50-32-8	7.30E+00	I	3.00E-02	D	3.00E-01	Z
Benzo[b]fluoranthene		205-99-2	7.30E-01	W	4.00E-02	B	4.00E-01	Z
Benzo[g,h,i]perylene		191-24-2	NA		6.00E-02	D	6.00E-01	Z
Benzo[k]fluoranthene		207-08-9	7.30E-02	W	4.00E-02	B	4.00E-01	Z
Chrysene		218-01-9	7.30E-03	W	3.00E-01	C	3.00E+00	Z
Dibenz[a,h]anthracene		53-70-3	7.30E+00	W	3.00E-01	M,C	3.00E+00	Z
Fluoranthene		206-44-0	NA		4.00E-02	I	1.00E-02	P
Fluorene		86-73-7	NA		4.00E-02	I	4.00E-02	E
Indeno[1,2,3-c,d]pyrene		193-39-5	7.30E-01	W	4.00E-02	B	4.00E-01	Z
2-Methylnaphthalene		91-57-6	NA		4.00E-03	I	4.00E-03	P
Naphthalene		91-20-3	NA		2.00E-02	I	6.00E-01	E
Phenanthrene		85-01-8	NA		3.00E-01	C	3.00E+00	Z
Pyrene		129-00-0	NA		3.00E-02	I	3.00E-01	P
Metals								
Antimony	(tetraoxide)	1332-81-6	NA		4.00E-04	H	4.00E-04	H
Arsenic	(Inorganic)	7440-38-2	1.50E+00	I	3.00E-04	I	5.00E-03	P
Beryllium	and compounds	7440-41-7	NA		2.00E-03	I	5.00E-03	H
Cadmium	(diet)	7440-43-9	NA		1.00E-03	I	5.00E-04	A
Chromium	(total)	7440-47-3	NA		1.50E+00	I	1.50E+00	I
Copper		7440-50-8	NA		4.00E-02	H	1.00E-02	E
Lead	and compounds	7439-92-1	NA		7.50E-04	M	7.50E-04	M
Mercury	(Inorganic Salts)	0000-07-7	NA		3.00E-04	I	3.00E-03	Z
Nickel	(Soluble Salts)	7440-02-0	NA		2.00E-02	I	2.00E-02	H
Selenium		7782-49-2	NA		5.00E-03	I	5.00E-03	H
Silver		7440-22-4	NA		5.00E-03	I	5.00E-03	H
Thallium	(Soluble Salts)	7440-28-0	NA		1.00E-05	P	4.00E-05	R
Zinc	and compounds	7440-66-6	NA		3.00E-01	I	3.00E-01	E

NOTES: Toxicity Vlaues derived from RAIS 2014 or structurally similar compounds.
CSF = Chronic cancer slope factor.
NA = Not Available
RfC = Chronic inhalation reference concentration.
RfD = Chronic oral reference dose.
B Surrogate non-cancer toxicity value based on fluoranthene.
C Surrogate non-cancer toxicity value based on anthracene.
D Surrogate non-cancer toxicity value based on pyrene.
F Surrogate non-cancer toxicity value based on acenaphthene.

A ATSDR (draft)
E ATSDR (final)
H HEAST
I IRIS
M MassDEP Specific Toxicity Value
P PPRTV
R RAIS (2014)
W WHO/TEF
Z Presumed to be 10-fold less stringent.

TABLE 9. CHEMICAL-SPECIFIC RELATIVE ABSORPTION FACTORS

Class Compound		RAF_{SI}		RAF_{SD}	
Semi-Volatile Organic Compounds					
Acenaphthene		1.00	D	0.130	E
Acenaphthylene		1.00	D	0.130	E
Anthracene		1.00	D	0.130	E
Benz[a]anthracene		1.00	D	0.130	E
Benzo[a]pyrene		1.00	D	0.130	E
Benzo[b]fluoranthene		1.00	D	0.130	E
Benzo[g,h,i]perylene		1.00	D	0.130	E
Benzo[k]fluoranthene		1.00	D	0.130	E
Chrysene		1.00	D	0.130	E
Dibenz[a,h]anthracene		1.00	D	0.130	E
Fluoranthene		1.00	D	0.130	E
Fluorene		1.00	D	0.130	E
Indeno[1,2,3-c,d]pyrene		1.00	D	0.130	E
2-Methylnaphthalene		1.00	D	0.130	E
Naphthalene		1.00	D	0.130	E
Phenanthrene		1.00	D	0.130	E
Pyrene		1.00	D	0.130	E
Metals					
Antimony	(tetraoxide)	0.150	D	1.000	G
Arsenic	(Inorganic)	1.000	D	0.030	E
Beryllium	and compounds	0.007	D	1.000	G
Cadmium	(diet)	0.025	D	0.001	E
Chromium	(total)	0.013	D	1.000	G
Copper		1.000	D	1.000	G
Lead	and compounds	0.150	H,J	0.055	H,J
Mercury	(Inorganic Salts)	0.070	D	1.000	G
Nickel	(Soluble Salts)	0.040	D	1.000	G
Selenium		1.000	D	1.000	G
Silver		0.040	D	1.000	G
Thallium	(Soluble Salts)	1.000	D	1.000	G
Zinc	and compounds	1.000	D	1.000	G

NOTE:

[A] = Assumed route of administration based on other compounds in class.
[B] = Surrogate toxicity value and route of administration (See footnotes for Table 6).
[C] = Based on chemical-specific information provided in IRIS (U.S. EPA 2000).
[D] = RAIS 2014. U.S. EPA RAGS Part E Gastrointestinal Absorption Factor.
[E] = RAIS 2014. U.S. EPA RAGS Part E Dermal Absorption Factor.
[G] = Assumed Relative Absorption Factor (RAF) based on similar compound values.
[H] = U.S. EPA. 1994. Technical Support Document: Parameters and Equations Used in Integrated Exposure Uptake Biokinetic Model for Lead in Children (v 0.99d). PB94-963505, `
[J] = EPA/540/R-94/040. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

RAF_{SI} = RAF Soil Ingestion
RAF_{SD} = RAF Soil Dermal Contact

TABLE 10. CHEMICAL-SPECIFIC FACTORS

Analyte		CAS	Dermal Contact K_p (aqueous) (cm/hr)[a]	Tau (hr)	t* (hr)	B	FA	
Semi-Volatile Organic Compounds								
Acenaphthene		83-32-9	8.60E-02	0.56	1.34	0.20	1.00	C
Acenaphthylene		208-96-8	9.11E-02	0.56	1.34	0.20	1.00	C
Anthracene		120-12-7	1.42E-01	2.69	11.67	4.30	1.00	D
Benz[a]anthracene		56-55-3	5.52E-01	2.03	8.53	2.80	1.00	A
Benzo[a]pyrene		50-32-8	7.13E-01	2.69	11.67	4.30	1.00	A
Benzo[b]fluoranthene		205-99-2	4.17E-01	2.77	12.03	4.30	1.00	A
Benzo[g,h,i]perylene		191-24-2	1.12E+00	2.69	11.67	4.30	1.00	D
Benzo[k]fluoranthene		207-08-9	6.91E-01	2.77	12.03	4.30	1.00	E
Chrysene		218-01-9	5.96E-01	2.03	8.53	2.80	1.00	A
Dibenz[a,h]anthracene		53-70-3	9.53E-01	3.88	17.57	9.70	0.60	A
Fluoranthene		206-44-0	3.08E-01	1.45	5.68	1.20	1.00	A
Fluorene		86-73-7	1.10E-01	1.45	5.68	1.20	1.00	F
Indeno[1,2,3-c,d]pyrene		193-39-5	1.04E+00	3.78	16.83	6.70	0.60	A
2-Methylnaphthalene		91-57-6	9.17E-02	0.56	1.34	0.20	1.00	C
Naphthalene		91-20-3	4.66E-02	0.56	1.34	0.20	1.00	A
Phenanthrene		85-01-8	1.44E-01	1.06	4.11	0.70	1.00	A
Pyrene		129-00-0	2.01E-01	2.69	11.67	4.30	1.00	D
Metals								
Antimony	(tetraoxide)	1332-81-6	1.0E-03	--	--	--	--	
Arsenic	(Inorganic)	7440-38-2	1.0E-03	--	--	--	--	
Beryllium	and compounds	7440-41-7	1.0E-03	--	--	--	--	
Cadmium	(diet)	7440-43-9	1.0E-03	--	--	--	--	
Chromium	(total)	7440-47-3	1.0E-03	--	--	--	--	
Copper		7440-50-8	1.0E-03	--	--	--	--	
Lead	and compounds	7439-92-1	1.0E-04	--	--	--	--	
Mercury	(Inorganic Salts)	0000-07-7	1.0E-03	--	--	--	--	
Nickel	(Soluble Salts)	7440-02-0	2.0E-04	--	--	--	--	
Selenium		7782-49-2	1.0E-03	--	--	--	--	
Silver		7440-22-4	6.0E-04	--	--	--	--	
Thallium	(Soluble Salts)	7440-28-0	1.0E-03	--	--	--	--	
Zinc	and compounds	7440-66-6	6.0E-04	--	--	--	--	

NOTES:
-- = No value is available.
NA = Not Applicable.
K_p = Aqueous skin permeability coefficient (measured preferred)
Tau = Resistance to diffusion (hour).
t* = time to reach steady state (hrs).

KEY
[A]When avialbale, taken from U.S. EPA RAGS Part E, otherwise obtained from RAIS (2014).
[C]Surrogate values based on naphthalene.
[D]Surrogate values based on benzo[a]pyrene.
[E]Surrogate values based on benzo[b]fluoranthene.
[E]Surrogate values based on fluoranthene.

TABLE 11. EXPOSURE POINT CONCENTRATIONS FOR SOILS

COMPOUND	Mean of Shallow Soils (mg/kg)	Mean of All Soils (mg/kg)
Semi-Volatile Organic Compounds		
Acenaphthene	0.12	0.08
Acenaphthylene	0.13	0.09
Anthracene	0.21	0.15
Benz[a]anthracene	0.56	0.39
Benzo[a]pyrene	0.58	0.41
Benzo[b]fluoranthene	0.74	0.52
Benzo[g,h,i]perylene	0.46	0.33
Benzo[k]fluoranthene	0.26	0.18
Chrysene	0.60	0.42
Dibenz[a,h]anthracene	0.11	0.08
Fluoranthene	1.07	0.76
Fluorene	0.09	0.06
Indeno[1,2,3-c,d]pyrene	0.47	0.33
2-Methylnaphthalene	0.06	0.04
Naphthalene	0.10	0.07
Phenanthrene	0.69	0.49
Pyrene	1.00	0.71
Metals		
Antimony	1.01	0.78
Arsenic	6.00	5.34
Beryllium	0.33	0.31
Cadmium	0.79	0.63
Chromium	20.57	17.45
Copper	18.29	15.03
Lead	158.33	108.08
Mercury	0.06	0.06
Nickel	18.14	17.10
Selenium	0.30	0.29
Silver	--	--
Thallium	--	--
Zinc	234.43	172.80

NOTES:

-- Not detected in analytical analysis.

TABLE 12. INCIDENTAL INGESTION OF SOIL - ADULT VISITOR (7 to 31 years)

Organic Chemical	Soil Concentration (mg/kg)	Compound RAF	Carcinogenic Effects: CID[b] $(day)^{-1}$	Carcinogenic Effects: Oral SF[a] $(mg/kg\text{-}day)^{-1}$	Carcinogenic Effects: Excess Risk	Noncarcinogenic Effects: CID[b] $(day)^{-1}$	Noncarcinogenic Effects: C Oral RfD[a] (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	1.00	1.6E-7	NA		4.7E-7	6.00E-02	9.1E-07
Acenaphthylene	0.13	1.00	1.6E-7	NA		4.7E-7	6.00E-02	9.9E-07
Anthracene	0.21	1.00	1.6E-7	NA		4.7E-7	3.00E-01	3.3E-07
Benz[a]anthracene	0.56	1.00	1.6E-7	7.30E-01	6.5E-08	4.7E-7	3.00E-02	8.7E-06
Benzo[a]pyrene	0.58	1.00	1.6E-7	7.30E+00	6.8E-07	4.7E-7	3.00E-02	9.1E-06
Benzo[b]fluoranthene	0.74	1.00	1.6E-7	7.30E-01	8.6E-08	4.7E-7	4.00E-02	8.6E-06
Benzo[g,h,i]perylene	0.46	1.00	1.6E-7	NA		4.7E-7	6.00E-02	3.6E-06
Benzo[k]fluoranthene	0.26	1.00	1.6E-7	7.30E-02	3.0E-09	4.7E-7	4.00E-02	3.0E-06
Chrysene	0.60	1.00	1.6E-7	7.30E-03	7.0E-10	4.7E-7	3.00E-01	9.4E-07
Dibenz[a,h]anthracene	0.11	1.00	1.6E-7	7.30E+00	1.3E-07	4.7E-7	3.00E-01	1.7E-07
Fluoranthene	1.07	1.00	1.6E-7	NA		4.7E-7	4.00E-02	1.3E-05
Fluorene	0.09	1.00	1.6E-7	NA		4.7E-7	4.00E-02	1.0E-06
Indeno[1,2,3-c,d]pyrene	0.47	1.00	1.6E-7	7.30E-01	5.5E-08	4.7E-7	4.00E-02	5.5E-06
2-Methylnaphthalene	0.06	1.00	1.6E-7	NA		4.7E-7	4.00E-03	6.8E-06
Naphthalene	0.10	1.00	1.6E-7	NA		4.7E-7	2.00E-02	2.3E-06
Phenanthrene	0.69	1.00	1.6E-7	NA		4.7E-7	3.00E-01	1.1E-06
Pyrene	1.00	1.00	1.6E-7	NA		4.7E-7	3.00E-02	1.6E-05
Metals								
Antimony	1.01	0.15	1.6E-7	NA		4.7E-7	4.00E-04	1.8E-04
Arsenic	6.00	1.00	1.6E-7	1.50E+00	1.4E-06	4.7E-7	3.00E-04	9.4E-03
Beryllium	0.33	0.01	1.6E-7	NA		4.7E-7	2.00E-03	5.4E-07
Cadmium	0.79	0.03	1.6E-7	NA		4.7E-7	1.00E-03	9.2E-06
Chromium	20.57	0.01	1.6E-7	NA		4.7E-7	1.50E+00	8.4E-08
Copper	18.29	1.00	1.6E-7	NA		4.7E-7	4.00E-02	2.1E-04
Lead	158.33	0.15	1.6E-7	NA		4.7E-7	7.50E-04	1.5E-02
Mercury	0.06	0.07	1.6E-7	NA		4.7E-7	3.00E-04	7.0E-06
Nickel	18.14	0.04	1.6E-7	NA		4.7E-7	2.00E-02	1.7E-05
Selenium	0.30	1.00	1.6E-7	NA		4.7E-7	5.00E-03	2.8E-05
Silver	--	0.04	1.6E-7	NA		4.7E-7	5.00E-03	
Thallium	--	1.00	1.6E-7	NA		4.7E-7	1.00E-05	
Zinc	234.43	1.00	1.6E-7	NA		4.7E-7	3.00E-01	3.7E-04
Total Ingestion Cancer Risk:					2.5E-06			
Total Ingestion Hazard Index:								2.5E-02
			Total Cancer Risk:		3.2E-06			
			Total Non-Cancer Risk:					5.8E-02

NOTES:
-- = Not Detected.
NA = Not Available
NE = Not Evaluated
C Oral RfD - Chronic Oral Reference Dose.
SF - Cancer Slope Factor.
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from RAIS 2014.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 13. INCIDENTAL INGESTION OF SOIL - CHILD VISITOR (<1 to 6 years)

Organic Chemical	Soil Concentration (mg/kg)	Compound RAF	Carcinogenic Effects CID[b] (day)$^{-1}$	Carcinogenic Effects Oral SF[a] (mg/kg-day)$^{-1}$	Carcinogenic Effects Excess Risk	Noncarcinogenic Effects CID[b] (day)$^{-1}$	Noncarcinogenic Effects C Oral RfD[a] (mg/kg-day)	Noncarcinogenic Effects Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	1.00	3.8E-7	NA		4.4E-6	6.00E-02	8.5E-06
Acenaphthylene	0.13	1.00	3.8E-7	NA		4.4E-6	6.00E-02	9.3E-06
Anthracene	0.21	1.00	3.8E-7	NA		4.4E-6	3.00E-01	3.1E-06
Benz[a]anthracene	0.56	1.00	3.8E-7	7.30E-01	9.2E-08	4.4E-6	3.00E-02	8.1E-05
Benzo[a]pyrene	0.58	1.00	3.8E-7	7.30E+00	9.5E-07	4.4E-6	3.00E-02	8.5E-05
Benzo[b]fluoranthene	0.74	1.00	3.8E-7	7.30E-01	1.2E-07	4.4E-6	4.00E-02	8.1E-05
Benzo[g,h,i]perylene	0.46	1.00	3.8E-7	NA		4.4E-6	6.00E-02	3.4E-05
Benzo[k]fluoranthene	0.26	1.00	3.8E-7	7.30E-02	4.3E-09	4.4E-6	4.00E-02	2.8E-05
Chrysene	0.60	1.00	3.8E-7	7.30E-03	9.9E-10	4.4E-6	3.00E-01	8.8E-06
Dibenz[a,h]anthracene	0.11	1.00	3.8E-7	7.30E+00	1.8E-07	4.4E-6	3.00E-01	1.6E-06
Fluoranthene	1.07	1.00	3.8E-7	NA		4.4E-6	4.00E-02	1.2E-04
Fluorene	0.09	1.00	3.8E-7	NA		4.4E-6	4.00E-02	9.6E-06
Indeno[1,2,3-c,d]pyrene	0.47	1.00	3.8E-7	7.30E-01	7.7E-08	4.4E-6	4.00E-02	5.1E-05
2-Methylnaphthalene	0.06	1.00	3.8E-7	NA		4.4E-6	4.00E-03	6.3E-05
Naphthalene	0.10	1.00	3.8E-7	NA		4.4E-6	2.00E-02	2.2E-05
Phenanthrene	0.69	1.00	3.8E-7	NA		4.4E-6	3.00E-01	1.0E-05
Pyrene	1.00	1.00	3.8E-7	NA		4.4E-6	3.00E-02	1.5E-04
Metals								
Antimony	1.01	0.15	3.8E-7	NA		4.4E-6	4.00E-04	1.7E-03
Arsenic	6.00	1.00	3.8E-7	1.50E+00	2.0E-06	4.4E-6	3.00E-04	8.8E-02
Beryllium	0.33	0.01	3.8E-7	NA		4.4E-6	2.00E-03	5.0E-06
Cadmium	0.79	0.03	3.8E-7	NA		4.4E-6	1.00E-03	8.6E-05
Chromium	20.57	0.01	3.8E-7	NA		4.4E-6	1.50E+00	7.8E-07
Copper	18.29	1.00	3.8E-7	NA		4.4E-6	4.00E-02	2.0E-03
Lead	158.33	0.15	3.8E-7	NA		4.4E-6	7.50E-04	1.4E-01
Mercury	0.06	0.07	3.8E-7	NA		4.4E-6	3.00E-04	6.6E-05
Nickel	18.14	0.04	3.8E-7	NA		4.4E-6	2.00E-02	1.6E-04
Selenium	0.30	1.00	3.8E-7	NA		4.4E-6	5.00E-03	2.6E-04
Silver	--	0.04	3.8E-7	NA		4.4E-6	5.00E-03	
Thallium	--	1.00	3.8E-7	NA		4.4E-6	1.00E-05	
Zinc	234.43	1.00	3.8E-7	NA		4.4E-6	3.00E-01	3.4E-03
	Total Ingestion Cancer Risk:				3.5E-06			
	Total Ingestion Hazard Index:							2.3E-01
			Total Cancer Risk:		4.2E-06			
			Total Non-Cancer Risk:					4.5E-01

