Kennedy/Jenks Consultants

20 September 2011

Technical Memorandum

To: Mr. Richard Bassett, Department of Ecology

From: Sherri Peterson/Ty Schreiner, Kennedy/Jenks Consultants

Subject: Frank Wear Vapor Intrusion Study, Yakima, Washington
Task 1 Technical Memorandum
K/J 1196016.00

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1. Background

The Frank Wear Site (Site) was historically the site of a dry cleaner that operated from the early 1940s to 2000. During many of these years, the dry cleaners used tetrachloroethene (PCE) as its dry cleaning solvent. As a result of the dry cleaning operations, PCE has subsequently been found to be present in the soil and groundwater at and adjacent to the Site. A soil vapor survey conducted in 1995 also showed the presence of PCE in the soil vapor at the Site.

A building is located adjacent to the Site that is currently operated as a childcare center (Buckle My Shoes Early Learning Center). Given the elevated groundwater and soil vapor concentrations at the Site, the Washington State Department of Ecology (Ecology) requested that a vapor intrusion study be conducted at the childcare center. The goal of the study is to evaluate whether vapor intrusion is occurring at the childcare center.

2. Vapor Intrusion Study

2.1 Technical Review of Existing Data

Historical soil vapor and groundwater data were reviewed as additional lines of evidence for the vapor intrusion study at the childcare center. A discussion of the review will be included in the vapor intrusion study report. In general, the following sources of information were reviewed as part of this task:

- Soil Vapor Survey, 106 South Third Avenue, Yakima, Washington, AGRA Earth & Environmental, Inc., January 1995.
- Memorandum Re: YRRA June 2011 Ground Water and PCE Data, Kane Environmental, July 2011.
- Figure 2: Site Plan, HartCrowser, July 2007.
- Figure 3: Recent Groundwater Elevations and PCE Concentrations, HartCrowser, July 2007.
- Monitoring Well Data in Excel files provided by Mr. Richard Bassett of Ecology in an email dated 2 September 2011.
- 2005 Cascade Drilling well logs.

A summary of overall Site conditions is provided in Ecology's *Vapor Intrusion Study Scope of Work – Frank Wear Site* (SOW) dated August 2011 provided as Attachment A.

2.2 Data Analysis, Modeling and Tier I Evaluation

Existing data from the Site indicates that groundwater and soil have been impacted by PCE from the dry cleaning operations. The PCE-impacted groundwater appears to extend below the adjacent childcare center, providing the potential for vapor intrusion at this building. In accordance with Ecology's *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State* (Draft Guidance), when the source is groundwater, the first step to evaluate vapor intrusion is to compare the data to the groundwater screening levels published in Table B-1 of the guidance document. The next step is to use the groundwater data with the Johnson and Ettinger Model (JEM) to predict indoor air concentrations. The predicted indoor air concentrations in the childcare center are also compared to Table B-1 to evaluate if an unacceptable exposure may exist and to evaluate whether a Tier II evaluation is warranted.

Two of the monitoring wells (MW-10 and SPW-15) at the Site are located northwest (upgradient) of the childcare center. Review of the most recent groundwater data available (2007) showed PCE concentrations in these wells to range from 200 to 43,500 micrograms per liter (µg/L). The Draft Guidance recommends comparing maximum groundwater concentrations to screening levels provided in Table B-1 of the guidance document, as long as the assumptions made by the Draft Guidance are consistent with the site conditions. Available information about the Site appears to be consistent with the Draft Guidance assumptions. The groundwater Method B screening level for PCE is 1 µg/L, so measured groundwater concentrations at the Site are significantly above screening levels. The Draft Guidance states that if groundwater concentrations are above the general screening levels, the next step is to proceed with one of the following options:

- Predict maximum indoor air concentrations using the JEM. If JEM modeling predicts indoor air concentrations above generic screening levels, then proceed with one of the following: 1) Tier II assessment (which includes subslab soil gas, indoor air, and ambient air sampling), 2) soil gas sample collection (at depths just above the water table, typically external to structures), or 3) proceed directly to mitigation.
- Collect and evaluate soil gas data, above the water table and external to structures.
- Proceed directly to Tier II assessment.
- Proceed directly to implementation of mitigation measures.

As the next step, the JEM model was run to predict indoor air concentrations based on the maximum groundwater PCE concentration of 43,500 µg/L. Ecology defaults were used for soil and groundwater temperature. Depth to water table was based on the information provided in the SOW; a conservative depth of 12 feet to water table was used in the model. Well construction logs indicated a soil type of sandy gravel; therefore, sand was used in the model. With these assumptions, the predicted indoor air concentration is 9,080 micrograms per cubic meter (µg/m^3). This is significantly greater than the generic Method B screening level of 0.42 µg/m^3. The model input and results are included in Attachment B. Inputs are highlighted in green, and the predicted attenuation and indoor air concentration are highlighted in yellow.

In summary, the Tier I evaluation shows groundwater concentrations greater than generic screening levels, and predicted indoor air concentrations above generic screening levels. Following the Draft Guidance, the next step is either Tier II assessment or implementation of mitigation measures. The Tier II assessment includes collection of indoor air, subslab soil gas, and ambient air samples. Kennedy/Jenks Consultants recommends that the Tier II assessment be conducted at the childcare center. The process for conducting the Tier II assessment is described in Sections 2.3 to 3.2 of this Technical Memorandum.

2.3 Indoor Air and Outdoor Ambient Air Sampling

As discussed above, Tier II assessment is recommended as the next step for assessment of vapor intrusion related to the Site at the adjacent childcare center. This includes indoor air, outdoor ambient air, and subslab soil gas sampling. The process for conducting the indoor air sampling activities is described below.

Initially, the occupants of the childcare building will be requested to suspend those types of activities that may impact indoor air such as use of sprays, solvents, paints, etc., 24 hours prior to sampling (if possible). The occupants will be requested to remove indoor air sources identified as potential contributors of volatile organic compounds (VOCs) prior to sampling, if possible. Occupants will also be requested to suspend outdoor activities such as painting, etc. 24 hours prior to sampling.

The building to be monitored will be sealed if at all possible (i.e., windows and doors shut) and mechanical fans, if used, will be turned off prior to the sampling event to minimize the dilution of contamination and built up contaminant concentrations, thereby achieving conditions typical of the “worst-case” scenario. This will allow for sampling during the “worst-case” scenario. Occupants will be asked to keep windows and doors shut as much as possible during sampling.

Four indoor air samples (including one duplicate) will be collected from the building. One sample and one duplicate sample will be collected near the northwestern side of the childcare center where elevated PCE concentrations were detected in groundwater samples collected at well MW-10 (i.e., 43,500 µg/L of PCE). This is also where the children take their naps. One sample will be collected near the center of the main floor, and one sample will be collected upstairs. If information obtained during the survey of the floor area (with floor coverings lifted) suggest a potential point of entry, the indoor air sample location(s) may be modified to sample near this point of entry. Two samples will be collected from the normal breathing zone, approximately 3 to 5 feet above the floor. The sample collected in the nap area will be collected closer to the floor to emulate the children’s breathing zone during naptime.

Two ambient air samples will be collected during the 24-hour period that the 24-hour indoor air samples are collected. The prevailing wind direction in Yakima is from the west throughout the year. One ambient air sample will be collected upwind from the childcare center in a location as free of obstructions as is possible while still maintaining the security of the sampling equipment. A second ambient air sample will be collected at a location to be determined at the time of sampling, potentially nearer to the building in the area where some of the monitoring wells are located.

Indoor air and ambient air samples for VOC analysis will be collected using Summa™ canisters. Air pumps will not be used with the canisters. Individually cleaned and certified 6-liter Summa™ canisters and flow controllers will be obtained from the analytical laboratory. The canisters will be certified using selective ion monitoring (SIM) levels if warranted. Before sample collection, the building occupants will be interviewed and a questionnaire completed to inventory items that may influence indoor air quality.

