Remedial Action Work Plan

Former Chevron Service Station 209335
1225 North 45th Street
Seattle, Washington

May 26, 2005

Prepared for:

ChevronTexaco

Chevron Environmental Management Company
6001 Bollinger Canyon Road, K2252
San Ramon, CA 94583

Prepared by:

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An Employee-Owned Company

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Bothell, WA 98011

C01-SAI-209335-01-07463

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1.0 INTRODUCTION

This Remedial Action Work Plan details tasks designed to remove petroleum hydrocarbon impacted soil and light non-aqueous phase liquids (LNAPL) observed at the former Chevron Service Station No. 209335, located in Seattle, Washington. This work plan has been produced by Science Applications International Corporation (SAIC) on behalf of Chevron Products Company (Chevron). In addition, revised vapor intrusion model results and memo are attached as Appendix A.

2.0 BACKGROUND

The former Chevron Service Station No. 209335 is located at 1225 North 45th Street, in Seattle, Washington. The property is located in a commercial/mixed retail and residential neighborhood in northern Seattle. Located north of the site are single-family residences and a vacant lot that was formerly a McDonald's restaurant. Located east of the site is Stone Way South. To the south is Big Wheel Auto Parts; southwest is an asphalt parking lot and residences; and to the west are the former Wallingford Medical Building and the Seattle Housing Authority.

The subject property is currently owned by the Seattle Housing Authority and is vacant. The property is scheduled for development as a mixed-use residential/commercial facility in Spring/Summer 2005.

A gasoline service station and a service building operated at this location beginning in approximately 1935. According to archive records, the Standard Oil Company (later Chevron USA) purchased the property in 1954. Chevron's tenure at the property covered the years 1954 to 1978. The original station was reported to contain two 1,000 gallon fuel underground storage tanks (USTs), one 550 gallon UST and one hydraulic lift. The 1935 service station was replaced in 1956 with one 3,000 gallon UST, one 2,000 gallon UST, and one 550 gallon UST. The gasoline service station building and service garage were removed in 1969 and the lot has remained undeveloped ever since (Phase I ESA, August 20, 1999, by EA, Inc.).

A series of site investigations, completed by various consultants, have resulted in a vertical and lateral delineation of impacted soil and groundwater. The lateral limits of shallow and deep soil contamination are presented in Figure 1. Depth to water ranges between 34.0 and 38.5 feet below ground surface (bgs). Groundwater flow direction is south-southeast. Concentrations of gasoline-range hydrocarbons and BTEX constituents have exceeded MTCA Method A cleanup levels in wells MW-2, MW-4, and MW-5. LNAPL has been detected in wells MW-2 (beginning in the first quarter 2002), MW-4 (2003), and MW-5 (beginning in the third quarter 2001).

An undocumented 1,000-gallon UST was removed in February 2001. No contamination was detected in the confirmation samples collected during the tank pull procedure.

3.0 OBJECTIVES

The objectives of this remedial action are to protect human health by closing the soil to direct contact exposure pathway and to remediate deep soil "hot spots" in order to accelerate the natural attenuation of the groundwater in the vicinity of the site. Appendix A includes a Johnson and Ettinger vapor model results showing that the vapor pathway from the subsurface to the indoor air of the parking garage does not result in any increase in risk for the residents of the future building.

The eventual objective of this remedial action is to obtain a no further action determination from the Washington State Department of Ecology.

4.0 SCOPE

The scope of work to be completed for this remedial action includes the following tasks:

- Locate underground utilities, if present, at the proposed off site drilling locations;
- Coordinate timing and tasks with HRG and Walsh Construction;
- Provide oversight and screen all soil excavated from the former Chevron property for organic vapors, noting any odors or sheen;
- Install approximately eighteen bucket auger borings to depths of approximately 40 feet below the current grade;
- Coordinate the disposal of soil impacted by petroleum hydrocarbons;
- Install three on-site monitoring wells prior to the construction of the parking lot floor;
- Install two monitoring wells located offsite down gradient from contaminated soil;
- Sample groundwater from newly constructed monitoring wells; and
- Prepare a final Remedial Action Report that will document field activities at the site as well as analytical results of the soil samples.