NOTES:
-- = Not Detected
NA = Not Available
NE = Not Evaluated
C Oral RfD - Chronic Oral Reference Dose.
SF - Cancer Slope Factor.
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from RAIS 2014.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 14. DERMAL CONTACT WITH SOIL - ADULT VISITOR (7 to 31 years)

Organic Chemical	Soil Concentration (mg/kg)	Compound RAF	Carcinogenic Effects CID[b] $(day)^{-1}$	Carcinogenic Effects Oral SF[a] $(mg/kg\text{-}day)^{-1}$	Carcinogenic Effects Excess Risk	Noncarcinogenic Effects CID[b] $(day)^{-1}$	Noncarcinogenic Effects C Oral RfD[a] (mg/kg-day)	Noncarcinogenic Effects Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	0.13	6.4E-7	NA		1.9E-6	6.00E-02	4.7E-07
Acenaphthylene	0.13	0.13	6.4E-7	NA		1.9E-6	6.00E-02	5.1E-07
Anthracene	0.21	0.13	6.4E-7	NA		1.9E-6	3.00E-01	1.7E-07
Benz[a]anthracene	0.56	0.13	6.4E-7	7.30E-01	3.4E-08	1.9E-6	3.00E-02	4.5E-06
Benzo[a]pyrene	0.58	0.13	6.4E-7	7.30E+00	3.5E-07	1.9E-6	3.00E-02	4.7E-06
Benzo[b]fluoranthene	0.74	0.13	6.4E-7	7.30E-01	4.5E-08	1.9E-6	4.00E-02	4.5E-06
Benzo[g,h,i]perylene	0.46	0.13	6.4E-7	NA		1.9E-6	6.00E-02	1.9E-06
Benzo[k]fluoranthene	0.26	0.13	6.4E-7	7.30E-02	1.6E-09	1.9E-6	4.00E-02	1.6E-06
Chrysene	0.60	0.13	6.4E-7	7.30E-03	3.7E-10	1.9E-6	3.00E-01	4.9E-07
Dibenz[a,h]anthracene	0.11	0.13	6.4E-7	7.30E+00	6.8E-08	1.9E-6	3.00E-01	9.0E-08
Fluoranthene	1.07	0.13	6.4E-7	NA		1.9E-6	4.00E-02	6.5E-06
Fluorene	0.09	0.13	6.4E-7	NA		1.9E-6	4.00E-02	5.3E-07
Indeno[1,2,3-c,d]pyrene	0.47	0.13	6.4E-7	7.30E-01	2.9E-08	1.9E-6	4.00E-02	2.9E-06
2-Methylnaphthalene	0.06	0.13	6.4E-7	NA		1.9E-6	4.00E-03	3.5E-06
Naphthalene	0.10	0.13	6.4E-7	NA		1.9E-6	2.00E-02	1.2E-06
Phenanthrene	0.69	0.13	6.4E-7	NA		1.9E-6	3.00E-01	5.6E-07
Pyrene	1.00	0.13	6.4E-7	NA		1.9E-6	3.00E-02	8.1E-06
Metals								
Antimony	1.01	1.00	6.4E-7	NA		1.9E-6	4.00E-04	4.7E-03
Arsenic	6.00	0.03	6.4E-7	1.50E+00	1.7E-07	1.9E-6	3.00E-04	1.1E-03
Beryllium	0.33	1.00	6.4E-7	NA		1.9E-6	2.00E-03	3.1E-04
Cadmium	0.79	0.00	6.4E-7	NA		1.9E-6	1.00E-03	1.5E-06
Chromium	20.57	1.00	6.4E-7	NA		1.9E-6	1.50E+00	2.6E-05
Copper	18.29	1.00	6.4E-7	NA		1.9E-6	4.00E-02	8.6E-04
Lead	158.33	0.05	6.4E-7	NA		1.9E-6	7.50E-04	2.2E-02
Mercury	0.06	1.00	6.4E-7	NA		1.9E-6	3.00E-04	4.0E-04
Nickel	18.14	1.00	6.4E-7	NA		1.9E-6	2.00E-02	1.7E-03
Selenium	0.30	1.00	6.4E-7	NA		1.9E-6	5.00E-03	1.1E-04
Silver	--	1.00	6.4E-7	NA		1.9E-6	5.00E-03	
Thallium	--	1.00	6.4E-7	NA		1.9E-6	1.00E-05	
Zinc	234.43	1.00	6.4E-7	NA		1.9E-6	3.00E-01	1.5E-03
Total Dermal Cancer Risk:					7.0E-07			
TotalDermal Hazard Index:								3.2E-02
			Total Cancer Risk:		7.0E-07			
			Total Non-Cancer Risk:					3.2E-02

NOTES:
-- = Not Detected
NA = Not Available
NE = Not Evaluated
C Oral RfD - Chronic Oral Reference Dose.
SF - Cancer Slope Factor.
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from RAIS 2014.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 15. DERMAL CONTACT WITH SOIL - CHILD VISITOR (<1 to 6 years)

Organic Chemical	Soil Concentration (mg/kg)	Compound RAF	Carcinogenic Effects CID[b] $(day)^{-1}$	Oral SF[a] $(mg/kg\text{-}day)^{-1}$	Excess Risk	Noncarcinogenic Effects CID[b] $(day)^{-1}$	C Oral RfD[a] (mg/kg-day)	Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	0.13	1.1E-6	NA		1.2E-5	6.00E-02	3.1E-06
Acenaphthylene	0.13	0.13	1.1E-6	NA		1.2E-5	6.00E-02	3.4E-06
Anthracene	0.21	0.13	1.1E-6	NA		1.2E-5	3.00E-01	1.1E-06
Benz[a]anthracene	0.56	0.13	1.1E-6	7.30E-01	3.3E-08	1.2E-5	3.00E-02	3.0E-05
Benzo[a]pyrene	0.58	0.13	1.1E-6	7.30E+00	3.5E-07	1.2E-5	3.00E-02	3.1E-05
Benzo[b]fluoranthene	0.74	0.13	1.1E-6	7.30E-01	4.4E-08	1.2E-5	4.00E-02	2.9E-05
Benzo[g,h,i]perylene	0.46	0.13	1.1E-6	NA		1.2E-5	6.00E-02	1.2E-05
Benzo[k]fluoranthene	0.26	0.13	1.1E-6	7.30E-02	1.5E-09	1.2E-5	4.00E-02	1.0E-05
Chrysene	0.60	0.13	1.1E-6	7.30E-03	3.6E-10	1.2E-5	3.00E-01	3.2E-06
Dibenz[a,h]anthracene	0.11	0.13	1.1E-6	7.30E+00	6.7E-08	1.2E-5	3.00E-01	5.9E-07
Fluoranthene	1.07	0.13	1.1E-6	NA		1.2E-5	4.00E-02	4.3E-05
Fluorene	0.09	0.13	1.1E-6	NA		1.2E-5	4.00E-02	3.5E-06
Indeno[1,2,3-c,d]pyrene	0.47	0.13	1.1E-6	7.30E-01	2.8E-08	1.2E-5	4.00E-02	1.9E-05
2-Methylnaphthalene	0.06	0.13	1.1E-6	NA		1.2E-5	4.00E-03	2.3E-05
Naphthalene	0.10	0.13	1.1E-6	NA		1.2E-5	2.00E-02	8.0E-06
Phenanthrene	0.69	0.13	1.1E-6	NA		1.2E-5	3.00E-01	3.7E-06
Pyrene	1.00	0.13	1.1E-6	NA		1.2E-5	3.00E-02	5.3E-05
Metals								
Antimony	1.01	1.00	1.1E-6	NA		1.2E-5	4.00E-04	3.1E-02
Arsenic	6.00	0.03	1.1E-6	1.50E+00	1.7E-07	1.2E-5	3.00E-04	7.4E-03
Beryllium	0.33	1.00	1.1E-6	NA		1.2E-5	2.00E-03	2.0E-03
Cadmium	0.79	0.00	1.1E-6	NA		1.2E-5	1.00E-03	9.6E-06
Chromium	20.57	1.00	1.1E-6	NA		1.2E-5	1.50E+00	1.7E-04
Copper	18.29	1.00	1.1E-6	NA		1.2E-5	4.00E-02	5.6E-03
Lead	158.33	0.05	1.1E-6	NA		1.2E-5	7.50E-04	1.4E-01
Mercury	0.06	1.00	1.1E-6	NA		1.2E-5	3.00E-04	2.6E-03
Nickel	18.14	1.00	1.1E-6	NA		1.2E-5	2.00E-02	1.1E-02
Selenium	0.30	1.00	1.1E-6	NA		1.2E-5	5.00E-03	7.4E-04
Silver	--	1.00	1.1E-6	NA		1.2E-5	5.00E-03	
Thallium	--	1.00	1.1E-6	NA		1.2E-5	1.00E-05	
Zinc	234.43	1.00	1.1E-6	NA		1.2E-5	3.00E-01	9.6E-03
Total Dermal Cancer Risk:					6.9E-07			
TotalDermal Hazard Index:								2.1E-01
			Total Cancer Risk:		6.9E-07			
			Total Non-Cancer Risk:					2.1E-01

NOTES:
-- = Not Detected
NA = Not Available
NE = Not Evaluated
C Oral RfD - Chronic Oral Reference Dose.
SF - Cancer Slope Factor.
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from RAIS 2014.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 16. INCIDENTAL INGESTION OF SOIL - CONSTRUCTION/UTILITY WORKER

Chemical	Soil Concentration (mg/kg)	Compound RAF	Carcinogenic Effects: CID[b] $(day)^{-1}$	Carcinogenic Effects: Oral CSF[a] $(mg/kg\text{-}day)^{-1}$	Carcinogenic Effects: Excess Risk	Noncarcinogenic Effects: CID[b] $(day)^{-1}$	Noncarcinogenic Effects: SC Oral RfD[a] (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	1.00	4.6E-8	NA		3.2E-6	2.00E-01	1.9E-06
Acenaphthylene	0.13	1.00	4.6E-8	NA		3.2E-6	6.00E-01	6.8E-07
Anthracene	0.21	1.00	4.6E-8	NA		3.2E-6	1.00E+00	6.8E-07
Benz[a]anthracene	0.56	1.00	4.6E-8	7.30E-01	1.9E-08	3.2E-6	3.00E-01	6.0E-06
Benzo[a]pyrene	0.58	1.00	4.6E-8	7.30E+00	2.0E-07	3.2E-6	3.00E-01	6.2E-06
Benzo[b]fluoranthene	0.74	1.00	4.6E-8	7.30E-01	2.5E-08	3.2E-6	4.00E-01	5.9E-06
Benzo[g,h,i]perylene	0.46	1.00	4.6E-8	NA		3.2E-6	6.00E-01	2.5E-06
Benzo[k]fluoranthene	0.26	1.00	4.6E-8	7.30E-02	8.7E-10	3.2E-6	4.00E-01	2.1E-06
Chrysene	0.60	1.00	4.6E-8	7.30E-03	2.0E-10	3.2E-6	3.00E+00	6.5E-07
Dibenz[a,h]anthracene	0.11	1.00	4.6E-8	7.30E+00	3.7E-08	3.2E-6	3.00E+00	1.2E-07
Fluoranthene	1.07	1.00	4.6E-8	NA		3.2E-6	1.00E-02	3.5E-04
Fluorene	0.09	1.00	4.6E-8	NA		3.2E-6	4.00E-02	7.1E-06
Indeno[1,2,3-c,d]pyrene	0.47	1.00	4.6E-8	7.30E-01	1.6E-08	3.2E-6	4.00E-01	3.8E-06
2-Methylnaphthalene	0.06	1.00	4.6E-8	NA		3.2E-6	4.00E-03	4.7E-05
Naphthalene	0.10	1.00	4.6E-8	NA		3.2E-6	6.00E-01	5.4E-07
Phenanthrene	0.69	1.00	4.6E-8	NA		3.2E-6	3.00E+00	7.5E-07
Pyrene	1.00	1.00	4.6E-8	NA		3.2E-6	3.00E-01	1.1E-05
Metals								
Antimony	1.01	0.15	4.6E-8	NA		3.2E-6	4.00E-04	1.2E-03
Arsenic	6.00	1.00	4.6E-8	1.50E+00	4.2E-07	3.2E-6	5.00E-03	3.9E-03
Beryllium	0.33	0.01	4.6E-8	NA		3.2E-6	5.00E-03	1.5E-06
Cadmium	0.79	0.03	4.6E-8	NA		3.2E-6	5.00E-04	1.3E-04
Chromium	20.57	0.01	4.6E-8	NA		3.2E-6	1.50E+00	5.8E-07
Copper	18.29	1.00	4.6E-8	NA		3.2E-6	1.00E-02	5.9E-03
Lead	158.33	0.15	4.6E-8	NA		3.2E-6	7.50E-04	1.0E-01
Mercury	0.06	0.07	4.6E-8	NA		3.2E-6	3.00E-03	4.8E-06
Nickel	18.14	0.04	4.6E-8	NA		3.2E-6	2.00E-02	1.2E-04
Selenium	0.30	1.00	4.6E-8	NA		3.2E-6	5.00E-03	1.9E-04
Silver	--	0.04	4.6E-8	NA		3.2E-6	5.00E-03	
Thallium	--	1.00	4.6E-8	NA		3.2E-6	4.00E-05	
Zinc	234.43	1.00	4.6E-8	NA		3.2E-6	3.00E-01	2.5E-03
Total Ingestion Cancer Risk:					7.1E-07			
Total Ingestion Hazard Index:								1.2E-01
Total Cancer risk:					8.6E-07			
Total Non-Cancer Risk:								2.9E-01

NOTES:
SC Oral RfD - SubChronic Oral Reference Dose (used for less than lifetime exposures).
CSF - Cancer Slope Factor.
-- - Not applicable
ND - Not Detected
NA - Not Available
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from RAIS 2014.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 17. DERMAL CONTACT WITH SOIL - CONSTRUCTION/UTILITY WORKER

Organic Chemical	Soil Concentration (mg/kg)	Compound ABS	Carcinogenic Effects: CID[b] (day)$^{-1}$	Carcinogenic Effects: Oral CSF[a] (mg/kg-day)$^{-1}$	Carcinogenic Effects: Excess Risk	Noncarcinogenic Effects: CID[b] (day)$^{-1}$	Noncarcinogenic Effects: SC Oral RfD[a] (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	0.13	1.4E-7	NA		9.7E-6	2.00E-01	7.3E-07
Acenaphthylene	0.13	0.13	1.4E-7	NA		9.7E-6	6.00E-01	2.7E-07
Anthracene	0.21	0.13	1.4E-7	NA		9.7E-6	1.00E+00	2.7E-07
Benz[a]anthracene	0.56	0.13	1.4E-7	7.30E-01	7.3E-09	9.7E-6	3.00E-01	2.3E-06
Benzo[a]pyrene	0.58	0.13	1.4E-7	7.30E+00	7.6E-08	9.7E-6	3.00E-01	2.4E-06
Benzo[b]fluoranthene	0.74	0.13	1.4E-7	7.30E-01	9.7E-09	9.7E-6	4.00E-01	2.3E-06
Benzo[g,h,i]perylene	0.46	0.13	1.4E-7	NA		9.7E-6	6.00E-01	9.7E-07
Benzo[k]fluoranthene	0.26	0.13	1.4E-7	7.30E-02	3.4E-10	9.7E-6	4.00E-01	8.1E-07
Chrysene	0.60	0.13	1.4E-7	7.30E-03	7.9E-11	9.7E-6	3.00E+00	2.5E-07
Dibenz[a,h]anthracene	0.11	0.13	1.4E-7	7.30E+00	1.5E-08	9.7E-6	3.00E+00	4.7E-08
Fluoranthene	1.07	0.13	1.4E-7	NA		9.7E-6	1.00E-02	1.4E-04
Fluorene	0.09	0.13	1.4E-7	NA		9.7E-6	4.00E-02	2.8E-06
Indeno[1,2,3-c,d]pyrene	0.47	0.13	1.4E-7	7.30E-01	6.2E-09	9.7E-6	4.00E-01	1.5E-06
2-Methylnaphthalene	0.06	0.13	1.4E-7	NA		9.7E-6	4.00E-03	1.8E-05
Naphthalene	0.10	0.13	1.4E-7	NA		9.7E-6	6.00E-01	2.1E-07
Phenanthrene	0.69	0.13	1.4E-7	NA		9.7E-6	3.00E+00	2.9E-07
Pyrene	1.00	0.13	1.4E-7	NA		9.7E-6	3.00E-01	4.2E-06
Metals								
Antimony	1.01	1.00	1.4E-7	NA		9.7E-6	4.00E-04	2.4E-02
Arsenic	6.00	0.03	1.4E-7	1.50E+00	3.7E-08	9.7E-6	5.00E-03	3.5E-04
Beryllium	0.33	1.00	1.4E-7	NA		9.7E-6	5.00E-03	6.4E-04
Cadmium	0.79	0.00	1.4E-7	NA		9.7E-6	5.00E-04	1.5E-05
Chromium	20.57	1.00	1.4E-7	NA		9.7E-6	1.50E+00	1.3E-04
Copper	18.29	1.00	1.4E-7	NA		9.7E-6	1.00E-02	1.8E-02
Lead	158.33	0.05	1.4E-7	NA		9.7E-6	7.50E-04	1.1E-01
Mercury	0.06	1.00	1.4E-7	NA		9.7E-6	3.00E-03	2.1E-04
Nickel	18.14	1.00	1.4E-7	NA		9.7E-6	2.00E-02	8.8E-03
Selenium	0.30	1.00	1.4E-7	NA		9.7E-6	5.00E-03	5.8E-04
Silver	--	1.00	1.4E-7	NA		9.7E-6	5.00E-03	
Thallium	--	1.00	1.4E-7	NA		9.7E-6	4.00E-05	
Zinc	234.43	1.00	1.4E-7	NA		9.7E-6	3.00E-01	7.6E-03
Total Ingestion Cancer Risk:					1.5E-07			
Total Ingestion Hazard Index:								1.7E-01
Total Cancer risk:					8.6E-07			
Total Non-Cancer Risk:								2.9E-01