The analytical laboratory will calibrate indoor and outdoor ambient flow controllers for a 24-hour sample. Samples will be collected in accordance with the procedures outlined in the Standard Operating Procedure (SOP) provided in Attachment C. The following parameters will be recorded in a field logbook, daily field log, or other appropriate field form before sampling begins:

- Sampling date
- Sampling personnel
- Sampling location (include sampling location identification and location within the structure)
- Temperature where sample is collected
- Weather (temperature, wind conditions, rain)
- Canister and flow controller serial number
- Initial vacuum of canister
- Sample start time.

The following information will be recorded upon completion of sample collection:

- Sample end time
- Final vacuum of canister
- Any disturbance of the sample apparatus.

When collecting 24-hour samples, the final vacuum of the canister should be 5 inches of mercury (in. Hg) or greater. As long as the differential pressure is greater than 4 in. Hg ambient pressure, the flow through the device will remain approximately constant as the canister fills. If insufficient differential pressure is present, the flow through the controller will decrease as the canister pressure approaches equilibrium with ambient air.

2.4 Subslab Soil Gas Sampling

The Draft Guidance also recommends that during a Tier II assessment, subslab soil gas samples be collected at the time indoor air samples are collected. The subslab results are used to estimate how much of the measured indoor air concentrations may be due to vapor intrusion. This is particularly helpful as background indoor or outdoor sources (i.e., common cleaners, paints, automobile exhaust) may also contribute to measured indoor air concentrations of VOCs.

The childcare center is of slab on grade construction. Three subslab soil gas samples will be collected at the childcare center. Sample locations will be selected based on structure-specific characteristics (e.g., slab size and configuration), proximity to the Site, owners' requirements, access, and aesthetic considerations.

The following will be noted for vapor samples collected during the soil gas investigation:

- Sample location and identification
- Date and start/end time of sample collection
- Sample probe depth
- Identity of sampler
- Weather conditions
- Sampling method and devices
- Soil gas purge volume
- Volume of sample

- Flow rate
- Vacuum of canister before and after sample collection (if used)
- Canister and flow controller serial numbers.

Helium will be used as a leak check compound for collection of soil gas samples. Helium shroud testing will be conducted in accordance with the SOP in Attachment C.

Subslab soil gas samples for VOC analysis will be collected in accordance with the procedures outlined in the SOP provided in Attachment C. Soil gas samples will be collected in individually cleaned and certified 6-liter Summa™ canisters. Soil gas will be collected as grab samples using a flow controller at a flow rate of approximately 150 milliliters per minute (mL/min). Holes drilled through floor slabs for sampling will be sealed upon completion of the sampling with neat cement or another appropriate sealant. Sealing of holes will be completed to the owners' reasonable satisfaction.

2.5 Access to Sampling Location

It is understood that Ecology will arrange access to the childcare center for sampling activities.

2.6 Sample Analysis

Samples collected for this vapor intrusion study will be analyzed for the VOCs of concern at the Site using EPA Method TO-15. The samples will be drawn from the canister and analyzed using gas chromatography/mass spectrometry (GC/MS). For the indoor air and ambient air samples, SIM analysis for TO-15 will be used if the method reporting limit for a given compound without SIM will not be low enough for comparison to its respective screening level. SIM analysis for TO-15 for soil gas samples is not typically performed by analytical laboratories due to the higher concentrations generally associated with soil gas samples and the concern of “fouling” the analytical equipment.

3. Quality Assurance/Quality Control (QA/QC)

The Summa™ canisters and flow controllers will be pre-cleaned and certified by the analytical laboratory. Summa™ canisters used for the sampling specified in this Technical Memorandum will be individually cleaned and certified to the reporting limits for the appropriate compounds and analyses used during the investigation (e.g., EPA Method TO-15 or EPA Method TO-15 with SIM). Gauges will be equilibrated in the field, and initial vacuum of the canisters checked to assure that each canister has the minimum vacuum required for use.

3.1 QA/QC Samples

Field QC samples will consist of one duplicate sample for indoor air VOC analysis. The primary and duplicate indoor air samples will be co-located samples with the canisters placed as close together as possible during sampling. If necessary, tubing will be used to place the inlets for both canisters in approximately the same location.

3.2 Laboratory QA/QC

The laboratory will be responsible for adhering to QC procedures specified in the EPA method. The laboratory will be responsible for verifying analytical results prior to the submittal of the final laboratory data report. During the analysis process, the laboratory will verify that the results have met the various performance-based control limits (e.g., surrogate recoveries and continuing calibration). Non-conformance of various method QC requirements and control limits warrant the re-analysis and/or re-extraction of a sample.

4. Reporting

Sample analytical data will be forwarded to Ecology after receipt of final analytical reports from the laboratory.

Within 60 days of the date of the contract, a vapor intrusion study report will be prepared that provides a description of the modeling and sampling conducted for the study, the sample results, and recommended actions.

Enclosures (3)

Attachment A

Department of Ecology
Vapor Intrusion Study Scope of Work – Frank Wear Site

Frank Wear Site, Yakima, WA

Vapor Intrusion Study Scope of Work

August 2011

1.0 INTRODUCTION

1.1 A vapor intrusion study shall be conducted at 108 South Third Street in Yakima, Washington with the results and recommendations submitted to Ecology within 60 days. The earliest historical recorded use at this address was a furniture repair business. In about 2007 it became a Children's Bookstore. The bookstore was in business for about two years before it transitioned to a daycare center, now known as the Buckle My Shoe Early Learning Center. The daycare center has been operational for several months.

The daycare center is adjacent to a known contaminated PCE Site, the Frank Wear Site. It is located at 106 South Third Street. An existing PCE groundwater plume is present at the Frank Wear site and its direction goes under the daycare property at 108 South Third Street. A groundwater monitoring well (MW-10) is located next to the daycare building footing. It had numerous samplings and has had continuous high concentrations of PCE, up to 43,500 ug/L. Due to the age of the 108 South Third building (1920's?), the high concentration of PCE in groundwater next to it, the plume direction (under the building), and an annual fluctuating (up to 9 feet) shallow groundwater, it is important that the vapor intrusion study consider indoor/outdoor monitoring to assess existing site risks.

2.0 FRANK WEAR SITE DESCRIPTION

The Frank Wear Site was a dry cleaning business from the early 1940s to 2000. The use of the site prior to 1940 is unknown. The business was owned and operated by the Frank Wear family from the early 1940s to 1980. The dry cleaning operations primarily used Stoddard solvent as the dry cleaning fluid (URS 1994). However, sometime during the 1970s, the business began using PCE as the dry cleaning solvent (AGRA). Spent PCE from the dry cleaning operations was reclaimed using a distillation unit. Sludges or still bottoms from the reclamation process were reportedly deposited on the property for dust abatement (AGRA). The waste management practices during the period when Stoddard solvent was in use are not known (URS 1994).

From 1980 to 1990 the business was owned and operated by Gregory Stoffers, and PCE was the primary dry cleaning solvent used at the facility. Up until 1985, sludges or still bottoms were removed from the distillation unit and disposed onto the gravel parking area west of the building (URS 1994). From 1985 to 1990, the sludges were transported to a permitted off-site recycling facility by Safety Kleen. Overflow from the dry cleaning machine was also periodically discharged to a catch basin or overflow tray located outside the southwest corner of the building. Occasionally, the catch basin would overflow, potentially causing spills of the PCE-contaminated liquids to the ground surface (Agra 1994). Leaks and spills from the dry cleaning machines and associated equipment would have collected in numerous floor drains and sumps with the building; these floor drains may have carried PCE-contaminated wastewaters out to the west end of the building.

Previous operations also included the use of two underground storage tanks (USTs); a 500-gallon tank for gasoline and a 1,000-gallon tank for heating oil. The USTs were reportedly removed in 1989 by the property owner (Maxim 1996).

2.1 Site Geology and Hydrogeology

The annual precipitation in the Yakima area averages about 7 to 9 inches. The nearest surface water is the southeasterly flowing Yakima River, located approximately 1 mile east of the site. The Naches River is approximately 1.5 miles to the north of the site.