5.0 PROCEDURES

5.1 Underground Utility Locating and Borehole Clearing

Prior to subsurface investigation activities, SAIC will arrange for the location of underground utilities by: (1) contacting the Utilities Underground Location Center; and (2) contracting a private locating service.

5.2 Permits

SAIC has reviewed the SEPA documentation obtained by Nancy Henderson of GGLO; we have had a discussion with the City of Seattle Department of Planning and Development; and evaluated any addition permit requirements for the site remediation. The city confirmed that the additional excavation and borings are covered by the construction SEPA and grading permits. The drilling subcontractor will procure the appropriate start card permits prior to drilling.

5.3 Excavation

SAIC will provide technical oversight throughout the remedial excavation activities on the former Chevron property. All excavation operations will be handled by Walsh Construction's subcontractor.

The segregation of soil will be based on field observations, such as degree of hydrocarbon odor, PID readings, sheen tests, and soil analytical data from previous borings. Field observations will be performed on discreet samples as the excavation proceeds and noted in the field logbook. Organic vapor concentrations will be taken using a calibrated, photo-ionization detector, and headspace vapor technique. Impacted soil will be sent to Rinker Materials in Everett, Washington for treatment. This includes soil with contaminant concentrations below MTCA Method A cleanup levels but with contaminant concentrations that prevent unhindered off-site disposal options (Class 2 Soils). Walsh Construction will provide transport of the impacted soils.

The excavation during planned development activities will proceed vertically until the desired grade elevation is achieved, 13 feet below original surface. SAIC will provide oversight during the lateral excavation of contaminated soil until field observations and laboratory analytical data indicate that contamination is no longer present. Soil that is contaminated below the final grade that are outside of the proposed limits of the deep soil bucket augers will be excavated vertically to a maximum depth of 18 feet below the original grade or until field observations indicate that contamination is no longer present. Once the contaminated soil is removed, the excavated areas will be filled with clean onsite soil or clean, imported pit run sand and gravel fill to return the site to the finished excavation grade. The fill will be compacted to meet the requirements of the structural and geotechnical engineers.

The excavation will occur in lifts as the soil nail shoring is completed along the north and east Site boundaries.

Soil samples will be collected from the base of the excavation and the soil stockpiles to determine where and when levels are below MTCA Method A criteria. Soils that contain detectable concentrations of petroleum hydrocarbon constituents but meet the MTCA Method A cleanup levels may be used on-site as backfill with property Owners sole approval. These soils will be removed and treated with the contaminated soil. The excavation will be monitored such that the excavated soil is separated into a contaminated and an uncontaminated stockpile. The segregation of soil will be based on the following field observations:

- Organic vapor concentrations measured by a photoionization detector (PID);
- Sheen testing; and
- Hydrocarbon odors.

Soil that fails any of these criteria will be visually categorized as impacted and treated as contaminated soil. Field observations will be performed on discreet samples as the excavation proceeds and noted in the field logbook. PID readings will be taken using a calibrated, photo-ionization detector, and headspace vapor technique.

The approximate contamination limits are depicted on Figure 1. These contamination limits also approximate the anticipated limits of SAIC's lateral involvement during the excavation. The anticipated depth of excavation is approximately 18 feet below current grade. The excavation will proceed laterally until field observations indicate that contamination is no longer present or until the shoring limits have been reached.

5.3.1 Field Screening Procedures

5.3.1.1 Headspace Vapor Screening

Headspace vapor screening consists of measuring the organic vapor content of a volume of air in the headspace surrounding a sealed sample of soil. Soil from each boring will be screened in the field using a PID.