NOTES:
SC Oral RfD - SubChronic Oral Reference Dose (used for less than lifetime exposures).
CSF - Cancer Slope Factor.
-- - Not applicable
ND - Not Detected
NA - Not Available
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from EPA Integrated Risk Information System (IRIS) files (April 1996), unless otherwise noted.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 18. INCIDENTAL INGESTION OF SOIL - MAINTENANCE WORKER

Chemical	Soil Concentration (mg/kg)	Compound RAF	Carcinogenic Effects: CID[b] (day)$^{-1}$	Carcinogenic Effects: Oral CSF[a] (mg/kg-day)$^{-1}$	Carcinogenic Effects: Excess Risk	Noncarcinogenic Effects: CID[b] (day)$^{-1}$	Noncarcinogenic Effects: SC Oral RfD[a] (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	1.00	5.8E-7	NA		1.6E-6	2.00E-01	9.4E-07
Acenaphthylene	0.13	1.00	5.8E-7	NA		1.6E-6	6.00E-01	3.4E-07
Anthracene	0.21	1.00	5.8E-7	NA		1.6E-6	1.00E+00	3.4E-07
Benz[a]anthracene	0.56	1.00	5.8E-7	7.30E-01	2.3E-07	1.6E-6	3.00E-01	3.0E-06
Benzo[a]pyrene	0.58	1.00	5.8E-7	7.30E+00	2.4E-06	1.6E-6	3.00E-01	3.1E-06
Benzo[b]fluoranthene	0.74	1.00	5.8E-7	7.30E-01	3.1E-07	1.6E-6	4.00E-01	3.0E-06
Benzo[g,h,i]perylene	0.46	1.00	5.8E-7	NA		1.6E-6	6.00E-01	1.2E-06
Benzo[k]fluoranthene	0.26	1.00	5.8E-7	7.30E-02	1.1E-08	1.6E-6	4.00E-01	1.0E-06
Chrysene	0.60	1.00	5.8E-7	7.30E-03	2.5E-09	1.6E-6	3.00E+00	3.2E-07
Dibenz[a,h]anthracene	0.11	1.00	5.8E-7	7.30E+00	4.7E-07	1.6E-6	3.00E+00	6.0E-08
Fluoranthene	1.07	1.00	5.8E-7	NA		1.6E-6	1.00E-02	1.7E-04
Fluorene	0.09	1.00	5.8E-7	NA		1.6E-6	4.00E-02	3.5E-06
Indeno[1,2,3-c,d]pyrene	0.47	1.00	5.8E-7	7.30E-01	2.0E-07	1.6E-6	4.00E-01	1.9E-06
2-Methylnaphthalene	0.06	1.00	5.8E-7	NA		1.6E-6	4.00E-03	2.3E-05
Naphthalene	0.10	1.00	5.8E-7	NA		1.6E-6	6.00E-01	2.7E-07
Phenanthrene	0.69	1.00	5.8E-7	NA		1.6E-6	3.00E+00	3.7E-07
Pyrene	1.00	1.00	5.8E-7	NA		1.6E-6	3.00E-01	5.4E-06
Metals								
Antimony	1.01	0.15	5.8E-7	NA		1.6E-6	4.00E-04	6.1E-04
Arsenic	6.00	1.00	5.8E-7	1.50E+00	5.2E-06	1.6E-6	5.00E-03	1.9E-03
Beryllium	0.33	0.01	5.8E-7	NA		1.6E-6	5.00E-03	7.4E-07
Cadmium	0.79	0.03	5.8E-7	NA		1.6E-6	5.00E-04	6.3E-05
Chromium	20.57	0.01	5.8E-7	NA		1.6E-6	1.50E+00	2.9E-07
Copper	18.29	1.00	5.8E-7	NA		1.6E-6	1.00E-02	3.0E-03
Lead	158.33	0.15	5.8E-7	NA		1.6E-6	7.50E-04	5.1E-02
Mercury	0.06	0.07	5.8E-7	NA		1.6E-6	3.00E-03	2.4E-06
Nickel	18.14	0.04	5.8E-7	NA		1.6E-6	2.00E-02	5.9E-05
Selenium	0.30	1.00	5.8E-7	NA		1.6E-6	5.00E-03	9.7E-05
Silver	--	0.04	5.8E-7	NA		1.6E-6	5.00E-03	
Thallium	--	1.00	5.8E-7	NA		1.6E-6	4.00E-05	
Zinc	234.43	1.00	5.8E-7	NA		1.6E-6	3.00E-01	1.3E-03
Total Ingestion Cancer Risk:					8.9E-06			
Total Ingestion Hazard Index:								5.8E-02
Total Cancer risk:					9.4E-06			
Total Non-Cancer Risk:								8.7E-02

NOTES:
SC Oral RfD - SubChronic Oral Reference Dose (used for less than lifetime exposures).
CSF - Cancer Slope Factor.
-- - Not applicable
ND - Not Detected
NA - Not Available
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from RAIS 2014.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 19. DERMAL CONTACT WITH SOIL - MAINTENANCE WORKER

Organic Chemical	Soil Concentration (mg/kg)	Compound ABS	Carcinogenic Effects CID[b] $(day)^{-1}$	Oral CSF[a] $(mg/kg\text{-}day)^{-1}$	Excess Risk	Noncarcinogenic Effects CID[b] $(day)^{-1}$	SC Oral RfD[a] (mg/kg-day)	Hazard Quotient
Semi-Volatile Organic Compounds								
Acenaphthene	0.12	0.13	5.4E-7	NA		1.6E-6	2.00E-01	1.2E-07
Acenaphthylene	0.13	0.13	5.4E-7	NA		1.6E-6	6.00E-01	4.4E-08
Anthracene	0.21	0.13	5.4E-7	NA		1.6E-6	1.00E+00	4.4E-08
Benz[a]anthracene	0.56	0.13	5.4E-7	7.30E-01	2.8E-08	1.6E-6	3.00E-01	3.9E-07
Benzo[a]pyrene	0.58	0.13	5.4E-7	7.30E+00	3.0E-07	1.6E-6	3.00E-01	4.1E-07
Benzo[b]fluoranthene	0.74	0.13	5.4E-7	7.30E-01	3.8E-08	1.6E-6	4.00E-01	3.9E-07
Benzo[g,h,i]perylene	0.46	0.13	5.4E-7	NA		1.6E-6	6.00E-01	1.6E-07
Benzo[k]fluoranthene	0.26	0.13	5.4E-7	7.30E-02	1.3E-09	1.6E-6	4.00E-01	1.4E-07
Chrysene	0.60	0.13	5.4E-7	7.30E-03	3.1E-10	1.6E-6	3.00E+00	4.2E-08
Dibenz[a,h]anthracene	0.11	0.13	5.4E-7	7.30E+00	5.7E-08	1.6E-6	3.00E+00	7.8E-09
Fluoranthene	1.07	0.13	5.4E-7	NA		1.6E-6	1.00E-02	2.3E-05
Fluorene	0.09	0.13	5.4E-7	NA		1.6E-6	4.00E-02	4.6E-07
Indeno[1,2,3-c,d]pyrene	0.47	0.13	5.4E-7	7.30E-01	2.4E-08	1.6E-6	4.00E-01	2.5E-07
2-Methylnaphthalene	0.06	0.13	5.4E-7	NA		1.6E-6	4.00E-03	3.0E-06
Naphthalene	0.10	0.13	5.4E-7	NA		1.6E-6	6.00E-01	3.5E-08
Phenanthrene	0.69	0.13	5.4E-7	NA		1.6E-6	3.00E+00	4.8E-08
Pyrene	1.00	0.13	5.4E-7	NA		1.6E-6	3.00E-01	7.0E-07
Metals								
Antimony	1.01	1.00	5.4E-7	NA		1.6E-6	4.00E-04	4.1E-03
Arsenic	6.00	0.03	5.4E-7	1.50E+00	1.5E-07	1.6E-6	5.00E-03	5.8E-05
Beryllium	0.33	1.00	5.4E-7	NA		1.6E-6	5.00E-03	1.1E-04
Cadmium	0.79	0.00	5.4E-7	NA		1.6E-6	5.00E-04	2.5E-06
Chromium	20.57	1.00	5.4E-7	NA		1.6E-6	1.50E+00	2.2E-05
Copper	18.29	1.00	5.4E-7	NA		1.6E-6	1.00E-02	3.0E-03
Lead	158.33	0.05	5.4E-7	NA		1.6E-6	7.50E-04	1.9E-02
Mercury	0.06	1.00	5.4E-7	NA		1.6E-6	3.00E-03	3.5E-05
Nickel	18.14	1.00	5.4E-7	NA		1.6E-6	2.00E-02	1.5E-03
Selenium	0.30	1.00	5.4E-7	NA		1.6E-6	5.00E-03	9.7E-05
Silver	--	1.00	5.4E-7	NA		1.6E-6	5.00E-03	
Thallium	--	1.00	5.4E-7	NA		1.6E-6	4.00E-05	
Zinc	234.43	1.00	5.4E-7	NA		1.6E-6	3.00E-01	1.3E-03
Total Ingestion Cancer Risk:					5.9E-07			
Total Ingestion Hazard Index:								2.9E-02
Total Cancer risk:					9.4E-06			
Total Non-Cancer Risk:								8.7E-02

NOTES:
SC Oral RfD - SubChronic Oral Reference Dose (used for less than lifetime exposures).
CSF - Cancer Slope Factor.
-- - Not applicable
ND - Not Detected
NA - Not Available
RAF - Relative absorption factor (default absorption efficiency, MADP 1995)
[a] Toxicity values obtained from EPA Integrated Risk Information System (IRIS) files (April 1996), unless otherwise noted.
[b] Chemical dependent intake (CDI) values are exclusive of chemical concentrations and RAF values.

TABLE 20. SUMMARY OF CHEMICAL-SPECIFIC UPPER-BOUND EXCESS LIFETIME CARCINOGENIC RISKS AND NONCARCINOGENIC HAZARD INDICES FOR EACH RECEPTOR SCENARIO

Receptors	RESIDENTS				WORKERS			
	Adult		Child		Construction/Utility		Maintenance	
Risk Estimates / Compounds	Upper-Bound Lifetime Excess Carcinogenic Risk Estimate	Upper-Bound Total Noncarcinogenic Hazard Index	Upper-Bound Lifetime Excess Carcinogenic Risk Estimate	Upper-Bound Total Noncarcinogenic Hazard Index	Upper-Bound Lifetime Excess Carcinogenic Risk Estimate	Upper-Bound Total Noncarcinogenic Hazard Index	Upper-Bound Lifetime Excess Carcinogenic Risk Estimate	Upper-Bound Total Noncarcinogenic Hazard Index
Semi-Volatile Organic Compounds								
Acenaphthene	--	1.4E-06	--	1.2E-05	--	2.6E-06	--	1.1E-06
Acenaphthylene	--	1.5E-06	--	1.3E-05	--	9.5E-07	--	3.9E-07
Anthracene	--	5.0E-07	--	4.2E-06	--	9.5E-07	--	3.8E-07
Benz[a]anthracene	9.9E-08	1.3E-05	1.2E-07	1.1E-04	2.6E-08	8.3E-06	2.6E-07	3.4E-06
Benzo[a]pyrene	1.0E-06	1.4E-05	1.3E-06	1.2E-04	2.7E-07	8.7E-06	2.7E-06	3.5E-06
Benzo[b]fluoranthene	1.3E-07	1.3E-05	1.6E-07	1.1E-04	3.4E-08	8.2E-06	3.5E-07	3.4E-06
Benzo[g,h,i]perylene	--	5.5E-06	--	4.6E-05	--	3.5E-06	--	1.4E-06
Benzo[k]fluoranthene	4.6E-09	4.6E-06	5.8E-09	3.9E-05	1.2E-09	2.9E-06	1.2E-08	1.2E-06
Chrysene	1.1E-09	1.4E-06	1.3E-09	1.2E-05	2.8E-10	9.0E-07	2.8E-09	3.6E-07
Dibenz[a,h]anthracene	2.0E-07	2.6E-07	2.5E-07	2.2E-06	5.2E-08	1.7E-07	5.2E-07	6.8E-08
Fluoranthene	--	1.9E-05	--	1.6E-04	--	4.8E-04	--	2.0E-04
Fluorene	--	1.6E-06	--	1.3E-05	--	9.8E-06	--	4.0E-06
Indeno[1,2,3-c,d]pyrene	8.4E-08	8.4E-06	1.1E-07	7.0E-05	2.2E-08	5.3E-06	2.2E-07	2.1E-06
2-Methylnaphthalene	--	1.0E-05	--	8.6E-05	--	6.5E-05	--	2.6E-05
Naphthalene	--	3.6E-06	--	3.0E-05	--	7.5E-07	--	3.0E-07
Phenanthrene	--	1.6E-06	--	1.4E-05	--	1.0E-06	--	4.2E-07
Pyrene	--	2.4E-05	--	2.0E-04	--	1.5E-05	--	6.1E-06
Metals								
Antimony	--	4.9E-03	--	3.3E-02	--	2.6E-02	--	4.7E-03
Arsenic	1.6E-06	1.1E-02	2.2E-06	9.5E-02	4.5E-07	4.2E-03	5.3E-06	2.0E-03
Beryllium	--	3.1E-04	--	2.0E-03	--	6.4E-04	--	1.1E-04
Cadmium	--	1.1E-05	--	9.6E-05	--	1.4E-04	--	6.6E-05
Chromium	--	2.6E-05	--	1.7E-04	--	1.3E-04	--	2.2E-05
Copper	--	1.1E-03	--	7.6E-03	--	2.4E-02	--	5.9E-03
Lead	--	3.6E-02	--	2.8E-01	--	2.1E-01	--	7.0E-02
Mercury	--	4.1E-04	--	2.7E-03	--	2.1E-04	--	3.7E-05
Nickel	--	1.7E-03	--	1.1E-02	--	8.9E-03	--	1.5E-03
Selenium	--	1.4E-04	--	1.0E-03	--	7.7E-04	--	1.9E-04
Silver	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--
Zinc	--	1.8E-03	--	1.3E-02	--	1.0E-02	--	2.5E-03
TOTAL SITE RISK	**3.2E-06**	**5.8E-02**	**4.2E-06**	**4.5E-01**	**8.6E-07**	**2.9E-01**	**9.4E-06**	**8.7E-02**
TOTAL RESIDENTIAL ELCR	**7.E-06**							

NOTES:
-- - Not applicable

TABLE 21. SUMMARY OF UPPER-BOUND EXCESS LIFETIME CARCINOGENIC RISKS AND NONCARCINOGENIC HAZARD INDICES FOR EACH PATHWAY AND SCENARIO

Exposure Pathway	*Route*	Media	Upper-Bound Lifetime Excess Carcinogenic Risk Estimate	Upper-Bound Total Non-Carcinogenic Hazard Index
Adult Resident				
	Ingestion			
		Soil	**2.5E-06**	**2.5E-02**
	Dermal Contact			
		Soil	**7.0E-07**	**3.2E-02**
		Total Adult Risk	**3.2E-06**	**5.8E-02**
Child Resident				
	Ingestion			
		Soil	**3.5E-06**	**2.3E-01**
	Dermal Contact			
		Soil	**6.9E-07**	**2.1E-01**
		Total Child Risk	**4.2E-06**	**4.5E-01**
Residential Receptor				
		Total Cancer Risk	**7E-06**	
Construction/Utility Worker				
	Ingestion			
		Soil	**7.1E-07**	**1.2E-01**
	Dermal Contact			
		Soil	**1.5E-07**	**1.7E-01**
		Total Risk	**8.6E-07**	**2.9E-01**
Maintenance Worker				
	Ingestion			
		Soil	**8.9E-06**	**5.8E-02**
	Dermal Contact			
		Soil	**5.9E-07**	**2.9E-02**
		Total Risk	**9.4E-06**	**8.7E-02**

Appendix C

COST ESTIMATES

Budgetary Cost Estimate
Option A: Limited Excavation of Contaminated Soil and Disposal
28 Archibald Street
Burlington, VT
26-Sep-14

Cubic Yards Contaminated Soil	12
Tons of Contaminated Soil	18
Number of 22-ton trucks	1

Task	Category	Description	No.		Per Unit Cost	Unit	Item Cost	State Tax 6%	Markup Factor	Total Item Cost	**Subtotals**
1.0 Final Design / Permitting / Contractor Bid Support											
	Project Coordination / Local Approvals	Geol./Engin	8	@	$80.00	/hr	$640.00		1.00	$640.00	
	Project Design / HASP	PE	2	@	$90.00	/hr	$180.00		1.00	$180.00	
	Principal Review	Principal	1	@	$100.00	/hr	$100.00		1.00	$100.00	
	Contractor Coordination	Geol./Engin	4	@	$80.00	/hr	$320.00		1.00	$320.00	**$1,240**
2.0 Waste Characterization Sampling (1 DAY)											
	Waste Characterization Sampling	Geol./Engin	2	@	$80.00	/hr	$160.00		1.00	$160.00	
	Travel (1 Visit)	Geol./Engin	1	@	$80.00	/hr	$80.00		1.00	$80.00	
	Mileage (1 Visit)	Expense	13	@	$0.57	/ea	$7.41		1.00	$7.41	
	Waste Characterization Analysis	Expense	1	@	$1,030.00	/ea	$1,030.00		1.15	$1,184.50	**$1,432**
3.0 Oversite of Planned Water Supply											
	Construction Inspection (1 Visit)	PE	8	@	$90.00	/hr	$720.00		1.00	$720.00	
	Travel (1 Visit)	PE	1	@	$90.00	/hr	$90.00		1.00	$90.00	
	Mileage (1 Visit)	Expense	13	@	$0.57	/ea	$7.41		1.00	$7.41	**$817**
4.0 Excavation / Confirmation Sampling / Contaminated Soil Disposal											
	KAS Construction Inspection (1 Visit)	PE	7	@	$90.00	/hr	$630.00		1.00	$630.00	
	KAS Travel (1 Visit)	PE	1	@	$90.00	/hr	$90.00		1.00	$90.00	
	KAS Mileage (1 Visit)	Expense	13	@	$0.57	/ea	$7.41		1.00	$7.41	
	Mobilization / Demobilization	Expense	1	@	$500.00	/ls	$500.00		1.15	$575.00	
	Excavator and Operator	Expense	4	@	$150.00	/hr	$600.00		1.15	$690.00	
	Earth Borrow (fill)	Expense	8	@	$20.00	/cy	$160.00		1.15	$184.00	
	Seed	Expense	1	@	$14.00	/lb	$14.00		1.15	$16.10	
	Fertilizer	Expense	1	@	$4.00	/lb	$4.00		1.15	$4.60	
	Agricultural limestone	Expense	0.10	@	$400.00	/ton	$40.00		1.15	$46.00	
	Hay Mulch	Expense	1.00	@	$35.00	/bale	$35.00		1.15	$40.25	
	Top soil	Expense	4	@	$35.00	/cy	$140.00		1.15	$161.00	
	Confirmation Sampling	Expense	1	@	$550.00	/ea	$550.00		1.15	$632.50	
	Contaminated Soil Disposal (min 1 truck)	Expense	18	@	$65.00	/ton	$1,170.00		1.15	$1,345.50	**$4,422**
5.0 As-Built Report Preparation											
	Report	Geol./Engin.	6	@	$80.00	/hr	$480.00		1.00	$480.00	
	Review	Senior	1	@	$100.00	/hr	$100.00		1.00	$100.00	
	Record Drawing	Geol./Engin.	2	@	$80.00	/hr	$160.00		1.00	$160.00	**$740**
6.0 Deed Restriction											
	Attorney Fees	Contract	12	@	$250.00	/hr	$3,000.00		1.00	$3,000.00	
	Paralegal	Contract	4	@	$100.00	/hr	$400.00		1.00	$400.00	
	Administrative/filing	Contract	6	@	$60.00	/hr	$360.00		1.00	$360.00	**$3,760**