The topography at the site is generally flat, with elevations ranging between 1,060 and 1,065 feet above mean sea level. The site's geology and shallow upper aquifer consist of unconsolidated alluvium, primarily coarse-grained sands, gravels, and cobbles with occasional interbedded lenses of clay and silt. This alluvium extends from approximately 10 feet to 23 feet below ground surface (bgs) and is representative of the alluvium that blankets most of the Yakima Valley floor (URS 1994). Below this material is the Ellensburg Formation, which consists of similar materials that have been semi-consolidated. The Ellensburg Formation overlies basalt bedrock. The lower basalt aquifer ranges from 300 to 500 feet bgs in this region.

The regional, near-surface, alluvial aquifer is unconfined with depths to groundwater varying between 5 and 15 feet. Groundwater velocities at a nearby facility were estimated to be greater than 345 feet per year. For the regional YRRA, flow velocities were calculated to range from 6 to 12 feet per day (YRRA Work Plan). The regional groundwater flow direction is east toward the Yakima River.

Site groundwater elevations fluctuate seasonally as a result of localized recharge created from irrigation canals. During the winter months (January through March), the water table is typically present at a depth of about 20 to 25 bgs, and through autumn months, the water table is generally between 12 to 18 feet bgs, and the groundwater flow direction is to the east-southeast. Irrigation ditches throughout the Yakima area are charged in late March and are turned off in early October of each year. Leakages from the charged irrigation ditches have caused groundwater flow directions from generally south flowing in winter to east flowing in summer.

The groundwater gradients at the site, based on monitoring results, varied from 0.008 to 0.025 foot per foot with the steeper gradients occurring in the summer months, consistent with the localized recharge from the irrigation system.

Under natural conditions, groundwater discharges to the Yakima River, which is, at its closest, approximately 11,000 feet east of the site. As groundwater flows in an eastern direction during certain times of the year, this distance was chosen as the most conservative. Based on hydraulic conductivities estimated for other sites in the YRRA of 28 feet per day, a hydraulic gradient of 0.008 foot per foot, and a porosity of 0.35, the calculated groundwater travel time within the upper aquifer is about 240 feet per year. Therefore, it would take at least 47 years for groundwater from the Frank Wear site to reach the Yakima River. This is a rough approximation assuming an average distance to the river from the site as the groundwater flow direction varies throughout the year. Additionally, there is little information on whether utility corridors or irrigation lines in the area serve as preferential pathways or short circuits for impacted groundwater.

2.2 Previous Environmental Investigations and Interim Cleanup Actions

The Frank Wear site was first inspected in 1985 by Ecology as a result of a complaint regarding the disposal of the PCE-contaminated sludges in the back parking lot. Analytical results of soil and liquid samples collected from a surface puddle in the vicinity of the disposal area were not able to confirm the presence of PCE in soils at the site. Subsequent site inspections by Ecology in 1987 and 1989 confirmed the presence of PCE in the soil. The soil samples collected in 1989 were collected from the UST tank excavations up to 12 feet bgs and contained PCE concentrations to 10 milligrams per kilogram (mg/kg) (AGRA).

Frank Wear Cleaners was named a potentially liable party by Ecology for the YRRA in 1991. In 1994, Ecology and Frank Wear Cleaners signed an Agreed Order for a remedial investigation (RI). Subsequent remedial investigations and interim remedial measures pursuant to the Agreed Order are described below.

Soil Vapor Survey (1995). A soil vapor survey was performed at the Frank Wear site by Agra Earth and Environmental, Inc. (AGRA) in January 1995 as part of the YRRA remedial investigations (AGRA). Twenty-five soil vapor samples were collected at the site; 9 samples from beneath the floor of the dry cleaning building at depths of approximately 3.5 feet below the concrete slab, and 16 samples from the parking area to the west of the building at depths of 4 to 7 feet bgs. PCE vapors were detected in all 25 samples at concentrations ranging from 7 to 727 micrograms per liter of air (parts per billion, ppb). Seventeen of the 25 samples had PCE vapor concentrations of less than 45 ppb. Only three samples had PCE vapor concentrations greater than 125 ppb. The distribution of the PCE vapor concentrations suggested two potential source areas: one beneath the northeast portion of the building along a plumbing access trench, and the other on the north end of the property near the former heating oil UST. Significant vapor concentrations did not appear to extend beyond the east, west, and south boundaries of the property, where PCE vapor concentrations were generally low (7 to 44 ppb).

Remedial Investigation and Interim Action Remediation (1995). A RI and interim actions were performed in 1995 on behalf of the facility owner by Huntingdon Engineering and Environmental, Inc., which was acquired by Maxim Technologies, Inc., that same year (Maxim 1996). The purpose of the RI was to characterize the nature and extent of the volatile organic compound (VOC) contamination in soil and groundwater at the site. The RI included the installation of soil test pits and strataprobes, sampling and analysis of soils, and the installation and sampling of four monitoring wells. The screen depths of the monitoring wells were completed from 10 to 35 feet bgs.

The soil characterization results showed elevated concentrations of PCE above the MTCA Method B groundwater protection cleanup level of 0.08 mg/kg in soils underneath the building, underneath the storage shed, and in the parking lot areas. The highest concentration of PCE of 1,260 mg/kg was in the soils collected from the test pit near the west end of the building in the location of the former heating oil UST. This was the only area of the site where diesel-range total petroleum hydrocarbons (TPH) were detected in soils above the MTCA Method A cleanup level of 200 mg/kg.

Results of the four quarters of groundwater monitoring during the RI indicated that PCE, trichloroethene (TCE), and 1,2-dichloroethene (DCE) were present above analytical method detection limits in the vicinity of the site. PCE was the predominant compound with detection in the samples from the four wells during all four quarters of monitoring. PCE concentrations ranged between 5 micrograms per liter (ug/L) and 1,140 ug/L, with the highest concentrations detected in monitoring well MW-1, located adjacent to the southeast corner of the building (see Figure 2). TCE and DCE were detected in all four wells in at least one of the quarterly monitoring events. TCE concentrations ranged from non-detect to 48.3 ug/L. DCE concentrations ranged from non-detect to 17.9 ug/L.

An evaluation of the quarterly monitoring data showed that VOC concentrations fluctuated dramatically over the year in all four wells, with ranges from 5 to over 1,000 ug/L in the same well. VOC concentrations in monitoring wells MW-2, MW-3, MW-4 were greater when the groundwater flow direction was to the south. VOC concentrations in MW-1 were greater with groundwater flow direction to the east.

An interim remedial action was performed by Maxim Technologies in September 1995 and included the excavation of 610 tons of soil in the former heating oil UST area, where high concentrations of PCE and TPH-diesel were observed during the test pitting. The excavation included an area of approximately 35 feet by 70 feet with depths ranging from 3 to 12 feet bgs. The extent of the excavation was based on confirmation sampling results. During the excavation, a ruptured 4-inch wastewater sewer line was encountered at 7 to 9 feet bgs in the central portion of the site. The sewer line was believed to transport wastewater from the washing machine inside the building. A second sewer line along the northern boundary of the site was described as the primary sewer line.

The excavated soils were stockpiled and tested to determine disposal options. Approximately 310 tons of the excavated soils were transported off-site for disposal at a permitted landfill, based on concentrations of PCE exceeding the MTCA Method B groundwater protection cleanup level. The concentrations of criteria and were deemed acceptable for placement back into the excavation. Approximately 300 tons of clean fill were imported and placed into the excavation to return the area to its previous grade.

Groundwater Interim Remedial Action (1997). In 1997, an interim action to address the elevated concentrations of PCE in groundwater was conducted on the site. Environmental Economic Solutions installed five, 4-inch-diameter PVC C-Sparge wells and a fifth 2-inch-diameter monitoring well to implement an ozone sparging system . The system operated intermittently during 1997 and 1998 with frequent shutdown periods due to mechanical problems. Because of the interruptions to continuous operation, the success of the sparging system was inconclusive. The results of groundwater monitoring performed during and after sparging indicated that PCE concentrations remained in excess of regulatory limits.