The screening procedure involves first placing the soil in a re-sealable (Ziploc) bag, leaving a small amount of open headspace in the bag for organic vapors, if present, to collect. The bag is then sealed and the headspace is allowed to equilibrate with the soil sample for several minutes at ambient air temperature prior to PID measurement. The bag is punctured or slightly unsealed, and the PID intake probe is inserted through the opening into the headspace. The concentration of organic vapor in the headspace of the bag is then measured and recorded.

Soils producing an organic vapor concentration of 25 ppm or greater will be treated as impacted soil.

5.3.1.2 Sheen Testing

Sheen testing involves placing soil in pan of water and observing the water surface for signs of sheen. Sheens are classified as follows:

- Slight Sheen: Light, colorless, dull sheen. The spread is irregular and dissipates rapidly;
- Moderate Sheen: Light to heavy sheen, may show color/iridescence. The spread is irregular to flowing. Few remaining areas of no sheen is evident on the water surface; and
- Heavy Sheen: Heavy sheen with color/iridescence. The spread is rapid and the entire water surface may be covered with sheen.

Soils exhibiting visible hydrocarbon sheen will be treated as impacted soils.

5.3.2 Soil Disposal/Reuse

Impacted soil from the site will be transported to the Rinker Materials facility in Everett, Washington. At the facility, Rinker will thermally treat the soil in accordance with federal, state, and local regulations.

Soil with analytical results that are clean, i.e. contaminant detections are less than MTCA Method A Cleanup Levels, may be used as backfill at the site as long as it conforms with engineering requirements that may be imposed on the project. If on-site soils are determined to be unsuitable for backfill, imported pit run sand and gravel fill will be placed as necessary to meet the engineering requirements at the desired grade..

5.4 Deep Soil Hot Spot Removal

SAIC will subcontract DBM Contractors Inc., of Federal Way, Washington (a licensed driller), to drill approximately 18 bucket-auger borings to remove LNAPL-saturated soil located along the smear zone (approximately 35 to 40 feet bgs). The removal of these deep "hot spots" will accelerate the natural attenuation, and shorten the time to achieve groundwater cleanup levels. The drilling and backfill will be coordinated with the shoring engineer.

The bucket-auger drilling and deep soil removal will commence after site shoring and the site excavation is completed. See Figure 1 for approximate soil boring locations. Locations are based on previous soil borings and groundwater monitoring.

Recent groundwater sampling results from MW-4 indicate that the area surrounding the well is not currently impacted by LNAPL. LNAPL has not been observed in MW-4 in the past year during weekly monitoring and bailing, and analytical data (January 2005) show relatively low dissolved phase gasoline–range concentrations.

Bucket-auger borings will measure six feet in diameter and will remove a column of soil to a depth of approximately 40 feet below the current grade Borehole casing will be installed during drilling if caving or slumping in the borehole is an issue. When each boring is completed, the casings will be removed and the borings will be backfilled with Control Density Fill (CDF), soil-cement slurry (the CDF mix will be per engineering requiments). The removed soil will be directed to Rinker Materials, located in Everett, Washington for thermal treatment and reuse.

5.5 Monitoring Well Construction

Replacement wells will be installed on-site during redevelopment and two monitoring wells will be installed off-site. The on-site monitoring wells will be situated in locations where LNAPL was observed and to monitor groundwater conditions on-site. Well placement will be finalized after discussions with HRG to assure that well placement doesn't interfere with any structures or construction design. The off-site wells will be installed down gradient from contaminated soil. SAIC will work with Walsh Construction to determine the best time to install the wells that are on-site in the underground parking garage.

The procedures that will be used to construct and develop the new on and off-site monitoring wells are described below.

5.5.1 Well Construction

SAIC will oversee a review of all utilities in the vicinity of the proposed drilling locations prior to mobilization of the drilling subcontractor to the site. Prior to drilling each of the off site borings will be cleared to a depth of 8 feet with an air knife. Any necessary permits will be secured prior to the commencement of drilling.