Cleanup Cost	**$12,412**
10% Contingency	**$1,241**
Total Cost For Project	**$13,653**

Budgetary Cost Estimate
Option B: Sitewide Excavation of Contaminated Soil and Disposal
28 Archibald Street
Burlington, VT
26-Sep-14

Cubic Yards Contaminated Soil	634
Tons of Contaminated Soil	951
Number of 22-ton trucks	43

Task	Category	Description	No.		Per Unit Cost	Unit	Item Cost	State Tax 6%	Markup Factor	Total Item Cost	**Subtotals**
1.0	**Final Design / Permitting / Contractor Bid Support**										
	Project Coordination	Geol./Engin	8	@	$80.00	/hr	$640.00		1.00	$640.00	
	Final Design / HASP	PE	16	@	$90.00	/hr	$1,440.00		1.00	$1,440.00	
	Principal Review	Principal	4	@	$100.00	/hr	$400.00		1.00	$400.00	
	Contractor Preparation / Coordination	Geol./Engin	6	@	$80.00	/hr	$480.00		1.00	$480.00	**$2,960**
2.0	**Waste Characterization Sampling (1 DAY)**										
	Waste Characterization Sampling	Geol./Engin	2	@	$80.00	/hr	$160.00		1.00	$160.00	
	Travel (1 Visit)	Geol./Engin	1	@	$80.00	/hr	$80.00		1.00	$80.00	
	Mileage (1 Visit)	Expense	13	@	$0.57	/ea	$7.41		1.00	$7.41	
	Waste Characterization Analysis	Expense	1	@	$1,030.00	/ea	$1,030.00		1.15	$1,184.50	
	Construction Inspection (1 Visit)	Geol./Engin	7	@	$90.00	/hr	$630.00		1.00	$630.00	
	Travel (1 Visit)	Geol./Engin	1	@	$90.00	/hr	$90.00		1.00	$90.00	
	Mileage (1 Visit)	Expense	13	@	$0.57	/ea	$7.41		1.00	$7.41	**$2,159**
3.0	**Excavation / Confirmation Sampling / Contaminated Soil Disposal**										
	Mobilization / Demobilization	Expense	1	@	$7,200.00	/ls	$7,200.00		1.15	$8,280.00	
	Excavation	Expense	634	@	$15.00	cy	$9,510.00		1.15	$10,936.50	
	Earth Borrow (fill)	Expense	534	@	$15.00	/cy	$8,010.00		1.15	$9,211.50	
	Seed	Expense	6	@	$37.50	/lb	$225.00		1.15	$258.75	
	Fertilizer	Expense	1	@	$37.50	/lb	$18.75		1.15	$21.56	
	Agricultural limestone	Expense	1.00	@	$600.00	/ton	$600.00		1.15	$690.00	
	Hay Mulch	Expense	0.20	@	$1,500.00	/ton	$300.00		1.15	$345.00	
	Characterization Sampling	Expense	2	@	$1,000.00	/ea	$2,000.00		1.15	$2,300.00	
	Contaminated Soil Disposal	Expense	951	@	$55.00	/ton	$52,305.00		1.15	$60,150.75	**$92,194**
4.0	**As-Built Report Preparation**										
	Report	Geol./Engin.	6	@	$80.00	/hr	$480.00		1.00	$480.00	
	Review	Senior	1	@	$100.00	/hr	$100.00		1.00	$100.00	
	Maps/Logs	Draftsman	1	@	$60.00	/hr	$60.00		1.00	$60.00	**$640**

Cleanup Cost	**$97,953**
10% Contingency	**$9,795**
Total Cost For Project	**$107,749**

Budgetary Cost Estimate
Option C: Excavation of Contaminated Soil to Accommodate Grades, and a 12" Clean Cap
28 Archibald Street
Burlington, VT
26-Sep-14

Cubic Yards Contaminated Soil	320
Tons of Contaminated Soil	480
Number of 22-ton trucks	22

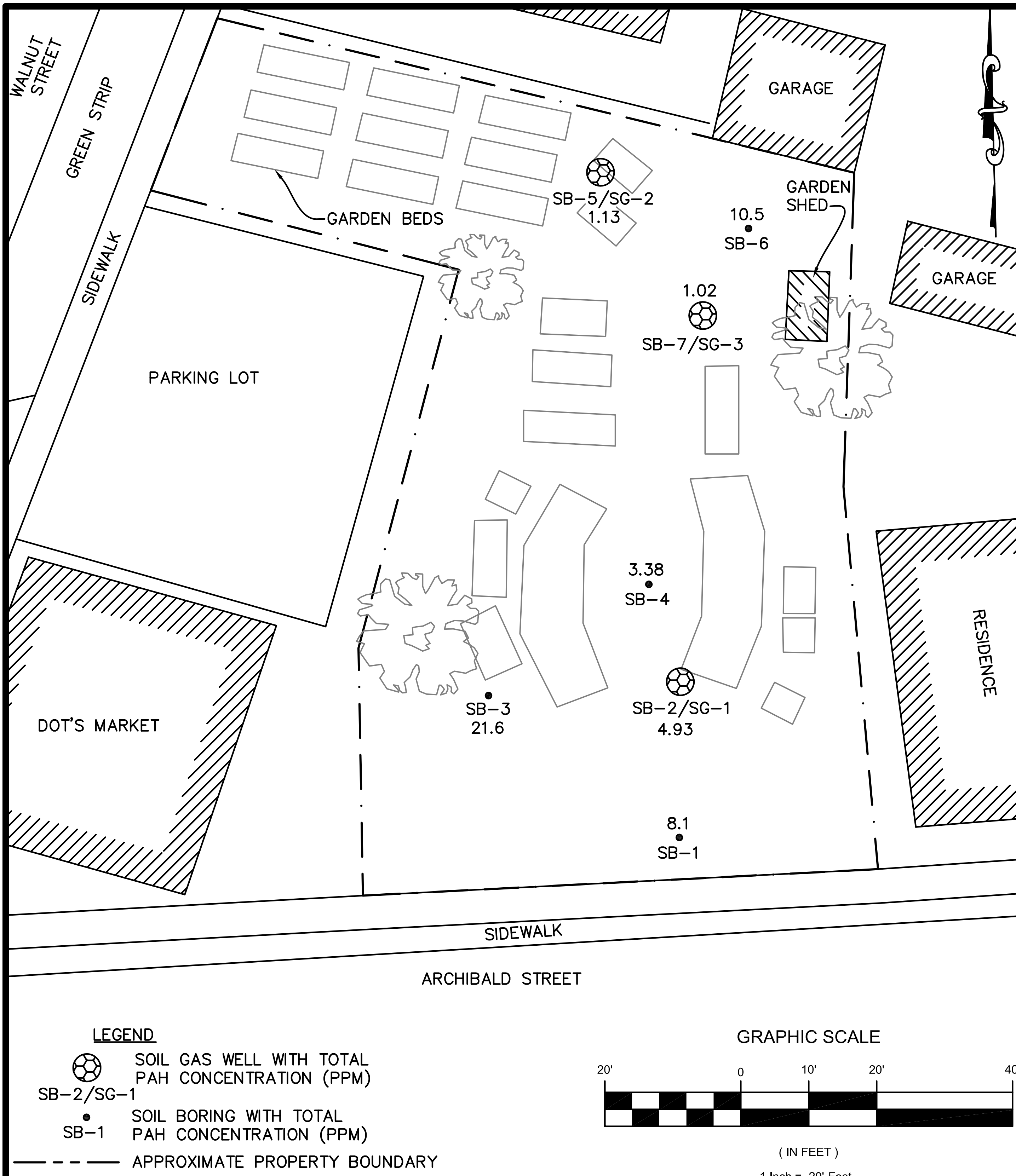
Site acreage	0.20
sf/cf 1' thick cap	8,712.00
cy 1' thick cap	322.67
sy property	968.00

Task	Category	Description	No.		Per Unit Cost	Unit	Item Cost	State Tax 6%	Markup Factor	Total Item Cost	**Subtotals**
1.0	**Final Design / Permitting / Contractor Bid Support**										
	Project Coordination / Bid Support	PE	10	@	$90.00	/hr	$900.00		1.00	$900.00	
	Final Design / HASP	PE	6	@	$90.00	/hr	$540.00		1.00	$540.00	
	Principal Review	Principal	2	@	$100.00	/hr	$200.00		1.00	$200.00	
	Contractor Preparation / Coordination	PE	4	@	$90.00	/hr	$360.00		1.00	$360.00	**$2,000**
2.0	**Construction Inspection and Oversight (2 DAYS)**										
	Construction Inspection (2 Visits)	PE	8	@	$90.00	/hr	$720.00		1.00	$720.00	
	Mileage (2 Visits)	Expense	28	@	$0.57	/ea	$15.96		1.00	$15.96	**$736**
3.0	**Construction Costs / Characterization Sampling / Contaminated Soil Disposal**										
	Mobilization / Demobilization	Expense	1	@	$3,800.00	/ls	$3,800.00		1.15	$4,370.00	
	Soil Erosion Control	Contractor	1	@	$1,200.00	/ea	$1,200.00		1.15	$1,380.00	
	Common Excavation	Expense	320	@	$14.02	/cy	$4,487.21		1.15	$5,160.29	
	Earth Borrow (fill for 12" soil cap)	Expense	210	@	$14.16	/cy	$2,974.55		1.15	$3,420.73	
	Top Soil (fill for 12" Soil Cap)	Expense	100	@	$29.70	/cy	$2,970.00		1.15	$3,415.50	
	Geotextile under soil cap	Expense	951	@	$0.97	/sy	$917.72		1.15	$1,055.37	
	Seed	Expense	6	@	$37.50	/lb	$225.00		1.15	$258.75	
	Fertilizer	Expense	1	@	$37.50	/lb	$18.75		1.15	$21.56	
	Agricultural limestone	Expense	1.00	@	$600.00	/ton	$600.00		1.15	$690.00	
	Hay Mulch	Expense	0.20	@	$1,500.00	/ton	$300.00		1.15	$345.00	
	Characterization Sampling	Expense	1	@	$1,000.00	/ea	$1,000.00		1.15	$1,150.00	
	Contaminated Soil Disposal	Expense	480	@	$55.00	/ton	$26,400.00		1.15	$30,360.00	**$51,627**
4.0	**As-Built Report Preparation**										
	Report	PE	8	@	$90.00	/hr	$720.00		1.00	$720.00	
	Review	Senior	1	@	$100.00	/hr	$100.00		1.00	$100.00	
	Maps/Logs	PE	6	@	$90.00	/hr	$540.00		1.00	$540.00	**$1,360**
5.0	**Deed Restriction**										
	Attorney Fees	contract	12	@	$250.00	/hr	$3,000.00		1.00	$3,000.00	
	Paralegal	Contract	4	@	$100.00	/hr	$400.00		1.00	$400.00	
	Administrative/filing	contract	6	@	$60.00	/hr	$360.00		1.00	$360.00	**$3,760**

Cleanup Cost	**$59,483**
10% Contingency	**$556**
Total Cost For Project	**$60,039**

Appendix D

CONTAMINANT MAPS



NOTE: BASE MAP DEVELOPED FROM KAS, INC. FIELD MEASUREMENTS ON 1/30/14 AND FROM GOOGLE MAPS SATELLITE IMAGERY.

KAS #: 509130312

368 Avenue D, Suite 15
PO Box 787
Williston, VT 05495
www.kas-consulting.com
802 383.0486 p
802 383.0490 f

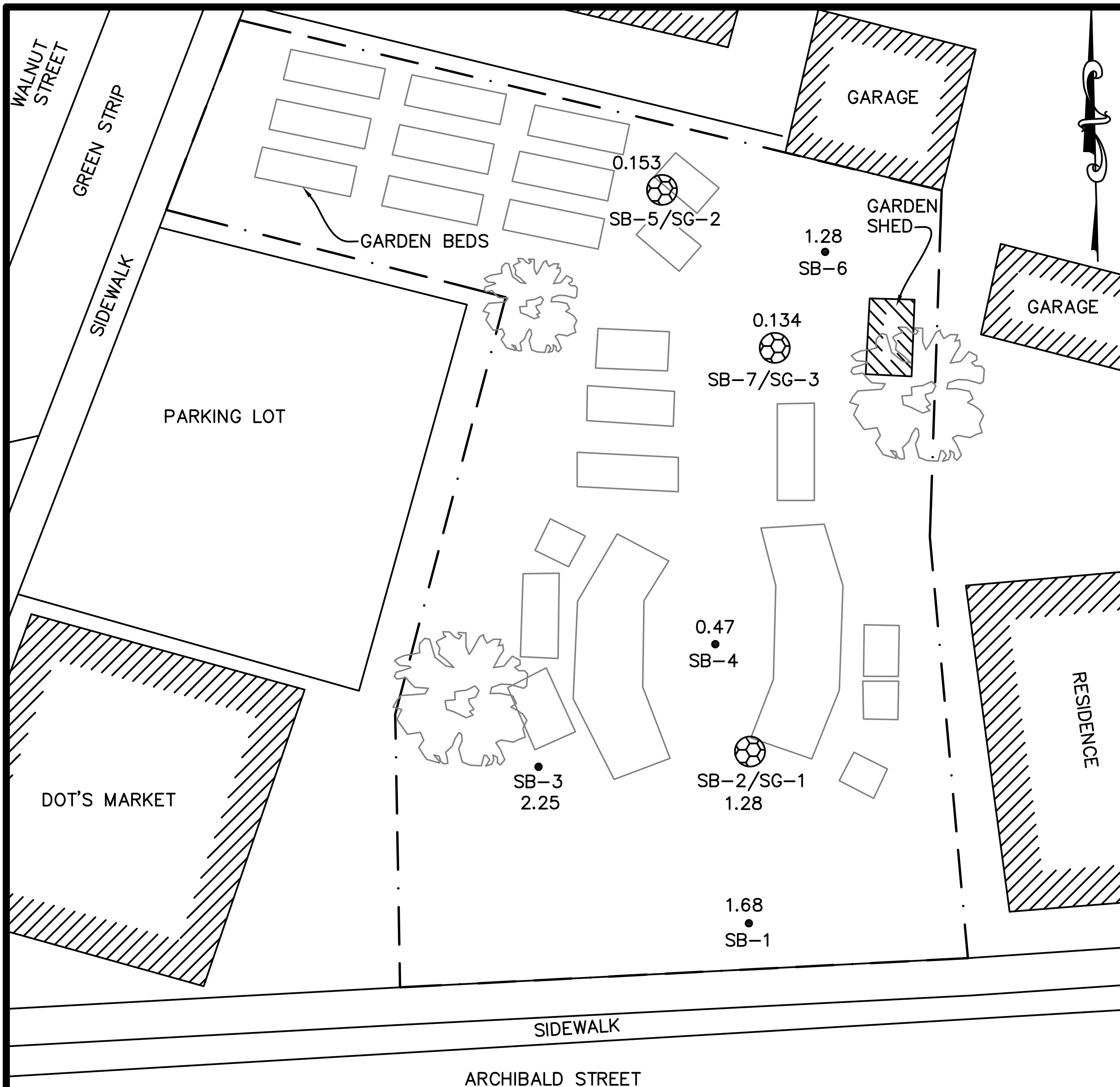
kas environmental science & engineering

28 ARCHIBALD STREET
BURLINGTON, VERMONT

CONTAMINANT CONCENTRATION (PAH) MAP IN SHALLOW SOIL

SAMPLED 1/30/2014

DATE: 3/10/14	DWG #: 2	SCALE: 1"=20'	DRN.: BG	APP.: AE



LEGEND

SB-2/SG-1 — SOIL GAS WELL WITH TOTAL BENZO (A) PYRENE TOXIC EQUIVALENCY (UNITLESS)

SB-1 — SOIL BORING WITH TOTAL BENZO (A) PYRENE TOXIC EQUIVALENCY (UNITLESS)

— - — APPROXIMATE PROPERTY BOUNDARY

GRAPHIC SCALE

20' 0 10' 20' 40'

(IN FEET)

1 Inch = 20' Feet

NOTE: BASE MAP DEVELOPED FROM KAS, INC. FIELD MEASUREMENTS ON 1/30/14 AND FROM GOOGLE MAPS SATELLITE IMAGERY.