Soil Interim Remedial Action (2001). In 2000, the dry cleaner building was demolished. Subsequently, in 2001, as part of the interim remedial action, Fulcrum Environmental Consulting, Inc., removed the building's concrete floor, and sampled and excavated impacted soils that were beneath the concrete floor and in other areas of concern and analyzed for PCE. Soils that exceeded the YRRA soil cleanup levels for protection of groundwater were excavated and disposed off-site. The extent of the excavations was determined by confirmation sampling. Depths of excavations ranged from 2 to 9 feet bgs. Approximately 432 tons of soil were excavated based on exceeding the YRRA soil cleanup levels. However, the PCE concentrations in these soils were determined to be below MTCA Method A cleanup levels and were approved for off-site disposal at an asphalt and gravel recycling facility. Clean fill was imported and used to fill the excavation back to its previous grade.

2.3 Summary of Groundwater Monitoring Results

In addition to the four wells previously installed in 1995, five new 2-inch-diameter monitoring wells were installed and four of the five four-inch-diameter ozone-sparging wells were converted to monitoring wells in March 2005. The site's 14 wells have been sampled and analyzed quarterly since July 2005, and ceased being sampled in 2007.

PCE concentrations up to 43,500 ug/L remain in the groundwater beneath the site and remain elevated downgradient from the site. Other VOCs of concern in the site's soil and groundwater include:

- Chloroform;
- Cis-1,2-dichlorothene;
- Trichloroethane;
- 1,1,1-Trichloroethane;
- 1,1,1,2-Tetrachloroethane;
- 1,2-Dichlorobenzene;
- Chlorobenzene;
- 1,2-Dichloroethane; and
- Trans-1,3-dichloropropene

The highest concentrations of PCE in groundwater at the site were detected in MW-10. This well is located within the footprint of the former dry cleaning building and next to the Buckle My Shoe Early Learning Center building to the south. Groundwater samples from monitoring wells SPW-12, SPW-13, and SPW-15 have had consistent high concentrations of PCE. Off-site monitoring well MW-3 along West Walnut Street, located south of the site, has recently had high concentrations of PCE in groundwater, greater than1,500 ug/L, in the last two April quarterly monitoring events, when the groundwater flow direction was primarily to the south (Ecology 2007b). Recent groundwater monitoring results are shown on Figure 3.

3.0 SCOPE OF WORK

This proposed scope of work has been developed based on previous environmental studies and current understanding that Ecology is prepared to move forward with an interim action at the childcare center if required. A final remedial action is anticipated to be implemented at the Frank Wear Site within the next three years. The objectives of this scope of work are for conducting a Vapor Intrusion Study at the Site and adjacent property and to implement an interim action, if necessary, to protect human health and the environment.

The following tasks comprise the work scope:

Task 1: Site & File Review

Task 2: Vapor Intrusion Study/Modeling/Investigation [soil-gas survey, indoor air sampling, etc]

Task 3: Vapor Intrusion Study Report

Task 4: Vapor Intrusion Emergency/Interim Action Plan

Task 5: Emergency/Interim Action Plans & Specifications

Task 6: Construction Inspection & Monitoring

A discussion of each task is provided below followed by the sampling and analytical procedures that will be implemented during the project.

Task 1 –Site & File Review: Develop a technical memo, following a comprehensive review of the site, outlining appropriate steps and needed actions to conduct a vapor intrusion study for the adjacent childcare center. The study should include technical review of existing data, modeling, and active sampling interior/exterior to the building, if indicated. The study should ensure for a high degree of confidence and answer all study questions regarding whether a threat exists to the occupants of the childcare center.

Task 2: Vapor Intrusion Study/Modeling/Investigation: Implement the Ecology approved study recommendations from Task 1. All actions for the vapor study should proceed as soon as possible with quick lab turnaround times.

Task 3: Vapor Intrusion Study Report: Prepare a technical memo on the vapor intrusion modeling, investigation, results, and recommended actions within 60 days of the date of the contract and it submission to Ecology.

Task 4: Vapor Intrusion Emergency/Interim Action Plan: Prepare an Emergency or Interim Action Plan for the site on the Ecology approved recommended actions.

Task 5: Emergency/Interim Action Plans and Specifications: Based on the interim action, develop plans and specifications for inclusion in a Public Works contract. For the purposes of cost estimating, the plans and specifications should be based on retrofitting, if necessary, the existing childcare center structure with an active sub-slab depressurization system. NOTE: For that portion of the interim action defined as Professional Services, a contract amendment shall be prepared under this task element.

Task 6: Construction Inspection and Monitoring: The task involves being the technical representative onsite during the interim action and to perform necessary construction inspection and monitoring services for the vapor intrusion sampling to include any in situ or laboratory sampling and analysis required, maintenance required, and any performance monitoring for the system constructed to demonstrate that vapors present are below levels that pose a threat to human health and the environment. NOTE: The task DOES NOT allow the technical representative to act as the contracting officer's representative for the site; this role will be performed by the Ecology site manager

REFERENCES

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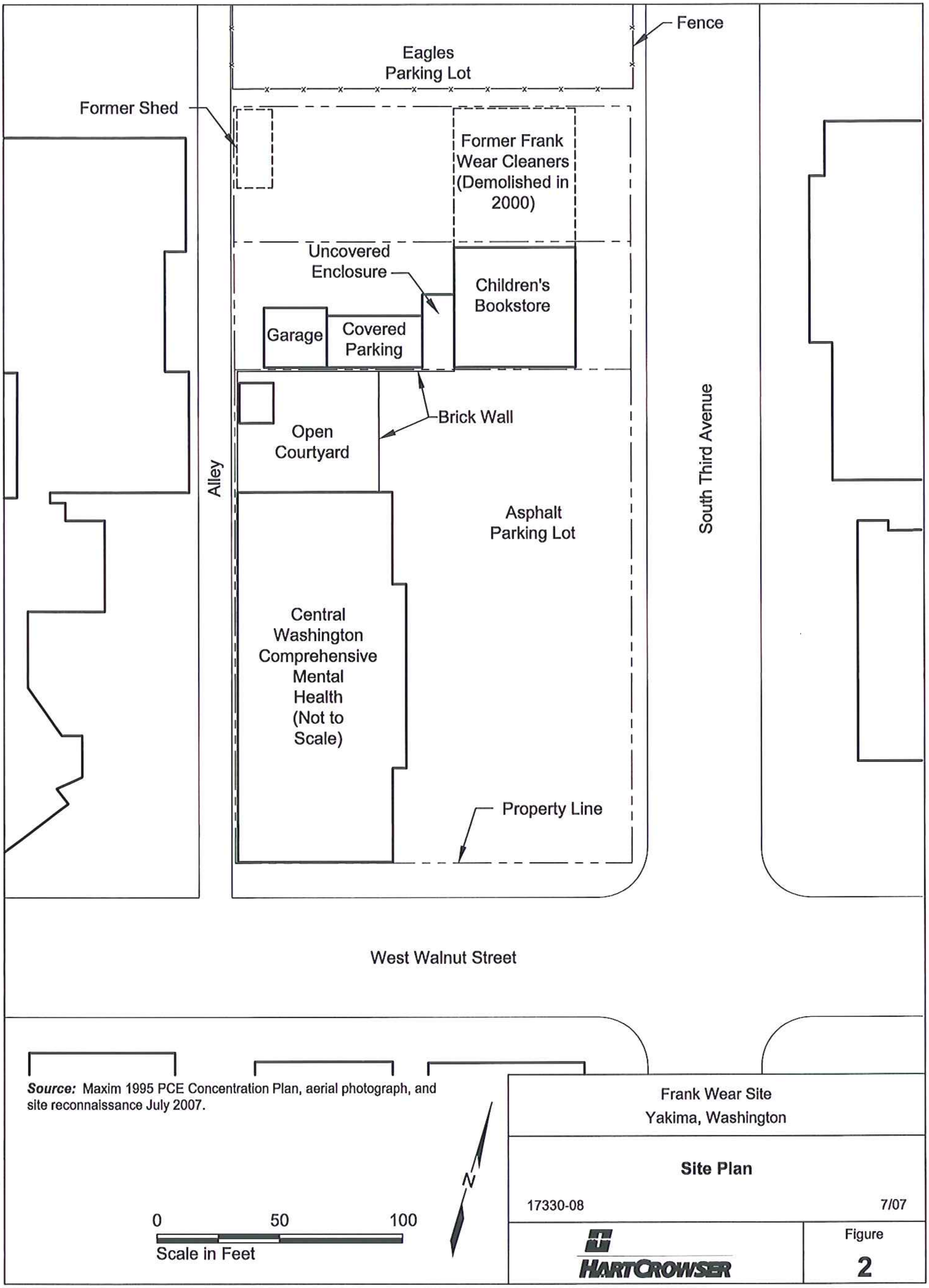


Source: Maxim 1995 PCE Concentration Plan, aerial photograph, and site reconnaissance July 2007.

Frank Wear Site
Yakima, Washington

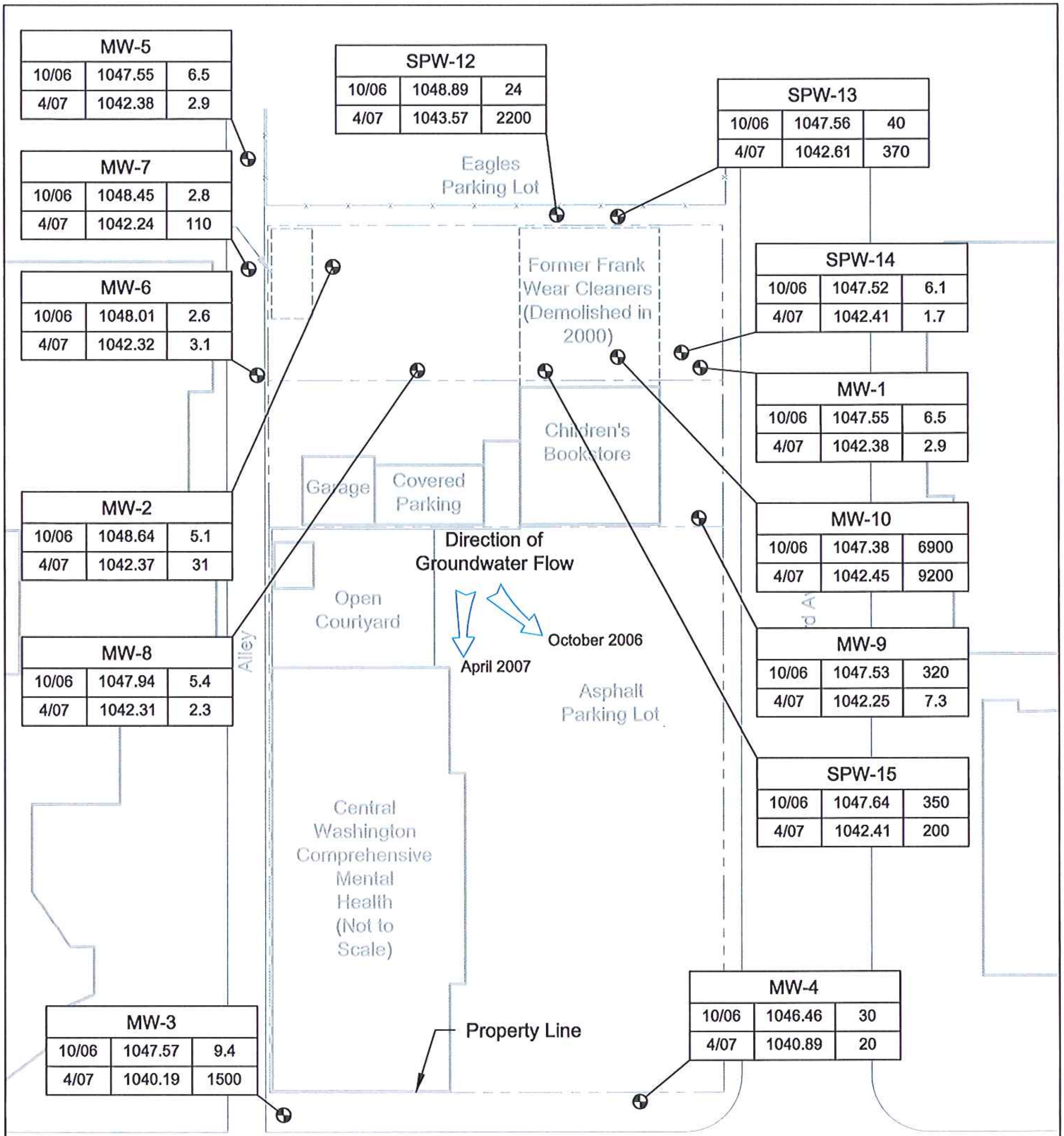
Site Plan

17330-08 7/07

HARTCROWSER

Figure
2

EAL 07/31/07 -001.dwg



MW-5		
10/06	1047.55	6.5
4/07	1042.38	2.9

SPW-12		
10/06	1048.89	24
4/07	1043.57	2200

SPW-13		
10/06	1047.56	40
4/07	1042.61	370

MW-7		
10/06	1048.45	2.8
4/07	1042.24	110

MW-6		
10/06	1048.01	2.6
4/07	1042.32	3.1

SPW-14		
10/06	1047.52	6.1
4/07	1042.41	1.7

MW-1		
10/06	1047.55	6.5
4/07	1042.38	2.9

MW-2		
10/06	1048.64	5.1
4/07	1042.37	31

MW-10		
10/06	1047.38	6900
4/07	1042.45	9200

MW-8		
10/06	1047.94	5.4
4/07	1042.31	2.3

MW-9		
10/06	1047.53	320
4/07	1042.25	7.3

SPW-15		
10/06	1047.64	350
4/07	1042.41	200

MW-4		
10/06	1046.46	30
4/07	1040.89	20

MW-3		
10/06	1047.57	9.4
4/07	1040.19	1500

Source: Maxim 1995 PCE Concentration Plan, aerial photograph, and site reconnaissance July 2007.

0 50 100
Scale in Feet

MW-8 ⊕ Groundwater Monitoring Well Location and Number

MW-1		
10/06	1047.55	6.5
4/07	1042.38	2.9

- Monitoring Well Number
- PCE Concentration in µg/L
- Groundwater Elevation in Feet
- Date Sampled

N

Notes:

1. Monitoring well locations are approximate.

Frank Wear Site
Yakima, Washington

Recent Groundwater Elevations and PCE Concentrations

17330-08 7/07

HARTCROWSER

Figure
3

EAL 07/31/07
8-012.dwg

Attachment B

Johnson and Ettinger Model Results

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES ☐

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES ☒ X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184	4.35E+04	Tetrachloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell G28)							
12.7	15	365.76	365.76	0	0	A	S			1.00E-08

MORE ↓

ENTER Stratum A SCS soil type Lookup Soil Parameters	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type Lookup Soil Parameters	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type Lookup Soil Parameters	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
S	1.66	0.375	0.054	C	1.43	0.459	0.215	C	1.43	0.459	0.215

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	366	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	350.76	0.321	0.244	0.244	#N/A	#N/A	#N/A	1.00E-08	17.05	0.375	0.122	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.54E+04	1.06E+06	3.77E-04	15	9,526	9.19E-03	3.92E-01	1.76E-04	1.16E-02	0.00E+00	0.00E+00	4.63E-04	5.35E-03	350.76

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m^3)	Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
15	1.70E+07	0.10	8.33E+01	1.16E-02	4.00E+02	5.42E+77	5.33E-04	9.08E+03	5.9E-06	6.0E-01

END

Attachment C

Standard Operating Procedures

Standard Operating Procedure (SOP) for Helium Shroud Testing During Soil Gas Sampling Activities

The purpose of performing leak testing using a helium shroud during soil gas sampling activities is to evaluate the potential for breakthrough of air down the probe annulus. It may also be used to assess the potential for leaks in the sample train. This Standard Operating Procedure (SOP) includes evaluation of the potential for breakthrough at the base of the soil gas probe using a helium shroud, and evaluation of the integrity of the sample train via a “shut-in” test.