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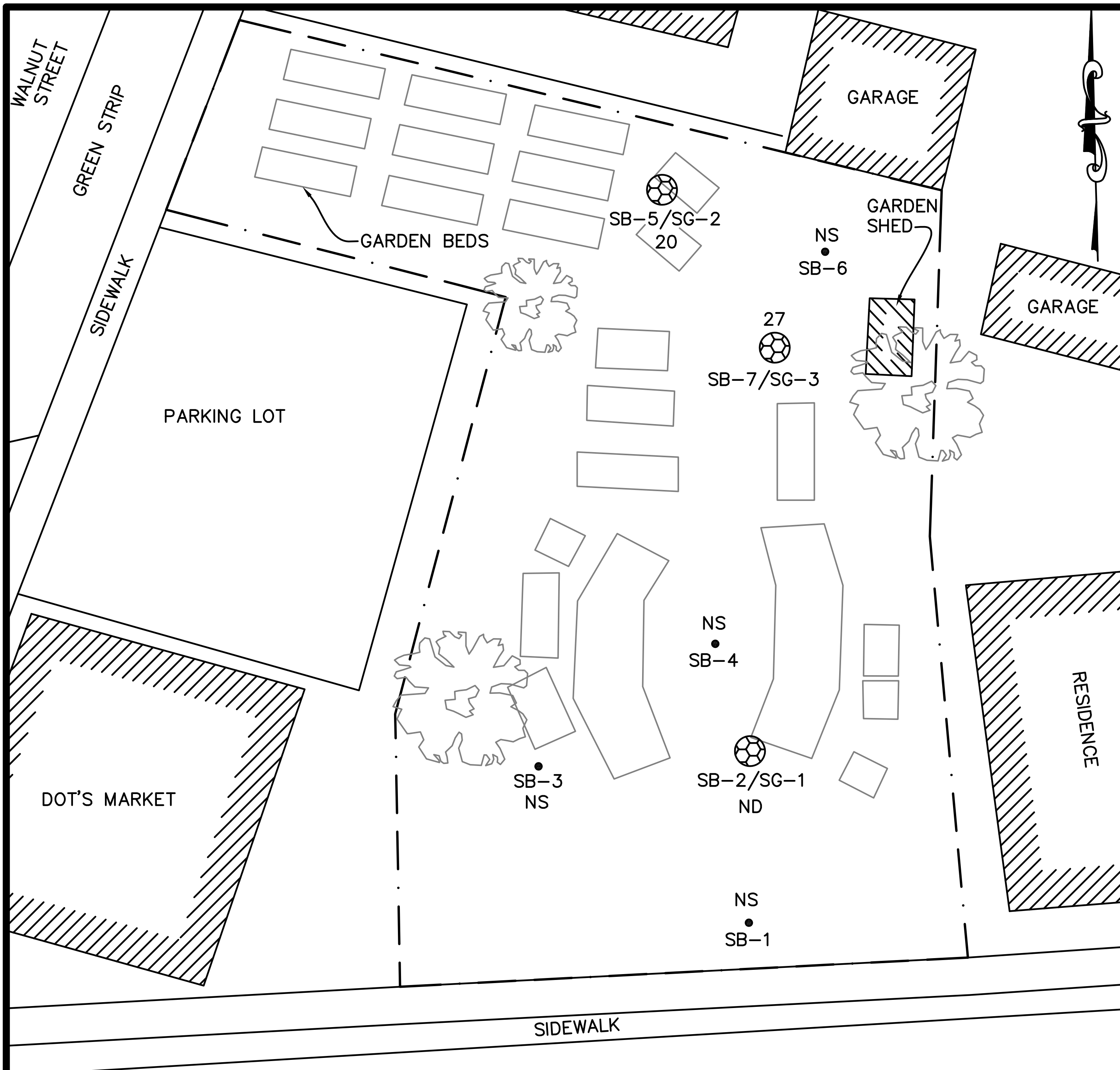
28 ARCHIBALD STREET
BURLINGTON, VERMONT

CONTAMINANT CONCENTRATION (BENZO (A) PYRENE TOXIC EQUIVALENCY) MAP IN SHALLOW SOIL

SAMPLED 1/30/2014

DATE: 3/10/14	DWG #: 3	SCALE: 1"=20'	DRN.: BG	APP.: AE



LEGEND

SB-2/SG-1 — SOIL GAS WELL WITH TOTAL PCE CONCENTRATION (MG/M^3)

SB-1 — SOIL BORING

— — — APPROXIMATE PROPERTY BOUNDARY

ND — NONE DETECTED

NS — NOT SAMPLED

GRAPHIC SCALE

20' 0 10' 20' 40'

(IN FEET)

1 Inch = 20' Feet

NOTE: BASE MAP DEVELOPED FROM KAS, INC. FIELD MEASUREMENTS ON 1/30/14 AND FROM GOOGLE MAPS SATELLITE IMAGERY.

KAS #: 509130312

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28 ARCHIBALD STREET
BURLINGTON, VERMONT

CONTAMINANT CONCENTRATION (SOIL GAS PCE) MAP

SAMPLED 2/4/2014

DATE: 3/10/14	DWG #: 4	SCALE: 1"=20'	DRN.: BG	APP.: AE

Appendix E

CONTAMINANT SUMMARY TABLES

kas

Soil Boring Data Summary
28 Archibald Street
Burlington, Vermont
30-Jan-14

Soil Boring #	Soil Sample #	Run Depth (feet)	Group Name	PID (ppm)	Comments / Observations
SB-1	SB-1 (0-2)	0-4	Dry, medium brown, well graded sand (Fill)	0.0	Collected soil sample from 0-2 ft bg
SB-1	-	4-8	Dry, light brown, well graded sand	0.0	-
SB-1	-	8-12	Dry, light brown, well graded sand	0.0	-
SB-1	-	12-16	Dry, light to medium brown, well graded sand	0.0	-
SB-1	-	16-20	Dry, light brown, well graded sand	0.0	-
SB-2	SB-2 (0-2)	0-4	Dry, dark brown, well graded sand (Fill)	0.0	Collected soil sample from 0-2 ft bg
SB-2	-	4-8	Dry, light brown, well graded sand	0.0	Set soil gas well SG-1 at 4 ft bg
SB-2	-	8-12	Dry, light to medium brown, well graded sand	0.0	-
SB-2	-	12-16	Dry, light brown, well graded sand	0.0	-
SB-2	-	16-20	Dry, light brown, well graded sand	0.0	-
SB-3	SB-3 (2-3)	0-4	Dry, medium brown and black, well graded sand (Fill-coal and glass)	0.0	Collected soil sample from 2-3 ft bg (frost top foot)
SB-3	-	4-8	Dry, light brown well graded sand	0.0	
SB-3	SB-3 (8-10)	8-12	Dry, light to medium brown light and medium sand	0.0	Collected soil sample from 8-10 ft bg
SB-3	-	12-15	Dry, light to medium brown light and medium sand	0.0	Borehole cave in at 15 ft bg
SB-4	SB-4 (0-2)	0-4	Dry, medium brown, well graded sand (Fill-coal fragments)	0.0	Collected soil sample from 0-2 ft bg
SB-4	-	4-8	Dry, medium brown, well graded sand	0.0	-
SB-4	-	8-12	Dry, light brown, well graded sand	0.0	-
SB-4	-	12-16	Dry, light brown, well graded sand	0.0	-
SB-4	-	16-20	Dry, light brown, well graded sand	0.0	-
SB-5	SB-5 (0-2)	0-4	Dry, light and medium brown, well graded sand (Fill)	0.0	Collected soil sample from 0-2 ft bg
SB-5	-	4-8	Dry, light brown well graded sand	0.0	Set soil gas well SG-2 at 4 ft bg
SB-5	-	8-12	Dry, light brown well graded sand	0.0	-
SB-5	-	12-16	Dry, light brown well graded sand	0.0	-
SB-5	-	16-20	Dry, light brown well graded sand	0.0	-
SB-6	SB-6 (0-2)	0-4	Dry, light to dark brown sand (Fill-coal and insulation fragments)	0.0	Collected soil sample from 0-2 ft bg
SB-6	-	4-8	Dry, light brown, well graded sand	0.0	-
SB-6	-	8-12	Dry, light brown, well graded sand	0.0	-
SB-6	-	12-16	Dry, light brown, well graded sand	0.0	-
SB-6	-	16-20	Dry, light brown, well graded sand	0.0	-
SB-7	SB-7 (0-2)	0-4	Dry, light and medium brown, well graded sand (Fill-coal fragments)	0.0	Collected soil sample from 0-2 ft bg
SB-7	-	4-8	Dry, light brown well graded sand	0.0	Set soil gas well SG-3 at 4 ft bg
SB-7	SB-7 (8-10)	8-12	Dry, light brown well graded sand	0.0	Collected soil sample from 8-10 ft bg
SB-7	-	12-16	Dry, light brown well graded sand	0.0	
SB-7	-	16-20	Dry, light brown well graded sand	0.0	-

Soil Sampling Data Summary
28 Archibald Street
Burlington, Vermont

Soil Sample	*SB-1 (0-2)*	*SB-2 (0-2)*	*SB-3 (2-3)*	*SB-3 (8-10)*	*SB-4 (0-2)*	*SB-5 (0-2)*	*SB-6 (0-2)*	*SB-7 (0-2)*	*SB-7 (8-10)*	*Duplicate*	IROCP	VDH
Sample Depth (ft.)	*1*	*1*	*2*	*9*	*1*	*1*	*1*	*1*	*9*	*9*	SSV	Values
PID reading (ppm)	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	Residential	
Sample Date	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*		
VOCs, EPA Method 8260b (mg/kg)												
Benzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	1.1	6.24
Toluene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	5,000	NA
Ethylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	5.4	NA
mp-Xylene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	3,400	NA
o-Xylene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	3,800	NA
MTBE	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	43	NA
1,3,5-trimethylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	780	NA
1,2,4-trimethylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	62	NA
Naphthalene	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	3.6	1070
IsoPropylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	NA	NA
n-Propylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	NA	NA
tert-Butylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	7,800	NA
sec-Butylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	7,800	NA
p-Isopropyltoluene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	NA	NA
1,4-Dichlorobenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	2.4	NA
1,2-Dichlorobenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	1,900	NA
n-Butylbenzene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	3,900	NA
Tetrachloroethene (PCE)	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	22	0.800
Trichloroethene (TCE)	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	0.91	0.860
1,1-Dichloroethane	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	3.3	NA
cis-1,2-Dichloroethene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	160	673
trans-1,2-Dichloroethene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	150	135
1,2,3-Trichloropropane	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	0.005	NA
Chloroform	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	0.29	NA
Styrene	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	ND<0.05	6,300	NA
Vinyl Chloride	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	ND<0.1	0.06	NA
Total Reported VOCs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-

NOTES:

All values reported in mg/kg, dry, unless otherwise indicated.

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SSV= Soil Screening Values from Appendix A of the IROCP with RSL updates from November 2013

ND<xx = Not Detected< Detection Limit

Results reported above detection limits are indicated in bold

Detection limits and reported concentrations above the residential SSV are shaded.

NA = No IRCOCP SSV available

VDH = Vermont Department of Health Soil Screening Values

Soil Sampling Data Summary
28 Archibald Street
Burlington, Vermont

Soil Sample *Sample Depth (ft.)* *PID reading (ppm)* *Sample Date*	*SB-1 (0-2)* *0-2* *0.0* *1/30/14*	*SB-2 (0-2)* *0-2* *0.0* *1/30/14*	*SB-3 (2-3)* *0-2* *0.0* *1/30/14*	*SB-3 (8-10)* *8-10* *0.0* *1/30/14*	*SB-4 (0-2)* *0-2* *0.0* *1/30/14*	*SB-5 (0-2)* *0-2* *0.0* *1/30/14*	*SB-6 (0-2)* *0-2* *0.0* *1/30/14*	*SB-7 (0-2)* *0-2* *0.0* *1/30/14*	*SB-7 (8-10)* *8-10* *0.0* *1/30/14*	*Duplicate* *8-10* *0.0* *1/30/14*	IROCP SSV Residential	VDH Values
PAHs, EPA Method 8270 (mg/kg)												
Acenaphthene	**0.018**	ND<0.008	**0.73**	ND<0.007	**0.0097**	ND<0.007	**0.045**	ND<0.008	ND<0.007	ND<0.007	3400	NA
Acenaphthylene	**0.22**	**0.16**	**0.280**	**0.012**	**0.077**	**0.039**	**0.091**	**0.020**	ND<0.007	**0.0087**	NA	NA
Anthracene	**0.15**	**0.089**	**0.88**	ND<0.007	**0.073**	**0.027**	**0.24**	**0.016**	ND<0.007	ND<0.007	17000	NA
Benzo(a)anthracene	**0.65**	**0.40**	**1.6**	ND<0.007	**0.26**	**0.082**	**0.82**	**0.081**	ND<0.007	ND<0.007	0.15	NA
Benzo(b)fluoranthene	**0.98**	**0.62**	**1.9**	ND<0.007	**0.40**	**0.015**	**1.1**	**0.13**	ND<0.007	**0.0079**	0.15	NA
Benzo(k)fluoranthene	**0.35**	**0.23**	**0.67**	ND<0.007	**0.14**	**0.046**	**0.33**	**0.045**	ND<0.007	ND<0.007	1.5	NA
Benzo(a)pyrene	**0.71**	**0.48**	**1.5**	ND<0.007	**0.31**	**0.098**	**0.87**	**0.091**	ND<0.007	ND<0.007	0.015	0.01
Benzo(g,h,i)perylene	**0.66**	**0.41**	**1.1**	**0.012**	**0.25**	**0.091**	**0.67**	**0.068**	ND<0.007	**0.012**	NA	NA
Chrysene	**0.73**	**0.46**	**1.6**	ND<0.007	**0.30**	**0.12**	**0.89**	**0.097**	ND<0.007	ND<0.007	15	NA
Dibenzo(a,h)anthracene	**0.15**	**0.097**	**0.28**	ND<0.007	**0.064**	**0.022**	**0.15**	**0.015**	ND<0.007	ND<0.007	0.015	NA
Fluoranthene	**1.2**	**0.65**	**3.1**	**0.016**	**0.50**	**0.20**	**1.7**	**0.17**	ND<0.007	**0.019**	2300	NA
Fluorene	**0.028**	**0.018**	**0.48**	ND<0.007	**0.015**	**0.0073**	**0.060**	ND<0.008	ND<0.007	ND<0.007	2300	NA
Indeno(1,2,3-cd)pyrene	**0.65**	**0.44**	**1.1**	ND<0.007	**0.26**	**0.093**	**0.67**	**0.068**	ND<0.007	ND<0.007	0.15	NA
2-Methylnaphthalene	**0.017**	**0.016**	**0.34**	**0.012**	**0.0082**	ND<0.007	**0.016**	ND<0.008	ND<0.007	**0.0082**	230	NA
Naphthalene	**0.036**	**0.029**	**0.57**	ND<0.007	**0.017**	ND<0.007	**0.039**	ND<0.008	ND<0.007	ND<0.007	3.6	1070
Phenanthrene	**0.43**	**0.20**	**2.7**	**0.013**	**0.24**	**0.11**	**1.1**	**0.069**	ND<0.007	**0.013**	NA	NA
Pyrene	**1.1**	**0.63**	**2.8**	**0.019**	**0.46**	**0.18**	**1.7**	**0.15**	ND<0.007	**0.022**	1700	NA
Total Reported PAHs	**8.1**	**4.93**	**21.6**	**0.084**	**3.38**	**1.13**	**10.5**	**1.02**	ND	**0.091**	-	-

NOTES:

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NA = No IRCOCP SSV available

VDH = Vermont Department of Health Soil Screening Values

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Soil Sampling Data Summary
28 Archibald Street
Burlington, Vermont

Soil Sample	*SB-1 (0-2)*	*SB-2 (0-2)*	*SB-3 (2-3)*	*SB-3 (8-10)*	*SB-4 (0-2)*	*SB-5 (0-2)*	*SB-6 (0-2)*	*SB-7 (0-2)*	*SB-7 (8-10)*	*Duplicate*	IROCP SSV Residential	VDH Values
Sample Depth (ft.)	*0-2*	*0-2*	*0-2*	*8-10*	*0-2*	*0-2*	*0-2*	*0-2*	*8-10*	*8-10*		
PID reading (ppm)	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*		
Sample Date	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*	*1/30/14*		
TOTAL METALS (mg/kg, dry)												
Total Antimony	**0.9**	**1.6**	**2.1**	ND<0.5	**1.1**	ND<0.5	**0.6**	**0.5**	ND<0.5	ND<0.5	31	NA
Total Arsenic	**5.2**	**7.0**	**6.8**	**2.6**	**5.4**	**4.8**	**6.5**	**6.3**	**3.7**	**5.1**	0.61	NA
Total Beryllium	ND<0.5	**0.8**	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	160	NA
Total Cadmium	**2.0**	**0.9**	**1.6**	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	70	34.5
Total Chromium	**20**	**21**	**27**	**8.5**	**18**	**14**	**20**	**24**	**11**	**11**	NA	NA
Total Copper	**14**	**24**	**28**	**6.8**	**16.0**	**12**	**16**	**18**	**7.2**	**8.3**	3,100	NA
Total Lead	**200**	**209**	**880**	**7.0**	**160**	**91**	**160**	**130**	**3.7**	**12**	400	NA
Total Mercury	ND<0.1	**0.1**	ND<0.1	ND<0.1	ND<0.1	ND<0.1	**0.1**	ND<0.1	ND<0.1	ND<0.1	10	NA
Total Nickel	**18**	**18**	**21**	**13**	**17**	**15**	**17**	**21**	**16**	**15**	1,500	NA
Total Selenium	ND<0.5	ND<0.5	**0.6**	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	390	NA
Total Silver	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	390	NA
Total Thallium	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	0.78	NA
Total Zinc	**240**	**240**	**670**	**29**	**140**	**81**	**120**	**150**	**28**	**30**	23,000	NA

NOTES:

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Soil Sampling Data Summary
28 Archibald Street
Burlington, Vermont

Soil Sample *Sample Depth (ft.)* *PID reading (ppm)* *Sample Date*	*SB-1 (0-2)* *0-2* *0.0* *1/30/14*	*SB-2 (0-2)* *0-2* *0.0* *1/30/14*	*SB-3 (2-3)* *0-2* *0.0* *1/30/14*	*SB-3 (8-10)* *8-10* *0.0* *1/30/14*	*SB-4 (0-2)* *0-2* *0.0* *1/30/14*	*SB-5 (0-2)* *0-2* *0.0* *1/30/14*	*SB-6 (0-2)* *0-2* *0.0* *1/30/14*	*SB-7 (0-2)* *0-2* *0.0* *1/30/14*	*SB-7 (8-10)* *8-10* *0.0* *1/30/14*	*Duplicate* *8-10* *0.0* *1/30/14*	IROCP SSV Residential
TPH, EPA Method 8100											
TPH (mg/kg, dry)	**98**	**81**	**160**	ND<20	**74**	**36**	**83**	**25**	ND<20	ND<20	200.

Soil Sample *Sample Depth (ft.)* *PID reading (ppm)* *Sample Date*	*SB-1 (0-2)* *0-2* *0.0* *1/30/14*	*SB-2 (0-2)* *0-2* *0.0* *1/30/14*	*SB-3 (2-3)* *0-2* *0.0* *1/30/14*	*SB-3 (8-10)* *8-10* *0.0* *1/30/14*	*SB-4 (0-2)* *0-2* *0.0* *1/30/14*	*SB-5 (0-2)* *0-2* *0.0* *1/30/14*	*SB-6 (0-2)* *0-2* *0.0* *1/30/14*	*SB-7 (0-2)* *0-2* *0.0* *1/30/14*	*SB-7 (8-10)* *8-10* *0.0* *1/30/14*	*Duplicate* *8-10* *0.0* *1/30/14*	IROCP SSV Residential (mg/kg)	VDH Value (mg/kg)
PCBs, EPA Method 8082												
Aroclor 1221	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.14	-
Aroclor 1242	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.22	-
Aroclor 1254	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.22	-
Aroclor 1061	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	3.9	-
Aroclor 1232	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.14	-
Aroclor 1248	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.22	-
Aroclor 1260	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.22	-
Total PCBs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		0.12

NOTES:

All values reported in mg/kg, dry, unless otherwise indicated.

IROCP = April 2012 Investigation and Remediation of Contaminated Properties document.

SSV= Soil Screening Values from Appendix A of the IROCP with RSL updates from November 2013

ND<xx = Not Detected< Detection Limit

Results reported above detection limits are indicated in bold

Detection limits and reported concentrations above the residential SSV are shaded.

Toxic Equivalency Calculations
Soil Samples - January 20, 2014
28 Archibald Street
Burlington, Vermont

Contaminant	*SB-1 (0-2)*	*SB-2 (0-2)*	*SB-3 (2-3)*	*SB-3 (8-10)*	*SB-4 (0-2)*	*SB-5 (0-2)*	*SB-6 (0-2)*	*SB-7 (0-2)*	*SB-7 (8-10)*	*Duplicate*
Benzo(a)anthracene	**0.65**	**0.04**	**0.16**	ND	**0.026**	**0.0082**	**0.082**	**0.0081**	ND	ND
Chrysene	**0.00073**	**0.00046**	**0.0016**	ND	**0.0003**	**0.00012**	**0.00089**	**0.000097**	ND	ND
Benzo(b)fluoranthene	**0.098**	**0.62**	**0.19**	ND	**0.04**	**0.015**	**0.11**	**0.013**	ND	**0.00079**
Benzo(k)fluoranthene	**0.0035**	**0.0023**	**0.0067**	ND	**0.0014**	**0.00046**	**0.0033**	**0.00045**	ND	ND
Benzo(a)pyrene	**0.71**	**0.48**	**1.5**	ND	**0.31**	**0.098**	**0.87**	**0.091**	ND	ND
Indeno(1,2,3-cd)pyrene	**0.065**	**0.044**	**0.11**	ND	**0.026**	**0.0093**	**0.067**	**0.0068**	ND	ND
Dibenz(a,h)anthracene	**0.15**	**0.097**	**0.28**	ND	**0.064**	**0.022**	**0.15**	**0.015**	ND	ND
Total Benzo(a)pyrene Equivalents	**1.68**	**1.28**	**2.25**	ND	**0.47**	**0.153**	**1.28**	**0.134**	ND	**0.00079**

NOTES:

B(A)P equivalents are unit-less

IROCP = April 2012 Investigation and Remediation of Contaminated Properties document

SSV= Soil Screening Values from Appendix A of the IROCP

< = Not Detected above detection limit

Results reported above detection limits are indicated in bold

Concentrations above the SSV for residential site are shaded

Appendix F

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

FOR PETROLEUM CONTAMINATED SITES

Prepared for:
28 Archibald Street
Burlington, Vermont

Project #: 509130312

KAS, INC.
P.O. Box 787
368 Avenue D, Suite 15
Williston, VT 05495

Date: January 28, 2014

Rev. 10/04, 9/08

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INDEX (cont.)

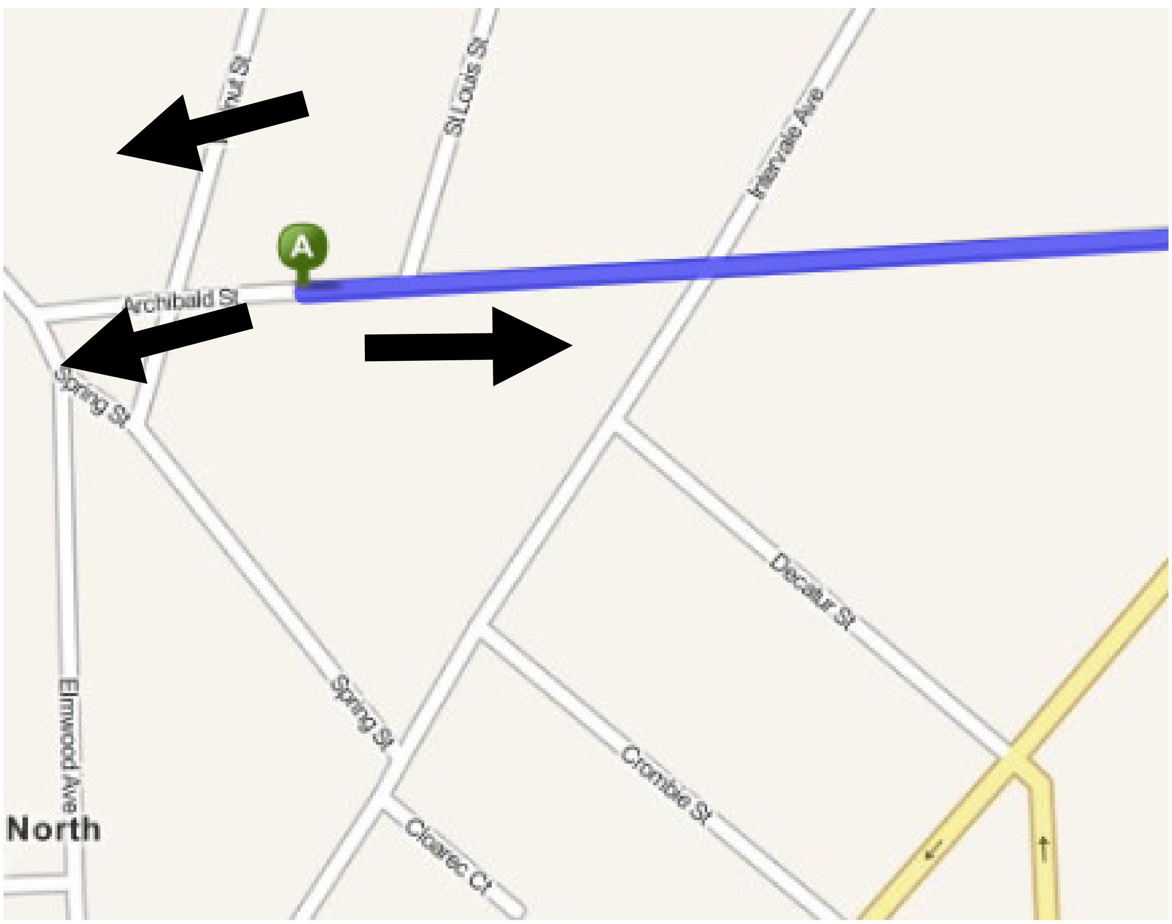
INDEX (cont.)

KAS, INC.
EVACUATION MAP

DIRECTIONS TO THE HOSPITAL:

1. Start out going east on Archibald St toward St Louis St
2. Turn right onto US-7 / US-2 / N Willard St.
3. Turn left onto Pearl St
4. Pearl St becomes Colchester Ave
5. Fletcher Allen Hospital will be on your right.111 Colchester Ave.

SITE EVACUATION MAP:



Evacuation Routes=

KAS, INC.
HEALTH AND SAFETY PLAN ACKNOWLEDGEMENT LOG

I have read this Health and Safety Plan and understand its contents. I agree to fully comply with it.

Name	Organization	Date	Time

KAS, INC.
WORKER/VISITOR LOG

NAME	ORGANIZATION	DATE	TIME IN	TIME OUT

GENERAL

This site-specific Health and Safety Plan has been developed for site investigations and monitoring at petroleum-contaminated sites. This plan (and subsequent revisions) shall be in effect throughout the duration of the project. All personnel, regardless of their professional affiliation, are subject to the requirements of this plan when they are in the area defined as the site.

1. OPERATIONAL INFORMATION

1.A. Chain of Command - Responsible Individuals

Clare Santos ,	Project Manager
On-Site KAS Personnel ,	Project Supervisor
On-Site KAS Personnel ,	Site Safety Officer
On-Site KAS Personnel ,	Assistant Site Safety Officer

Non KAS Personnel:

The chain of command for this project is as follows:

Immediate job coordination issues and/or scheduling will be brought to the attention of the Project Manager. If the project is of a size where there is no Project Manager assigned, issues will be brought to the attention of the Project Supervisor.

Issues relative to personnel health and safety will be brought to the attention of the Site Safety Officer.

Job progress meetings and issues requiring Corporate coordination and KAS input will be coordinated by the Project Manager or Project Supervisor.

1.B Emergency Notification

A list of all State and Local Police, Ambulance, and Rescue Departments and a listing complete with routes to hospitals and emergency facilities shall be maintained by the Site Safety Officer. The list must include phone numbers and quickest routes to areas facilities. The Site Safety Officer shall also contact the hospitals or emergency treatment center and inform them of an injured worker. Advice on the transportation method, and if necessary, decontamination or treatment shall be offered.

Facilities to be posted on the site are listed below, including telephone numbers.

Police Department: Phone__________911____________________________

Address____

Fire Department: Phone____________911____________________________

Address____

EMS Unit: Phone_________________911____________________________

Address____

Hospital:_________________________911____________________________

Address:

1.C. Site Personal Protective Equipment (PPE)

Personal Protection Equipment (PPE) for this site will be Level D or Level D Plus, as described in Section 4 of this plan, and as dependent upon the task(s) to be conducted.

Task	Level of Protection
Water/product level monitoring	D
Water sampling	D
Soil screening/ sampling	D
Product bailing	D
O & M of Remedial Systems	D
Drilling/ Soil Borings/ Monitoring Well Installation	D Plus
Trenching	D Plus
Tank Pull Inspection	D Plus
Drum changes	D Plus (hard hat optional)

PPE will be automatically upgraded to higher levels if the action limits for Level D are exceeded (see Section 4.C). The Site Supervisor or the Site Safety Officer has the authority to change the PPE level to suit the site conditions in accordance with the prescribed limits contained in this plan.

1.D. Fire Extinguisher Location

At least one fire extinguisher shall be kept in an accessible location on the KAS support vehicle. In addition, a fire extinguisher must be kept in an accessible location on any drill rig used on site.

1.E. First Aid

A first aid kit is located in the KAS support vehicle on-site.

1.F. Worker/Visitor Log

The attached logs must be completed for each worker or visitor to the site.

1.G. Plan Acknowledgment Form

Each worker or visitor must read and understand this plan and then sign the attached acknowledgment form before being allowed on-site.

1.H. Daily Air Monitoring Record

The attached Daily Air Monitoring Record must be completed by the end of each work day.

1.I EMERGENCY CONTINGENCY PLANS

The following Emergency Contingency Plans represent the most likely emergencies to be encountered on-site. These Emergency Plans shall be followed if they have to be activated. The Site Supervisor has senior authority to implement and modify the plans to suit particular situations until a higher authority is physically on-site. All workers also carry the responsibility to initiate emergency plans if the situation presents and the Site Supervisor is not in the immediate area.

EMERGENCY CONTINGENCY PLAN

1.I.1. EVACUATION

It is possible that a site emergency could necessitate evacuating all personnel from the site. If such a situation develops, the Site Safety Officer, or designated representative, shall notify the Project Supervisor, or vice versa, of the event and they shall ensure that the evacuation is carried out in a calm, controlled fashion.

All personnel shall exit the site and congregate in an area designated by the Project Supervisor and/or Site Safety Officer during the daily tailgate safety meeting. The route of evacuation will be dependent on wind direction, severity and type of incident, etc.

The Project Supervisor and/or Site Safety Officer shall ensure that all personnel are accounted for. If someone is missing the Site Safety Officer shall alert emergency personnel.

EMERGENCY CONTINGENCY PLAN

1.I.2. MEDICAL EMERGENCY

The following procedures should be followed in the event of a medical emergency involving illness or injury to on-site personnel.

EMS units should be called immediately, unless the injury or illness is determined to be minor, not requiring emergency care.

Site operations should be shut-down and the site should be immediately secured. The area in which the injury or illness occurred shall be considered off-limits until the cause of the illness or injury is known.

Assess the nature of the injury or illness and insure the site is safe for additional personnel to enter and provide care to the injured/ ill person(s).

Assess the victim's condition, noting the level of consciousness and any cardiac or respiratory involvement. Administer first aid treatment to the injured person(s).

1) Check to see if the victim is conscious by talking loudly to them and gently jostling their shoulders.
2) If the victim is unconscious, check to see if they are breathing. Place an ear directly above their mouth and nose, at the same time looking toward the abdomen to watch for rise and fall of the chest cavity.
3) If the victim is not breathing, notify an EMS unit immediately, if one has not already been contacted. Administer rescue breathing if trained in this procedure, and check for a pulse.
4) If the victim is not breathing but maintains a pulse, continue rescue breathing (if trained) until the victim breathes on their own or until EMS rescue staff arrives.
5) If the victim is not breathing and has no pulse, administer Cardiopulmonary Resuscitation (if trained in this procedure) until EMS staff arrives and takes over, or until the victim recovers.

If site work has been conducted at Personal Protective Level C or higher, the victim should be decontaminated as soon as possible after removal from the contaminated environment. This should be done in a non-contaminated area well away from the source of the problem. Extreme care should be used to avoid cross-contamination to rescuer personnel. The victim should be washed by water spray or safety shower. Contaminated protective clothing should be removed after washing. The victim should be covered with plastic or fitted with a Tyvek suit. The SCBA or respirator should be removed last, except in the case of a critical injury where the victim requires respiratory support. The victim should not be transported until decontamination is performed to the degree that other personnel will not be unduly subjected to cross-contamination.

Instantaneous real-time air monitoring with photoionization detectors should be performed to ascertain if the illness or injury was caused by potential exposure to hazardous materials. Monitoring should be done both upwind and downwind of the incident site.

The Fire Department should be notified if additional help is immediately needed, or if access to water for decontamination of the victim is not available at the site.

If the victim appears to be critically injured, transport them to the nearest Emergency Room as soon as possible. The victim should not be transported to the hospital in anything other than an EMS Unit staffed by qualified personnel.

If the victim's condition appears to be non-critical, and is anything more severe than minor cuts or bruises, they can be transported to the nearest hospital in a vehicle other than a EMS Unit staffed by qualified personnel.

If the victim has sustained extremely minor injuries or a minor illness, it will be up to the discretion of the Site Safety Officer whether or not the victim should be treated on-site, and whether the victim may resume work. If the Site Safety Officer determines that the victim may not continue to work, the victim should be decontaminated and relieved of duty for the day. A physician or the victim's family physician should be contacted by the victim.

Any incident shall be documented both in the project file and on an Injury/Illness Report Form available from KAS management personnel.

EMERGENCY CONTINGENCY PLAN

1.I.3. ACCIDENTAL CONTAMINATION

The following procedures shall be instituted immediately in the event of contamination of any person on-site by Hazardous Materials.

If emergency rescue is needed to remove the victim from the contaminated area, notify EMS, Police, and Fire units immediately.

Absolutely no emergency rescue is to be attempted without trained emergency rescuers.

If the victim is able to move under their own power, escort them to a non-contaminated area as soon as possible.

The site should be shut-down and immediately secured. The area in which the contamination occurred shall be considered off limits until the arrival of trained personnel who are properly equipped with the appropriate personal protective equipment and monitoring instrumentation.

Assess the victim's condition for the nature of injury or contamination. The victim should be considered symptomatic if they exhibit any evidence of abnormal symptoms. Monitor the level of consciousness and any cardiac or respiratory involvement. Use special care to insure that you do not become contaminated as well. If any abnormal symptoms are present, notify EMS, Police, and Fire Department units immediately.

Attempt to identify the exact type of material involved. If the material cannot be positively identified, attempt to acquire a grab sample. Use extreme caution if the danger of being contaminated exists.

The victim should be decontaminated as soon as possible after removal from the contaminated environment. This should be done in a non-contaminated area well away from the source of the problem. Extreme care shall be taken to avoid cross-contamination. The victim should be washed by water spray or safety shower. Contaminated protective clothing should be removed after washing. The victim should be covered with plastic or fitted with a Tyvek suit. The SCBA or respirator should be removed last, except in the case of critical injury where the victim requires respiratory support. The victim should not be transported until decontamination is performed to the degree that other personnel will not be unduly subjected to cross-contamination.

If the victim appears to be critically injured (i.e. unconscious, cardiac or respiratory abnormalities, seizures, etc.), support the victim's vital functions. Administer CPR if needed.

The Fire Department should be notified if additional help is immediately needed, or, if access to water to wash and decontaminate the victim is not available at the site.

If the victim appears to be symptomatic, the victim should be decontaminated and then transported to the nearest Emergency Room or appropriate medical assistance facility as soon as possible. The victim should not be transported other than by an EMS unit staffed by qualified personnel.

The incident shall be documented both in the project file and on an Injury/Illness report form.

EMERGENCY CONTINGENCY PLAN

1.I.4. FIRE

The following procedures shall be instituted immediately in the event of a fire on-site.

The site should be shut-down and immediately secured. The area in which the fire occurred should be considered off limits until the cause can be determined. All nonessential site personnel shall be evacuated from the site to a safe, secure area. Notify the Fire Department immediately.

The four classes of fire along with their constituents are as follows:

- Class A - Wood, cloth, paper, rubber, many plastics, ordinary combustible materials.
- Class B - Flammable liquids, gases and greases.
- Class C - Energized electrical equipment.
- Class D - Combustible metals such as magnesium, titanium, sodium, potassium.

Small fires on site may be actively attacked for control and extinguishing. Extreme care shall be taken while in this operation and protective clothing should be worn to protect personnel. If the fire involves hazardous materials, positive pressure self contained breathing apparatus is mandatory.

The Site Safety Officer, or his/her representative, shall be responsible for all fire fighting activities on the site until a Fire Department is present.

All approaches to the fire should be from the upwind side if possible. Distance from personnel to the fire should be close enough to ensure proper attack of the extinguishing material, but far enough away to ensure that personnel are safe. The proper extinguisher shall be utilized for the Class(es) of fire present on the site.

If possible, the fuel source should be cut off or separated from the fire. Care must be taken when performing operations involving shut-off of valves and manifolds, if present.

No attempt should be made against large fires. These should be handled by the Fire Department.

All fire extinguishers should be recharged and inspected by qualified personnel after any use. All equipment shall be properly decontaminated prior to repair/recharging.

EMERGENCY CONTINGENCY PLAN

1.I.5. RELEASE OF HAZARDOUS MATERIAL

The following procedures shall be instituted immediately in the event of a spill or air release of a hazardous material on site.

Site activities should be shut down and immediately secured. The area in which the spill or release occurred shall be considered off limits until the cause can be determined and site safety can be evaluated. All nonessential site personnel shall be evacuated from the site to a safe, secure area.