During helium shroud leak testing, helium gas is introduced at the base of the probe and the annular seal integrity is verified by collecting and analyzing soil gas samples for the helium (aka tracer compound). A plastic shroud is placed over the soil vapor probe location with the tubing of the probe exiting the shroud through a small hole. The valve on the probe termination is connected to the sampling apparatus that is to be used. Smaller purge volumes may only require a syringe to purge, while larger purge volumes may require a sample pump with flow meter and vacuum gauge.

A “shut in” test is performed to check for leaks in all sample fittings and connections not contained within shroud. This is achieved by shutting the valve at the probe termination to the off position, then applying a vacuum to all connections between the valve and the sample container (i.e. syringe or summa canister). An in-line vacuum gauge is used to observe any loss in vacuum over a period of time (i.e., 60 seconds), which would indicate a leak in the system.

Helium is released into the shroud and a hand-held helium detector is used to monitor and maintain a reasonably steady concentration of helium in the shroud (between 10 percent to 50 percent, or two orders of magnitude higher than the reporting limit of the laboratory helium analysis or field meter). The helium concentration within the shroud should be maintained at a reasonably steady state and recorded periodically throughout the test for verification purposes. Once the steady-state concentration is reached, the soil vapor probe is purged at the recommended flow rate. A Tedlar bag is then collected from the probe by connecting to the exhaust port of the purge syringe to fill, or by using the Tedlar lung box. The contents of the Tedlar bag are then screened with the helium detector. If the concentration in the bag is greater than or equal to 10 percent of the helium concentration in the shroud, the sampling is stopped and efforts to improve or replace the probe are made.

The soil vapor sample is then collected in the appropriate sample contained (i.e., syringe or summa canister). Once the sample is taken, a final reading of the shroud concentration is measured with the meter and recorded. Approximately 10 percent of the samples will be analyzed for helium by the laboratory for confirmation of the leak check testing.

Standard Operating Guideline
Air Sampling

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy/Jenks Consultants personnel during the collection of air samples. This SOG provides guidance on procedures that are generally consistent with standard practices used in environmental sampling. Federal, state and/or local regulatory agencies may require air sampling procedures that differ from those described in this SOG and/or may require additional procedures. As guidance, this SOG does not constitute a specification of requirements for air sampling. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific sampling objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of air sampling activities.

This SOG does not address Quality Assurance/Quality Control (QA/QC) procedures for air sampling in detail. While some general QA/QC procedures are addressed, project-specific QA/QC procedures should be developed and presented in a Quality Assurance Project Plan (QAPP), field sampling and analysis work plan, or other project- or activity-specific document. U.S. Environmental Protection Agency (EPA) guidance for specific sampling methods, including QA/QC practices, for both criteria and toxic air pollutants, are found at the following web site: http://www.epa.gov/ttnamti1/methods.html

This SOG contains the following sections:

- Sampling Methods
- Equipment and Typical Procedures – Personal Air Pumps and Tedlar® Bags
- Equipment and Typical Procedures – Personal Air Pumps and Filters or Sorbent Tubes/Cartridges
- Equipment and Typical Procedures – Hi-Volume Samplers and Filters, TENAX®, or PUF
- Equipment and Typical Procedures – Summa™ Canisters
- Packaging Air Samples
- Shipping Air Samples
- Quality Control Guidance
- Calculation of Average Constituent Concentrations.

Sampling Methods

The target analytes, method detection and reporting limits, data quality objectives, and sampling environment will determine the specific type of medium, sampling equipment, field procedures, and laboratory analytical procedures to be used during the air sampling program. Five air sampling methods are summarized below. The sampling and analysis plan (SAP) and/or work plan will identify which sample method will be used.

Personal Air Pumps and Tedlar® Bags

Tedlar bags are used to collect and transport air samples that contain non-reactive chemicals. The target analytes must be suspected to be present in relatively high concentrations. A known volume of air is drawn directly into the bag, which is subsequently transported to an analytical laboratory for direct analysis of gaseous compounds (typically organic vapors) in the air within the bag. The analysis quantifies concentrations at one point in time. Reporting limits are generally quite high. Note that EPA guidance does not support use of Tedlar® bags for compliance determination.

Personal Air Pumps and Filters or Sorbent Tubes/Cartridges

Personal air pumps are generally used in industrial hygiene applications to collect air samples to detect moderate to high concentrations of analytes. A large volume of air is drawn through a collection medium or filter at a known rate, between 0.25 and 3 liters per minute (L/min), for a specified period. Analytes are concentrated on the filter or media, which is then analyzed. The mass of the analyte is divided by the total airflow to obtain an average concentration throughout the sampling period.

With sorbent tubes, a known amount of air is pulled through a sorbent packing to collect volatile organic compounds (VOCs). Subsequent analysis is by thermal desorption and capillary gas chromatography/mass spectrometry (GC/MS). The sorbent mix is tailored to the target analyte list, data quality objectives, and sampling environment. The possibility of breakthrough must be considered.

High-Volume Air Samplers and Filter, TENAX®, or PUF

High-volume air samplers (Hi-Vols) are used to collect samples of ambient air that contain trace concentrations of the target analyte. A large volume of air (>10 L/min) is drawn through a filter to collect particulate matter, or through a filter or other collection medium (e.g., TENAX®, or PUF) for a specified period of time (typically up to 24 hours). The mass of the analyte is divided by total airflow to obtain an average concentration through the sampling period. Particulate matter concentrations are determined from gravimetric analysis. The presence of metals may be determined from additional analysis of the filters. Other laboratory techniques are employed to analyze TENAX® or PUF samples, depending on the target analytes. Reporting limits are generally much lower due to the large volume of air collected. Specific guidance regarding high-volume air sampling is presented in appendices to 40 Code of Federal Regulations (CFR) Part 50.

Summa™ Canisters

An evacuated canister fitted with a calibrated intake flow controller is opened for a predetermined period to collect air potentially containing VOCs. Subsequent laboratory analysis of the air sample is by GC/MS. The sampling procedure presented below for Summa™ canisters fills the canister to atmospheric pressure. Under normal canister use, most VOCs can be recovered in their original concentrations, with little degradation, transformation, or deposition onto the canister walls.

Equipment and Typical Procedures

Personal Air Pumps and Tedlar® Bags

Equipment

- Tedlar® bag available in various sizes (typically 1 liter)
- Personal air sampling pump
- Calibrated rotameter, bubble meter, or other flowmeter, as appropriate
- Inert tubing (i.e. Teflon™ or Tygon)
- Watch
- Sample labels, pens, field logbook or other appropriate field forms, chain-of-custody forms, signed access agreements, and third-party sample receipts
- Screwdriver set
- Support stands to place inlet in breathing zone, if applicable
- Personal protective equipment as specified in the Health and Safety Plan (HASP).

Typical Procedures

1. Position pump inlet in area of concern (e.g., breathing zone).
2. Calibrate and record the pump flow rate with a calibrated rotameter, bubble meter, or flowmeter, if appropriate for the method. Flow rate is not important for grab samples.
3. Purge sample port.
4. Attach Teflon tubing from sample port or probe to low flow rate pump. Do not reuse tubing.
5. Attach Teflon tubing from outlet of air sampling pump to Tedlar bag valve. Do not reuse tubing.
6. Open Tedlar bag valve.
7. Turn pump on and fill bag no more than half to two-thirds full at the time of sampling based on size of bag and pump flow rate. For example, at a pump flow rate of 0.5 L/min, a 1 liter Tedlar® bag would be approximately half full after one minute.
8. Close Tedlar bag vavle by hand tightening valve clockwise.
9. Record the fill time and affix sample label to filled bag.
10. Measure and record the final pump flow rate with a calibrated rotameter, bubble meter, or flowmeter, if necessary.

11. Place the bag in a shipping container and ship the bag to the analytical laboratory (see below for shipping procedures).