The spilled or released product should be immediately identified and appropriate measures, such as dikes or berms, instituted to halt and contain the flow. If the spill extends into waterways, the Coast Guard and the National Response Center (1-800-424-8802) and appropriate State and Local Agencies should be notified immediately. Spill booms should be put in place in an attempt to curb downstream contamination.

Instantaneous real-time air monitoring with ionization and combustible gas indicators should be started. Monitoring should be performed both upwind and downwind of the spill site or release point. Results of the air monitoring will determine the appropriate level of Personal Protective Equipment.

If the released material is unknown, Level B protection is mandatory. Samples of the material should be acquired to facilitate identification of the material.

If the results of the air monitoring show that the levels of contaminants exceed immediately dangerous to life or health (IDLH) values, the site shall be immediately evacuated and the appropriate Federal, State, County, and local regulatory authorities and emergency response personnel should be notified.

Notify the Police and Fire Department immediately if contaminants are found to have migrated off site into populated areas, a large spill of flammable products is involved, or, the material is considered acutely toxic or exceeding published IDLH values.

The procedures listed above shall be instituted if there is a discovery of an acutely toxic material in much larger quantities than expected. In this case, all personnel on the site should be cleared to a safe area and briefed in a tailgate safety meeting.

The spill or release shall be reported to the appropriate Federal, State, County and Local regulatory authorities per the reporting standards of those regulatory agencies.

2. SITE HISTORY AND TASK DESCRIPTION

Site is a Federal Brownfields Site. Tasks include soil gas sampling, and soil sampling.

3. WORK AREAS

Work and support areas shall be established based on ambient air data at the work sites. They shall be established in order to contain contamination within the smallest areas possible and shall ensure that each person on the site has the proper personal protective equipment for the area or zone in which work is to be performed.

Adequate safety instruction signs shall be placed in areas where admittance is restricted due to a hazardous environment.

Personnel shall not be permitted on the site alone during the following site activities:

- all work conducted in Level C or above
- Confined Space Entry activities
- trenching and pipe installation for remedial system installation
- drilling activities

Personnel in these situations shall use the "Buddy System", in groups of two or more, while on site. Non-KAS personnel (i.e., drillers, excavators) may serve in the capacity of a "Buddy" while on site conducting the above-noted activities.

Personnel may be on-site alone for Level D site activities, if Confined Space Entry activities are not in progress.

4. PROTECTIVE EQUIPMENT

4.A. Protective Clothing

Protective clothing shall be worn by all persons on site as directed by the Site Supervisor and/or Site Safety Officer for the job.

4.B. Personnel Protection Requirements and Methods

Action levels are those concentrations of which an upgrade in protective clothing or equipment is required. Organic vapor concentrations are to be continuously monitored in the field by use of an HNu, or a device of similar capability, with readings being taken in the breathing space occupied by the field personnel to determine whether an action level has been exceeded.

The Site Safety Officer shall designate the appropriate level of protection for personnel entering the work area as determined by the predetermined action level. It shall be the responsibility of each contractor to supply their personnel with the required personal protective equipment and to ensure that they are knowledgeable and proficient in its use. The Site Safety Officer has the authority to reject the credentials of any person and disallow their entry to the site if he/she feels that any person is insufficiently qualified or protected for the tasks at hand.

Respiratory protection shall be selected for use as warranted by breathing zone air monitoring and type of site work being performed. Levels of Protection are as follows, listed in order from highest to lowest protection:

Level A Protection

Level A should be selected when the highest level of respiratory, skin and eye protection is needed. Level A is generally used when extremely hazardous substances are known to be present in high atmospheric concentrations and were Level B splash gear does no offer adequate protection against any dermal-active substances present or where materials and concentrations are unknown. Level A is used where air-borne compound(s) exceeding the Immediately Dangerous to Life or Health limit may be encountered.

- Approved, positive pressure-demand, self contained breathing apparatus (SCBA) or airline
- Full encapsulating, chemical-resistant clothing
- Gloves (outer/inner), chemical resistant
- Chemical-resistant disposable outer-boot coverings,
- Boots with toe and shank protection
- Hard hat
- All seams between protective clothing items will be sealed with duct tape
- Two-way radio communications

Level B Protection

Level B should be selected when the type and atmospheric concentrations of substances have been identified and the highest level of respiratory protection is required, but a lesser level of skin protection is needed. Generally Level B protection is used in situations where the chemical(s) is known, the atmosphere is oxygen deficient (less than 19.5%), no IDLH concentrations of substances which pose a respiratory hazard are present, or where dermal contact with a hazardous substance is unlikely.

- Approved, positive pressure-demand, self contained breathing apparatus (SCBA) or airline
- Chemical-resistant clothing
- Gloves (outer/inner), chemical resistant
- Chemical-resistant disposable outer-boot coverings
- Boots with protective toe and shank
- Hard hat
- All seams between protective clothing items will be sealed with duct tape

Level C Protection

Level C should be selected when the type of air contaminants have been identified, concentrations have been measured, and the criteria for using air-purifying respirators are met, and skin-exposure to dermal-hazardous compounds are not expected. Appropriate cartridges must be available removal of the subject contaminant(s) to be encountered. The atmospheric concentration of oxygen must be greater than and equal to 19.5% (but not in-excess of 23%). Use of Level C requires continuing measurement of air contaminants to ensure that IDLH concentrations do no exist and that the concentrations of the contaminants present do not exceed the service limits of the respirator.

- Approved, full face or half-face air purifying, cartridge/canister-equipped respirator
- Chemical-resistant clothing
- Gloves (outer/inner), chemical resistant
- Chemical-resistant disposable outer-boot coverings,
- Boots with protective toe and shank
- Hard hat
- All seams between protective clothing items will be sealed with duct tape

Level D Protection:

Level D should be selected when the contaminants are known, when airborne contaminant levels are below appropriate TLV limits, and there is no hazard for direct skin contact. At a minimum, Level D protection shall require use of the following protective equipment.

- Standard work uniform
- Substantial boots
- Goggles or safety glasses w/ side shields
- Latex gloves
- Chemical resistant outer gloves are required for work tasks involving contact with pure petroleum products.

In addition, certain work site tasks will require additional personal protective equipment to protect against injury around heavy machinery and overhead hazards, as well as potential splash hazards. These tasks will be conducted in **Level D Plus protection**

Level D Plus

- all PPE listed for Level D above
  except boots must have protective toe and shank
- hard hat

No person may be assigned a task requiring the use of respiratory protection equipment without first being properly trained in its use and limitations and having passed the appropriate OSHA physical. Before the wearing of any respiratory protection equipment is permitted, the wearer must first complete a fit test, and must be completely aware of fitting procedures.

No person may be assigned a task requiring the use of respiratory equipment where it has been determined that that person has a physical limitation which might result in injury in conjunction with respiratory equipment use.

All respiratory equipment shall be properly fitted to worker(s) who will be using such equipment. All equipment shall be properly cleaned and inspected for work parts as often as necessary. SCBA's should be inspected once a month at a minimum. All respiratory equipment shall be cleaned and a fit test shall be satisfactorily passed before being worn by a different operator.

Any persons wearing glasses who must wear respiratory equipment must wear short-templed or no-templed glasses which may be taped to the wearers face, to prevent interference with the respiratory face piece.

Applicable protective clothing shall be selected and worn at all times by personnel exposed to, or in areas suspected of, contamination.

4.C. Action Levels

All initial site access and activities will be done in Level D attire.

4.C.1. Photoionization Detector Response in breathing zone (ppm):

0 to 100: Level D
101 to 750: Level C
751 to 10,000: Level B or A
Above 3,000: Immediately vacate the area

4.C.2. Combustible Gas Response

0.0 to 20.0% LEL: Continue with normal activity
Above 20.0% LEL: Immediately vacate the area

Note: Confined Space activities have lower LEL levels.
See KAS Confined Space Plan for levels.

4.C.3. Oxygen Detector Response

0.0 to 19.5% Oxygen: Level B is mandatory
19.5% to 23.0% Oxygen: Continue with normal activity
Above 23.0% Oxygen: Immediately vacate the area

4.D. Decontamination Procedures

Where high levels of site contamination are discovered such that respiratory, skin and eye protection are necessary, decontamination will be required. The support area will be positioned so that no one is permitted to enter or leave without passing through the decontamination station. At the boundary between the work and support areas, decontamination processes for equipment and personnel are required. All access to and from the work area will be through this section of the support area.

Decontamination shall be performed to protect workers from exposure to dangerous materials and to eliminate the hazard of contamination on equipment.

All water used in decontamination procedures, which is not treated at the site, shall be stored in portable storage tanks, until disposal takes place.

At each work location reusable sampling and personal protective equipment shall be decontaminated prior to sampling, between each sample, and after sampling. Sampling equipment shall be decontaminated by steam cleaning or washing with a mixture of Alconox and water, then rinsed twice with distilled water and allowed to air dry. All decontamination solutions shall be disposed at the work station where they were generated. Disposable sampling and personal protective equipment will be placed in plastic bags and temporarily stored in designated drums. These drums shall be disposed of according to regulatory guidelines.

The sequence of steps for removing and cleaning personal protective equipment follows:

- Wash gloves, boots, and outer disposable coveralls
- Rinse work gloves, boots, coveralls
- Remove outer boots (if used) and outer gloves
- Remove hard hat
- Remove disposable coveralls
- Remove respirator or masks
- Wash respirator
- Package and/or dispose of respirator or filters
- Dispose of all contaminated items in properly labeled drums
- If necessary, copy notes from contaminated paper onto clean paper while wearing inner gloves (surgical gloves) at decontamination station area.
- Remove latex gloves
- Dispose of latex gloves and contaminated note paper
- Wash hands and face.

5. SAFETY EQUIPMENT

5.A. Color Code

5.A.1. Red

Red shall be used to identify fire equipment; identify containers of flammable materials; stop bars/buttons on mechanical machinery used for emergency power disconnection.

5.A.2. Yellow

Yellow shall be used as the basic color for identifying caution. Physical hazards shall be marked by yellow signs.

5.B. Warnings and Notifications

Signs and tags shall be of a design in accordance with 29 CFR 1910.145.d. Specific signs designated in this section are danger, caution, slow-moving vehicle, biological hazard, and safety instruction. Signs shall be worded in a clear, concise manner.

Tags shall be used for temporary situations, to warn of broken equipment or other similar hazard. Temporary hazards should be remedied as quickly as possible. Tags will be designed in accordance with 29 CFR 1920.145.f-2.

5.C. Communications for Entry Into Hazardous Areas

Where large distances may separate workers or in extremely dangerous areas, a communication network shall be established. The use of hand signals may be employed in close areas where portable radios are inconvenient, or unavailable.

6. FIRE PREVENTION

6.A. General Considerations

Fire prevention and protection techniques shall be instituted on-site to minimize sparks. All smoking and utilization of tools requiring open flames will be used only with the express permission of the Site Safety Officer. A fire extinguisher must be maintained in the immediate vicinity of the open-flame work. Emergency procedures in case of fire shall be discussed with workers before every new work area location or new work activity begins. Diagrams of emergency routes shall be displayed in the work areas and in areas and any other areas where workers will break from work activities.

Only Fire Marshall approved metal safety cans will be used to transport and store flammable liquids.

All gasoline and diesel-driven engines requiring refueling must be shut down and allowed to cool before filling.

No open flame or spark is allowed in any area containing flammable liquids.

6.B. Explosive Gas Survey

Before new work locations are entered in which the there is a probability for the buildup of explosive vapors, an explosive gas survey shall be conducted. If there are no explosive gases or vapors, work activities may commence. If explosive levels are registered, then work activities shall stop and workers moved out of the immediate work area. Work shall not begin until explosive levels are no longer registering on the meter or the source of the explosive gases are found and corrected. During work activities, monitoring for explosive vapors shall be continuous.

7. ON-SITE MEDICAL PROVISIONS

7.A. Accident Reporting

When an emergency situation occurs, a warning procedure shall be initiated by the first person to recognize the situation. As appropriate, EMS, Fire, and Police Departments shall be notified immediately. In the event of an accident or injury of any type on-site, a report of the incident shall be completed immediately after appropriate first aid has been rendered. The Site Supervisor shall be responsible for remedial plan of action and for completing an injury report.

7.B. First Aid

A first aid kit shall be located on site. It shall be the responsibility of the Site Supervisor/Safety Officer to notify all personnel as to the location and proper use of these items.

Vehicles used for site work shall be equipped with a first aid/safety kit and safety equipment.

7.C. Heat Stress

Heat stress may be of concern depending upon the ambient temperature. The heat stress of personnel on-site shall be monitored continually when heat stress potential is evident.

One or more of the following control measures can be used to help control heat stress:

> Adequate replacement of lost body fluids. Personnel must replace water and salt lost from sweating. Personnel must be encouraged to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.
>
> Replacement fluids can be a 0.1% salt water solution, a commercial mix or a combination of these and fresh water.
>
> Establishment of a work regimen that will provide adequate rest periods for cooling down.
>
> All breaks are to be taken in cool areas.
>
> Personnel shall remove impermeable protective garments during rest periods.
>
> Personnel shall not be assigned other tasks during rest periods.
>
> All personnel shall be informed of the importance of adequate rest, acclimatization and proper diet in the prevention of heat stress.

<u>Heat Stress Monitoring</u>

Heat stress may occur even in moderate temperatures and may present heat rash, heat cramps, heat exhaustion, and/or heat stroke.

Monitoring procedures shall be implemented to prevent heat stress arising from any of the following: environmental conditions, use of personal protective equipment, intensity of workload. Such procedures may include the following:

Signs and Symptoms of Heat Stress	Treatment
Heat rash - red rash on the skin	Increase fluid intake
Heat cramps - muscle spasms - pain in the hands, feet, and abdomen	Rest in cool areas
Heat exhaustion - pale, cool moist skin - heavy sweating - dizziness, nausea, fainting	Loosen clothing Apply cool water to skin surfaces
Heat stroke - red, hot, usually dry skin - lack of or reduced perspiration - nausea - dizziness and confusion - strong, rapid pulse - coma	Transport to nearest hospital if symptoms are not reversed by the above listed measures;

7.D. Cold Stress

If the project is conducted during cold weather, cold stress must be addressed.

Persons working outdoors in temperatures at or below freezing may become frostbitten. Extreme cold, even for a short time, may cause severe injury to the surface of the body, or result in profound generalized cooling, causing death. Areas of the body which have high surface-area-to volume ratios such a fingers, toes, and ears are the most susceptible.

Two factors heavily influence the development of a cold injury; ambient temperature and the velocity of the wind. Wind chill is used to describe the chilling effect of moving air in combination with temperature. For instance, 10 degrees F., with a wind of 15 miles per hour is equivalent in chilling effect to still air at least 18 degrees below zero.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph is increased to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is perspiration soaked.

Local injury resulting from cold is generally termed frostbite. Frostbite of the extremities can be categorized into:

Frost nip or initial frostbite: characterized by sudden blanching or whitening of the skin.

Superficial frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.

Deep frostbite: tissues are cold, pale and solid; extremely serious injury.

Systematic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages: shivering, apathy/listlessness, unconsciousness/slow responses, freezing of the extremities, death.

Thermal socks, long poly or thermal underwear, hard hat liners and other cold weather gear can aid in the prevention of hypothermia. Cotton should be avoided due to its moisture retention characteristics.

Blankets, warm drinks (other than caffinated coffee) and warm break areas are essential.

The overall goal is to keep from getting wet. If one does get wet, he/she should dry off and change clothes.

7.E. Emergency Notification

A list of all State and Local Police, Ambulance, and Rescue Departments and a listing complete with routes to all hospitals and emergency facilities shall be maintained by the Site Safety Officer (see Section 1 of this HASP). The list must include phone numbers and quickest routes to appropriate emergency facilities. The Site Safety Officer shall also contact the hospitals or emergency treatment center and inform them of an injured worker. Advice on the transportation method, and if necessary, decontamination or treatment shall be offered.

Facilities to be posted on the site are listed below.

Police Department
Fire Department
EMS Unit
Hospital

8. AIR QUALITY/AMBIENT AIR MONITORING

8.A. Preliminary Survey

All air monitoring will be conducted by a trained professional. The professional shall have adequate working experience. He/she will have a sound working knowledge of State and Federal Occupational, Safety and Health regulations, and formal training in occupational safety and health. The preliminary survey will be conducted using one or more of the following portable real-time instrumentation:

- Photoionization Detector
- Explosimeter
- Oxygen Meter
- Draeger type tube

8.B. Daily Surveys

Ambient air monitoring shall be conducted throughout the duration of all operations on site. A minimum of five locations around the perimeter of the site will be established and actively monitored during operations.

In the event that daily air analyses determine that ambient air quality exceeds recommended levels for the respiratory equipment utilized, the Project Site Supervisor/Site Safety Officer shall be notified immediately. The Project Site Supervisor/Site Safety Officer shall immediately inspect operating conditions at the site and attempt to determine the cause of the elevated levels in the ambient air. The Project Site Supervisor/Site Safety Officer may require changes in the operating procedures in order to reduce or eliminate elevated conditions.

In the event elevated levels persist after several attempts to reduce such levels, the Project Site Supervisor shall immediately stop all operations at that location and either remove workers from the location until conditions are improved or a higher level of PPE is employed.

Ambient air monitoring will be continued until safe levels are assured.

This program will be conducted and monitored by the Site Safety Officer or his/her designee. All equipment utilized for sampling shall be maintained and calibrated and shall be documented and included in project record documents.

8.C. Records

Accurate records shall be kept of all air monitoring results. These records should include date, time, place of sample, air temperature, weather conditions, and a physical description of any obvious hazards that may influence the results of the tests. These records shall be maintained as part of the permanent job records by KAS, Inc.

8.D. Hazard Assessment

Personnel present on-site shall be advised of all potential hazards associated with the substances that are present.

The following are physical and chemical parameters of typical gasoline:

Specific Gravity 60/60 deg. F	0.72 to 0.76
ODOR T. - Odor Threshold	Approximately 10 ppm
FL-P - Flash Point	- 50 F
Flammability Limit - Lower	1.3 %
Flammability Limit - Upper	6 %

Source: The Merck Index, 10th Ed., 1983, Merck & Co., Inc., Rahway, NJ.
Physical parameters of other petroleum products are presented in the Material Safety Data Sheets (MSDSs) included in Appendix A of this HASP.

The following are air quality limits for **gasoline** obtained from the MSDSs included in Appendix A.

TLV-TWA - Threshold Limit Value, Time-Weighted Average	300 ppm
TLV-STEL - Threshold Limit Value, Short-Term Exposure Limit	500 ppm
MUC – Maximum Use Concentration (OV Cartridge)	3,000 ppm

Sources: VOSHA Table Z-1-A Limits for Air Contaminants Final Rule Limits, at http://159.105.83.167/Portals/0/WP%20Safety/VTPELs.pdf; ACGIH 2004

Slippery Surfaces:

Skid proof soles are highly recommended.

Organic Vapors:

The inhalation of volatile organic vapors during any operation can pose a potential health hazard. Hazard reduction procedures include monitoring the ambient air with a PID and use of appropriate PPE. Workers should stand upwind of the source of contamination whenever possible. If ambient air levels in the breathing zone exceed the limits specified in Section 4C of this HASP, upgrades in PPE must be immediately undertaken.
Flammable Vapors:

Presence of flammable vapors can pose a potential fire hazard and health hazard. Hazard reduction procedures include monitoring the ambient air with an O2/LEL meter. If the LEL reading exceeds 20%, leave the site immediately and contact the Fire Department.

Oxygen:

Atmospheres that contain a level of oxygen greater than 23% pose an extreme fire hazard (the usual ambient oxygen level is approximately 20.5%). This hazard can be compounded by the fact that vapors typical of gasoline retailing facilities are highly flammable. All personnel encountering atmospheres that contain a level of oxygen greater than 23% must evacuate the site immediately and must notify the fire department. If oxygen level is less than 19.5%, do not enter the space.

Vehicular Traffic:

When working on or near traveled ways, all personnel will be required to wear a fluorescent safety vest. In addition, the following safety equipment procedures must be adhered to for day time work. To secure an ongoing work site overnight in a heavy traffic area, appropriate lighted barricades must be used.

TASK	TRAFFIC SAFETY EQUIPMENT
Soil boring samples	A
Drilling	A
Subsurface Entry	A
Well Installation	A
Well Maintenance	B
Well Survey	B
Well Gauging	B
Well Development	B
Sampling	B
Pump Test	B
Excavation	A

Safety Equipment Key :

A = Cones and barricades required- tapes and flags are recommended but optional.
B = Cones are required - flags are recommended but are optional.

Well Installation; Well Development; Well Gauging; Well Bailing; Soil & Groundwater Sampling:

Skin and eye contact with contaminated groundwater and/or soil may occur during these tasks. Nitrile or Viton gloves and approved safety goggles should be worn when contact with contaminated substance and/or splash is possible. This PPE will be worn at the discretion of the Site Safety Officer, dependent on the task.

Sample Preservation:

When hydrochloric acid is used, skin and eye contact can occur. This hazard can be reduced with the use of Nitrile or Viton gloves and the use of safety goggles or glasses.

Cleaning Equipment:

Skin and eye contact with methanol, Alconox, or other cleaning substances can occur while cleaning equipment. This hazard can be reduced with the use of Nitrile or Viton gloves and the use of goggles or glasses.

8.E. Engineering Controls

Where feasible, engineering controls shall be the primary means utilized to maintain containment exposure within the limits prescribed to be safe.

9. SITE SECURITY

The Project Site Supervisor shall be responsible for the management of any security implemented at the site. Access to the site shall be at the discretion of the Site Supervisor.

No visitors shall be allowed without the approval of the Project Supervisor. Visitors shall not be permitted to enter known or suspected active hazardous work areas without proper indoctrination by the Site Safety Officer and Project Supervisor.

10 . PROGRESS MEETINGS/PERSONNEL TRAINING

10.A. Tailgate Safety Meetings

Tailgate safety meetings shall be held at the beginning of each shift at a central location in a non-contaminated area. All ongoing activities shall be discussed, and air monitoring results will be presented. Safety measures shall be reviewed to ensure all employees are aware of all precautionary methods and emergency procedures.

10.B. Orientation/Indoctrination

Orientation and Indoctrination of all new personnel shall be conducted by the Project Site Supervisor/Site Safety Officer before new workers are allowed access to the work area. The indoctrination shall include discussion of work activities, chain of command, respiratory protection program, emergency work exits and any other applicable information governing everyday work activities.

10.C. Training

All personnel are required to be trained in the following areas of health and safety awareness:

Basic Safety: this includes cause and prevention of slip, trip and fall hazards, safe drum handling and opening techniques, safe lifting techniques, heat stress illness and its prevention, etc.

Hazardous Protection: dealing with the identification, recognition and safe work procedures for toxic materials. This would include having knowledge of the use and limitation of applicable protective clothing, respirators, and decontamination procedures. Respirator fit tests for all personnel required to use respirators fall under this category. Information pertaining to routes of exposure, toxic effects, and specific nature of the job which could result in exposure shall be conveyed at this time.

10.D. Worker and Community Right-To-Know

The following contaminants have been identified, or are suspected, in either groundwater or soil samples as being in excess of prescribed limits:

Unleaded Gasoline
Leaded Gasoline
Kerosene
Diesel Fuel
Waste Oil

Health Effects:

Potential health effects from a chemical exposure are dependent on several exposure factors such as: toxicity of substances, duration of exposure, concentration during exposure and the overall health of the person exposed.

The chemicals or chemical constituents potentially contaminating this site are: Gasoline, Benzene, Toluene, Ethyl benzene, and Xylene and methyl tert-butyl ether. The following is a health analysis of these chemicals. Additional information on these chemicals can be found in the generic Material Safety Data Sheets attached in Appendix A.

Gasoline constituents can be divided into five major groups: alkanes, alkenes, cycloalkanes, aromatics and additives. The aromatics are the constituents generally regarded to be of greatest toxic concern. The major aromatics in gasoline are benzene, toluene, ethyl benzene and xylene. Of these, benzene is considered to be the most toxic. One characteristic effect of gasoline and its aromatic constituents is their ability to irritate the skin when repeated or prolonged exposure occurs.

Benzene
Benzene can enter the body through inhalation, ingestion and skin contact. Studies have noted that chronic exposure to benzene vapor can produce neurotoxic and hematopoietic (blood system) effects. Other effects can include headache, dizziness, nausea, convulsions, coma and possible death if exposure is not reversed. One significant effect from chronic benzene exposure is bone marrow toxicity. There is also an association between chronic exposures to benzene and the development of certain types of leukemia. OSHA lists benzene as a human carcinogen.

Toluene
Inhalation exposure to toluene vapor can produce effects such as central nervous system depression. Depending on exposure factors signs and symptoms can include headache, dizziness, fatigue, muscular weakness, in coordination, drowsiness, collapse and possible coma. Toluene can be a skin and mucous membrane irritant and studies have shown that high levels of toluene exposure can cause liver and kidney damage.

Xylenes
Depending on exposure factors, inhalation exposure to xylene vapor may produce central nervous system excitation followed by depression. Exposure to xylene vapor may produce lung irritation, nausea, vomiting and abdominal pain. Xylene is not known to possess the chronic bone marrow toxicity of benzene, but liver enlargement and nerve-cell damage have been noted from chronic overexposure.

Ethyl Benzene
Exposure to ethyl benzene at high vapor concentrations may produce irritation to the skin, eyes and upper respiratory tract. Overexposure to ethyl benzene vapors can produce central nervous system depression with symptoms of headache, nausea, dizziness, shortness of breath and unsteadiness. Prolonged skin exposure to ethyl benzene may result in drying and cracking of the skin (dermatitis).

Methyl tertiary Butyl Ether (MTBE)
Exposure to ethyl benzene at high vapor concentrations may irritate respiratory tract. Causes central nervous system effects. Breathing high concentrations in air can cause lightheadedness, dizziness, weakness, nausea, headache. Liquid is slightly irritating to the skin.

Any person needing specific information on any of the chemicals listed above should contact the Site Safety Officer. They will be provided in accordance with OSHA 29 CFR 1910.1200.

11. CONTRACTOR/VISITOR COMPLIANCE

All EPA, State and Federal regulations shall be adhered to by contractors and visitors during excavation, disposal and construction operations or any other site operation.

12. OCCUPATIONAL NOISE

Requirements set forth in the OSHA Hearing Conservation Amendment (OSHA 1910.95) shall be adhered to during work on-site. Hearing protection shall be provided where sound pressure levels exceed 85 dBA, 8 hours per day, 90 dBA, 4 hours per day. Hearing protection shall be required where sound pressure levels exceed 90dBA. Hearing Protection shall be worn during all rotary drilling operations.

13. HEAVY EQUIPMENT OPERATIONS AND HEAVY MATERIALS HANDLING SAFETY

The following information warrants extra attention regarding work around heavy equipment (drilling rigs, front and back hoe loaders, etc.) and heavy materials:

Use common sense

Hard hats shall be worn at all times on-site

Pay attention at all times

Maintain visual contact at all times

Establish hand signal communication when verbal communication is difficult. Designate one person per work group to give hand signals to equipment operators.

Be aware of footing at all times

All heavy equipment shall have backup alarms of some type

Only qualified people are to operate heavy equipment

Use chains, hoists, straps, and any other equipment to safely aide in moving heavy materials

Never walk directly in back of, or to the side of, heavy equipment without the operator's knowledge

Never use a piece of equipment unless you are familiar with its operation

Pipe sections and other materials to be removed during any project may be extremely heavy. Make sure all precautions have been taken prior to moving. Let the equipment, not your body, do the moving.

Be sure that no underground or overhead power lines, sewer lines, gas lines, or telephone lines will present a hazard in the work area

Get help whenever you are in doubt about a material's weight. Use the "Buddy System"

Ensure that compressed air bottles are secured properly at all times.

14. PLAN ACKNOWLEDGMENT

All on-site workers, regardless of their affiliation, are required to have read this entire Health and Safety Plan, and must sign the accompanying form to acknowledge this.

15. SITE SAFETY PERSONNEL RESPONSIBILITIES

The responsibilities of all personnel involved in health and safety operations are stated below:

KAS, Inc. will oversee and act accordingly during all phases of the project. The following management structure will be used.

Project Manager:(If required by work scope)
The Project Manager shall be responsible for implementing the project and obtaining any necessary personnel or resources for the completion of the project. Specific duties will include:

coordinating the activities of all subcontractors, to include informing them of the required personal protective equipment and insuring their signature acknowledging this Site Safety Plan,

selecting a Site Safety Officer and field personnel for the work to be undertaken on site, ensuring that the tasks assigned are being completed as planned and on schedule,

providing authority and resources to ensure that the Site Safety Officer is able to implement and manage safety procedures,

preparing reports and recommendations about the project to clients and affected KAS personnel,

ensuring that all persons allowed to enter the site (i.e., EPA, Contractors, State Officials, visitors) are made aware of the potential hazards associated with the substances known or suspected to be on site, and are knowledgeable as to the on-site copy of the specific site safety plan.

ensuring that the Site Safety Officer is aware of all of the provision of this site safety plan and is instructing all personnel on site about the safety practices and emergency procedures defined in the plan, and

ensuring that the Site Safety Officer or the Site Safety Officer's designee is making an effort to monitor site safety.

Site Safety Officer
The Site Safety Officer shall be responsible for the overall coordination and oversight of the site safety plan. Specifically:

approving the selection of the types of (PPE) to be used on site for specific tasks,

evaluating weather and chemical hazard information and making recommendations to the Project Manager/Site Supervisor about any modifications to work plans or personal protection levels in order to maintain personal safety,

coordinate upgrading or downgrading PPE with Site Safety Officer, as necessary, due to changes in exposure levels, monitoring results, weather, other site conditions,

approving field personnel for work on-site, taking into consideration their level of safety training, their physical capacity, and their eligibility to wear the protective equipment necessary for their assigned tasks,

overseeing the air monitoring procedures as they are carried out by site personnel for compliance with all company health and safety policies,

monitoring the compliance of field personnel for the routine and proper use of the PPE that has been designated for each task,

routinely inspecting PPE and clothing to ensure that it is in good condition and is being stored and maintained properly, stopping work on the site or changing work assignments or procedures if any operation threatens the health and safety of workers or the public,

monitoring personnel who enter and exit the site and all controlled access points,

reporting any signs of fatigue, work-related stress, or chemical exposures to the Project Manager and/or Site Supervisor,

dismissing field personnel from the site if their actions or negligence endangers themselves, co-workers, or the public, and reporting the same to the Project Manager and/or the Site Supervisor,

reporting any accidents or violations of the site safety plan to the Project Manager and/or the Site Supervisor, and documenting the same for the project in the project records,

knowing emergency procedures, evacuation routes and the telephone numbers of the ambulance, local hospital, poison control center, fire and police departments,

ensuring that all project-related personnel have signed the acknowledgments form contained in this site safety plan,

coordinate upgrading and downgrading PPE , as necessary, due to changes in exposure levels, monitoring results, weather, and other site conditions, and

perform air monitoring with approved instruments in accordance with requirements stated in this Site Safety Plan.

Site Supervisor
In the event that the Project Manager and the Site Safety Officer are not on site, the Site Supervisor shall assume all their responsibilities and authority.

Other Field Personnel
All field personnel shall be responsible for acting in compliance with all safety procedures outlined in the Health and Safety Plan. Any hazardous work situations or procedures shall be reported to the Site Safety Officer so that corrective steps can be taken.

16. CONFINED SPACE ENTRY

The reader is referred to the KAS Permit-Required Confined Spaces Program on file at KAS offices for more details on confined space entry protocols. A confined space:

a) is large enough and so configured that a person can bodily enter and perform assigned work; and
b) has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and
c) is not designed for continuous occupancy.

Included within this definition are excavations, storage tanks, impoundment, soils, pipelines, pits and vaults.

All personnel are urged to use caution in identifying any of the area listed above to their immediate Supervisor, and, to plan their approach to operations conducted in these areas to be in compliance with KAS's Confined Space Plan.

All personnel are urged to use all engineering controls possible to avoid entering these areas. Examples of this would include using remote sampling equipment, or, using a contractors back hoe bucket to collect soils for sampling, rather than personnel entering the excavation. Entry into a confined space is defined as breaking the plane of the opening to the confined space with any part of the body.

17. DRILLING SAFETY

During the drilling operation (2) persons designated as "driller" and "helper" must be present on the rig at all times.

The immediate area around the rig shall be cordoned off with temporary barricades, fencing or cones to assist in preventing unauthorized entry.

Only personnel authorized by KAS are to be allowed within the area of drilling. If any unauthorized personnel enter the work area, KAS will shut down operations until the area is cleared.

The mast of the drilling rig must maintain a minimum clearance of 20 feet from any overhead electrical cables. The drilling rig must not be moved from its set up position without first putting down the mast.

All drilling operations shall cease immediately during any electrical storms.
KAS, Inc. retains sole authority to shut down the drilling operations at any time a hazardous situation is deemed present.

18. EXCAVATING/TRENCHING SAFETY

All excavation and trenching work must comply with all safety regulatory agency rules. Prior to any excavation work, the existence and location of underground pipe, electrical conductors, etc. must be determined. The walls and spaces of all excavations more than four (4) feet deep or excavated below a building footing or foundation shall be guarded properly by shoring, sloping of the ground, or equivalent means.

Maximum Allowable Slopes are specified by OSHA for various soil types in 29 CFR Part 1926, Subpart P.

Soil/ Rock Type	Maximum Allowable Slope (H:V) for Excavations less than 20 ft	
Stable Rock	Vertical	(90 degrees)
Type A	3/4:1	(53 degrees)
Type B	1:1	(45 degrees)
Type C	1.5:1	(34 degrees)

Type A soils: clays, silty clays, sandy clays, clay loam, and cemented soils (caliche, hardpan)
Type B soils: silt, silt loam, sandy loam, unstable dry rock
Type C soils: granular soils including gravel, sand, and loamy sand; submerged, unstable soil or rock

Daily inspections of excavations shall be made. If there is evidence of possible cave-ins or slides, all work in the excavation shall cease until the necessary safeguards have been taken.

Trenches more than four (4) feet deep shall have ladders or steps located so as to require no more than 25 feet of lateral travel between means of access.

All equipment such as pipe, tools, etc. shall be kept out of traffic lanes and access ways. Equipment shall be stored to prevent danger to personnel at any time.

Trenches shall be completely guarded on all sides in areas where pedestrian and vehicular traffic is expected. A minimum of two (2) feet from the edges will be maintained. Trench guarding shall consist of wooden, metal, or heavy plastic barricades. Such barricades shall not be less than 36 inches high when erected.

Battery-lighted barricades shall be used to secure trenched areas left open overnight, as follows:

A minimum of two (2) battery-lighted barricades shall be used at corners, one on either side of the barricades.

At least one (1) battery-lighted barricade shall be used where vehicular traffic approaches the trench at the right angles.

Where trenches parallel roadways the distance between battery-lighted barricades should not exceed 40 feet.

All battery-lighted units should be regularly serviced to ensure equipment is operating.

Protection between barricades shall consist of at least 3/4 inch wide nylon tape (yellow or yellow and black). The tapes shall be stretched between barricades.

All barricaded sections immediately adjacent to where pedestrians cross trenches shall be guarded with a minimum of 2 by 2 inch wooded rails from the bridge to the first adjacent barricade. This barricade shall not be less than eight (8) feet horizontally to the top of the first barricade.

All pedestrian bridges shall be of sufficient strength to prevent no greater vertical deflection than 1/2 inch when a 250 pound weight is applied to the center of the bridge.

Handrails shall consist of an intermediate and top rail on both sides of the bridge. The top rail shall be a minimum of 42 inches high and capable of withstanding a lateral force of 200 pounds against the center of the top rail.

All surfaces which a person could reasonably contact should be sufficiently free of splinters, nails, or protrusions which may cause injury.

All bridges intended for vehicular traffic shall be constructed to withstand twice the load of the heaviest vehicle anticipated.

All trenches shall be back filled as soon as practical after work is completed and all associated equipment removed.

19. ELECTRICAL SAFETY

All electrical equipment and power cables in and around wells or structures suspected of containing chemical contamination must be equipped with a three-wire, ground lead. In accordance with OSHA 29 CFR 1926.404, approved ground fault circuit interrupters (GFCI) must be used for all 120 volt, single phase, 15 and 20 ampere receptacle outlets on the site which are in use by personnel and which are not part of the permanent wiring as defined by the NEC 1987.

The GFCI is a fast-acting circuit breaker which senses small imbalances in the circuit caused by current leakage to ground, and in a fraction of a second shuts off the electricity. However, the GFCI will not protect personnel from line-to-line contact hazards (such as a person holding two "hot" wires or a hot and neutral wire in each hand). The GFCI provides protection against the most common form of electrical shock hazard, the ground fault.

GFCIs can be used successfully to reduce electrical hazards on construction sites. Tripping of GFCIs, interruption of current flow, is sometimes caused by wet connectors and tools. It is good practice to limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors. Providing more GFCIs or shorter circuits can prevent tripping caused by the cumulative leakage from several tools or by leafages from extremely long circuits. (Adapted from OSHA 3007; Ground-Fault Protection on Construction Sites, 1987).

Electrical cords shall be inspected thoroughly prior to each work day for fraying of or damage to the cord. Electrical cords which are frayed or damaged will be permanently removed from service.