12. Recharge air sampling pumps for next use.

Personal Air Pumps and Filters or Sorbent Tubes/Cartridges

Equipment

- Sample labels, pens, field notebook, or other appropriate field forms, chain-of-custody forms, signed access agreements, and third-party sample receipts
- Personal air sampling pump
- Calibrated rotameter, bubble meter, or other flowmeter
- Inert tubing (i.e. Teflon™ or Tygon)
- Self-contained filter cassettes or glass tubes from manufacturer
- Glass tube breaker, if needed
- Screwdriver set
- Watch
- Support stands to place inlet in breathing zone, if applicable
- Aluminum foil to protect tube from sunlight, if applicable
- Sample shipping and packaging supplies
- Personal protective equipment as specified in the HASP.

Typical Procedures

1. Obtain filter cassette or glass media tube from manufacturer for specific chemical of concern.

2. Assess minimum volume of air and sampling time required for analysis, and determine pump flow rate accordingly.

3. Remove filter cassette end cap and/or break glass tube at each end.

4. Attach sampling filter/media to inlet tube of sampling pump. Make sure flow indicator is aligned with the flow. This filter/tube is used to calibrate the pump.

5. Calibrate and record the pump flow rate with a calibrated rotameter, bubble meter, or flowmeter.

6. Remove sample filter/tube used for calibration and replace with the filter/tube used to collect the sample. Some sampling methods may require the use of more than one tube.

7. When ready to begin sampling, turn on pump and record start time.

8. Periodically visually check pump during sampling period to assess if pump is operating properly and filters are not clogged (moisture or particulates).

9. At end of sampling period, record pump flow rate with rotameter, bubble meter, or flowmeter and turn off the pump. Record the flow rate and end time.

10. Remove sampling filter/media from pump and cap ends of cassette/glass tube.

11. Place a completed label on the sample.

12. Follow sampling packaging and shipping procedures outlined below.

13. Recharge air sampling pumps for next use.

High-Volume Samplers and Filters, TENAX®, or PUF

Equipment

- Sample labels, pens, field logbook or other appropriate field forms, chain of-custody forms, signed access agreements, and third-party sample receipts
- Hi-Vol with volume controller to maintain constant flow rate, filter holder, elapsed timer, and on-off timer
- Thermometer, calibrated orifice transfer standard, and manometer
- Glass fiber filter and/or TENAX® or polyurethane foam (PUF) sampling medium
- Glass tube breaker, if needed
- Lint-free gloves
- Tools and spare parts
- Personal protective equipment as specified in the HASP.

Typical Procedures

1. Place the sampler on a suitable platform in an area exposed to the maximum anticipated concentrations of the target analytes. A source of power will be required.

2. Leak test the sampler with a representative sampling medium in place.

3. Calibrate the Hi-Vol by measuring the pressure drop across the filter and/or medium using the orifice transfer standard and varying the flow over the expected range of flow conditions. Develop a calibration curve from the measurements for each Hi-Vol sampler.

4. Immediately before sampling, measure the pressure drop across the filter and/or medium with the manometer and determine the flow rate from the calibration curve.

5. Inspect the filter and/or medium, record sample identifiers, and load filter and/or medium into sampler.

6. Set the sampler on and off times. Record the number of minutes on the elapsed time counter.

7. During the sampling period, note the occurrence of adverse weather conditions such as high wind speeds. Record the barometric pressure (available from the Internet or weather radio) and ambient temperature. If possible, periodically check the condition of the sampler.

8. After sampling, carefully remove filters and/or medium and transfer to appropriate shipping containers.

9. Place a completed label on sample.

10. Record the elapsed time, temperature, and barometric pressure.

11. With representative medium in place, measure the pressure drop across the medium and estimate the flow from the calibration curve.

12. Calculate total flow from the elapsed time and average standard flow.

13. Follow sample packaging and shipping procedures outlined below.

14. For analysis of particulate matter, determine net weight by weighing the filter after moisture equilibration and before and after use. The filter may be subjected to further analysis (for example, for the presence of metals).

15. Compute the concentration (mass divided by total volume of air sampled corrected to standard conditions).

Summa™ Canisters

Equipment

- Sample labels, pens, field logbook, or other appropriate field forms (e.g., sample log forms, chain-of-custody forms), and access agreements and third-party sample receipts (if warranted)

- Summa™ canisters, flow controller, and filter (as appropriate) prepared by the laboratory

- Flexible inert (i.e. Tygon or Teflon™) or stainless steel tubing of the appropriate diameter to allow sampling in the breathing zone

- Fittings for connection of tubing and for collection of co-located duplicate samples (precleaned and/or provided by the laboratory)

- Support stands, if necessary, to place the inlet in the breathing zone
- Tools and spare parts
- Watch
- Personal protective equipment as specified in the Health and Safety Plan (HASP).

Typical Procedures

1. Obtain tubing, stands (if needed), and canisters with flow controllers. The flow controllers should be pre-set by the vendor to allow continuous sampling through the desired time.

2. Unpack the canister from the shipping container and inspect it for damage.

3. Identify sampling location, place a small table or stand at the sampling location, and place the canister on the table or attach the tubing to the stand.

4. Before sampling, verify initial vacuum of canister using the following steps. These steps will also be used to verify the final vacuum of the canister after sampling.

    a. Confirm that the valve is closed (the knob should be tightened clockwise).

    b. Remove the brass cap.

    c. Attach gauge.

    d. Attach the brass cap to the side of the gauge tee fitting.

    e. Open and close the valve quickly (a few seconds).

    f. Read the vacuum on the gauge.

    g. Record the gauge reading in the “initial vacuum” column of the chain-of-custody form (or record the gauge reading when beginning sampling).

    h. Verify the canister valve is closed and remove the gauge.

    i. Replace the brass cap.

5. Attach particulate matter filter (if using) and flow controller and any tubing to be used.

6. Open the canister valve one-half turn.

7. Record date and time. Note weather conditions during sampling period, especially any high wind conditions.

8. Note the condition of the sampling location and the presence of any potential chemical sources (for example, paints, cleaners).

9. At the completion of sampling, close the canister valve.

10. Record date and time.

11. Remove the filter (if used) and flow controller.

12. Complete the canister sample tag.

13. Prepare the canister label.

14. Complete the chain-of-custody form. It is important to note both the canister and flow controller serial numbers on the chain-of-custody form.

15. Follow sample packaging and shipping procedures outlined below.

16. The laboratory concentrations may be reported in volumetric units of parts per million (ppm) or parts per billion (ppb). If required, convert these concentrations to mass concentrations of micrograms per cubic meter ($\mu g/m^3$).

Packaging Air Samples

Packaging guidelines for air samples are as follows:

Personal Air Pumps and Tedlar® Bags

Pack Tedlar® bag in protective box provided by the laboratory out of direct sunlight. Store the box at room temperature. If the laboratory did not provide a box, use an ice chest for storage, but do not chill.

Sorbent Cartridges/PUF

1. Once sample collection is complete, replace the end caps on the tube. For “VOST” tubes (a modified TO-10A tube), tighten the fittings so that they cannot be rotated by hand, and place the sealed tube in the culture tube used for shipping. This culture tube contains activated charcoal to remove contaminants from the ambient air.

2. For TO-4A, TO-10A, and TO-13A tubes, replace the plastic caps and Teflon™ liners.

3. NEVER write sample identification notations on the glass cartridge.

4. Wrap the tube with aluminum foil. Place in a plastic bag.

5. Store the tubes in a refrigerator until shipment.

6. Storage and transportation of all sorbent tubes should be at 4 degrees Celsius (°C) ±2º C both prior to and after sample collection. Water ice, placed in two ziplock bags, sealed tightly, is best for this application. A vial of water should be included when returning the tubes to the laboratory to allow the laboratory to easily document the temperature upon sample receipt.

Sorbent Tubes/TENAX®

1. Once sample collection is complete, replace the stainless steel end caps on the tube. Tighten so that the fittings cannot be rotated by hand and placed the sealed tube in the culture tube used for shipping. The culture tube contains activated charcoal to remove contaminants from the ambient air.

2. Store the tubes in a refrigerator until shipment.

3. Storage and transportation of all sorbent tubes should be at 4°C ±2º C both prior to and after sample collection. Water ice, placed in two ziplock bags, sealed tightly, is best for this application. A vial of water should be included when returning the tubes to the laboratory to allow the laboratory to easily document the temperature upon sample receipt.

Summa™ Canisters

1. Replace brass cap.

2. Repackage canister in box provided by laboratory. Use bubble wrap to keep canister from shifting within box.

3. Repackage gauge and particulate filter (if used) in packaging provided by the laboratory.

4. Prior to shipment, store air samples at room temperature. Do not chill.

Shipping Air Samples

For all samples collected, the following chain-of-custody and shipping guidelines apply:

1. Prior to shipping the samples, review the chain-of-custody form and bag labels to check that the required entries are filled. Sign and date the chain-of-custody form and enter the time the samples are released to the shipping agency or analytical laboratory. When more than one chain-of-custody form is needed, number them sequentially.

2. If multiple boxes/coolers are needed for shipping a single batch of samples, one chain-of-custody form can be placed inside one box/cooler. However, a label should be attached to each box/cooler in the batch indicating the total number of shipping containers and which container contains the original chain-of-custody form.

3. Band the box/cooler closed with strong adhesive tape and apply custody seals. Custody seals may not be necessary if the samples are picked up from the sampling location by the analytical laboratory, or a sampling technician delivers the samples directly to the analytical laboratory.

4. Throughout the sampling activities and during transport to the analytical laboratory, maintain the samples in the secure custody of the sampling team, shipping agency, and/or analytical laboratory personnel. The sampling team will retain copies of all chain-of-custody forms. Original chain-of-custody forms will remain with the sample during storage, shipping, and analysis and will be forwarded with the final analytical reports to Kennedy/Jenks Consultants.

Ship air samples using priority overnight service if the samples cannot be driven directly to, or collected by, the analytical laboratory on the day of sampling.

Quality Control Guidance

Follow the quality control requirements specified in the QAPP, project-specific field sampling and analysis work plan, and/or project-specific regulatory requirements, as applicable. The following may be used as guidelines.

- A blind duplicate should be collected for every 20 samples, unless otherwise specified.
- A field blank should be prepared each day by attaching an open filter/glass tube to a sampling pump that is not drawing air.
- A media (transport) blank should be analyzed for every 20 samples. Not applicable to Summa canister sampling.
- The rotameter should be returned to the manufacturer for calibration or calibrated against a soap film primary standard once a year

Calculation of Average Constituent Concentrations

The laboratory results for some sampling methods will be expressed as milligrams (or micrograms) of target analyte(s). The average target analyte concentration is the mass of the analyte divided by the volume of air sampled (most often in cubic meters). The total volume of air sampled is calculated from the average measured flow times the time sampled. For Hi-Vol sampling, the total volume of air is expressed in standard pressure and temperature conditions. Analytical laboratories will provide the option of expressing the concentrations in volumetric units [parts per million by volume (ppmv) or parts per billion by volume (ppbv)] or in mass units (nanograms or milligrams).Divide the constituent mass by the total volume of air collected to obtain the average concentration of analyte in air during sampling period. The analytical results for some sampling methods (i.e. Summa canister samples) will be expressed in ppmv, ppbv, µg/m^3, or mg/m^3.

Standard Operating Guideline
Soil Gas Sampling

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically used by Kennedy/Jenks Consultants personnel in collecting soil gas samples. This SOG provides guidance on procedures that are generally consistent with standard practices used in environmental sampling. Federal, state and/or local regulatory agencies may require soil gas sampling procedures that differ from those described in this SOG and/or may require additional procedures. As guidance, this SOG does not constitute a specification of requirements for soil gas sampling. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific sampling objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of soil gas sampling activities.

This SOG does not address Quality Assurance/Quality Control (QA/QC) procedures for soil gas sampling in detail. While some general QA/QC procedures are addressed, project-specific QA/QC procedures should be developed and presented in a Quality Assurance Project Plan (QAPP), field sampling and analysis work plan, or other project- or activity-specific document.

This SOG contains the following sections:

- Equipment
- Typical Procedures for Soil Gas Sampling Within Structures
- Typical Procedures for Soil Gas Sampling
- Quality Control Guidance
- Investigation-Derived Waste (IDW) Management.

Equipment

Analytical laboratories may supply much of the equipment necessary to conduct the soil gas sampling, such as sampling probes and sampling containers. Other equipment that may be necessary include the following:

- Electric drill or rotohammer, if necessary

- Portable generator, if necessary

- Cement, appropriate for vapor intrusion investigations

- Sand, appropriate for vapor intrusion investigations

- Bentonite, appropriate for vapor intrusion investigations

- Lab-grade or distilled water
- Extension cords
- Measuring devices (i.e. tapes or electronic measuring tools)
- Flashlight or trouble light
- Decontamination supplies, if necessary
- Zero air or nitrogen, if necessary
- Vacuum pump, if necessary
- Tedlar bags, if necessary
- Flow-cell regulator, if necessary
- Leak check compound, appropriate for use in vapor intrusion investigations

Typical Procedures for Soil Gas Sampling Within Structures

The procedures typically followed by these subcontractors are outlined below.

1. Access to the structure and approval for sampling is obtained. Access is typically the responsibility of Kennedy/Jenks Consultants. Kennedy/Jenks Consultants will discuss with the owner the presence of any known utilities in the subsurface.

2. In structures with earthen floors, probes are advanced into the subsurface to a depth of approximately 2 to 5 feet below ground surface. The probes are sealed, allowed to equilibrate, the sampling train is purged, and the sample is collected.

3. In structures with concrete floors, a small hole is drilled through the concrete, and a probe placed and sealed in place. After an equilibration time, the sampling train is purged, and the sample is collected.

4. Sampling of the soil vapor stream will be performed using a disposable syringe, Tedlar bag, or stainless steel evacuated canister.

5. The sample will be analyzed onsite using a mobile gas chromatograph (GC-ECD or GC-FID) or submitted to a stationary analytical laboratory.

Typical Procedures for Soil Gas Sampling

The procedures typically followed for soil gas sampling are outlined below.

Prior to sampling, the sample locations will be identified and the possible presence of underground utilities will be checked. The utility check is typically the responsibility of Kennedy/Jenks Consultants. Kennedy/Jenks Consultants will also contact Underground Service Alert (USA) prior to commencing fieldwork (minimum 48-hour notification required).

Active soil gas sampling is performed by inserting a hollow probe into the subsurface, approximately 3 to 10 feet below ground surface. Typically, a vacuum is applied to the sampling probe using a vacuum pump or syringe and soil vapor is removed. If the vacuum gauge indicates that an excessive vacuum pressure is encountered (about 17 inches of mercury or more), then an alternate sample location will be identified.

Permanent/semi-permanent sampling probes may be installed using a variety of drilling methods. Nested probes may be installed at one location to sample at various depths and may even be set near the groundwater table if diffusion from impacted groundwater is suspected. After installation of the probes, the location will be allowed to equilibrate before purging and sampling.

Some soil gas investigations may require a purge volume test be conducted before sampling can commence. During this test, typically three different volumes are tested (i.e. 1, 3, and 7 purge volumes).

Sampling of the soil vapor stream will be performed using a disposable syringe, Tedlar bag, glass bulb, or stainless steel evacuated canister.

The sample will be analyzed onsite using a mobile gas chromatograph (GC-ECD or GC-FID) or submitted to a stationary analytical laboratory.

Quality Control Guidance

The following techniques and procedures will be used by the analytical laboratory (mobile or fixed) to calibrate the analytical equipment and assure quality control.

- Standards will be prepared using ultra-pure grade chemical analytes. The GC will be calibrated to the analytes of concern using a three point standardization process. Standardization checks will be performed at the beginning of the day and throughout the day to assure the accuracy of the calibration.

- Equipment blank samples will be analyzed each morning prior to sampling to identify possible cross contamination.

Investigation-Derived Waste (IDW) Management

Any IDW, including personnel protective equipment (PPE) IDW, generated is to be contained onsite in an appropriate labeled container for disposition by the client unless other project-specific procedures are defined. Refer to the IDW SOG.