A Washington-licensed well driller using a hollow stem auger drilling rig will install the wells (two off-site and three on-site) . All down-hole drilling equipment will be steam cleaned prior to drilling. Decontamination will take place in a designated decontamination area located away from the wells. Soil cuttings and decontamination water generated during the installation of the wells will be securely sealed in 55-gallon steel drums.

Soil samples will be collected during the drilling of each for the purpose of lithologic logging, field screening and chemical analysis. An experienced field geologist will log the soil samples, monitor the drilling operations, record the well installation procedures, and prepare a boring log and a well construction diagram.

Both the on and off-site wells will be constructed of a 2-inch diameter, schedule 40 PVC casing with 0.010-inch factory slotted screen. Well screens of approximately 10-foot length will be placed near the bottom of each boring below the groundwater surface and will extend a distance above the groundwater surface at the time of installation. The annular space across the entire screened interval and extending approximately 2 feet above the screen will be filled with 12-20 Monterey Sand. The remaining annular space above the sand will then be sealed with hydrated bentonite chips to approximately 3 feet bgs. Two feet of concrete will then be poured into the remaining annular space to provide a surface-seal at the wellhead. The remaining blank well casing will then be cut at approximately 0.5 foot bgs and a locking well plug installed. A traffic-rated waterproof well monument set in concrete will be installed by Walsh construction at each well location flush with the surrounding surface.

Selected soil samples should be placed into laboratory prepared sample containers as per laboratory instructions. Samples will be immediately placed on ice for preservation. All Chain-of-Custody procedures will be followed. The sampler will enter samples onto a Chain of Custody form as they are collected. Soil samples will be packed and shipped to Lancaster Laboratories for analysis the same day or immediately the next morning. Samples must be to the lab within 48 hours from when they were obtained.

5.5.2 Well Development

Each new monitoring well will be developed by over pumping with an electric down-well pump (Whale pump). The development procedure consists of lowering the Whale pump into the bottom of the well. The pump is raised and lowered repeatedly to surge the groundwater within the well. Surging the well by raising and lowering the pump produces an outward surge of water that is forced from the borehole through the well screen and into the formation. This tends to break up any bridging that has developed within the formation. As the pump is repeatedly raised and lowered through the well, the surging action created in the borehole causes the particulate matter outside the well to flow into the well. During this process, water containing this particulate material is removed from the well by the pump. Pumping is continued until approximately 10 casing volumes of water have been removed.

Purged groundwater produced during well development will be contained in 55-gallon DOT-approved drums where they will be temporarily stored to allow fines and sediments to settle.

The purged groundwater will be removed along with the soil cuttings. Any LNAPL accumulated during this project will be stored in an overpack container at site and disposed of at a later date.

5.5.3 Monitoring Well Survey

The TOC elevation of each new monitoring well will be surveyed to the nearest 0.01-foot with respect to the TOC of at least two of the existing monitoring wells on the site. A survey reference mark will be scribed on the lip of the new well casings for future groundwater elevation measurements. The location of each monitoring well installed will be determined with respect to existing buildings or other site features. Well locations will be measured to the nearest 0.5 foot using a survey tape or rolling-wheel measuring device.

5.6 Groundwater Sampling

Groundwater samples will be collected from each of the new monitoring wells by SAIC within 48 hours of completion. Each monitoring well will be purged with a disposable polyethylene bailer until a minimum of three well volumes of groundwater has been removed from each well. In the event a monitoring well runs dry during purging, the groundwater level in the well will be allowed to recover to approximately 75 percent of its original static level and purging will continue. If the well is again purged dry, it will be allowed to recover to 75 percent of its original static water level (if possible), at which point it will be considered sufficiently purged.

After purging is complete, groundwater samples will be collected with a disposable polyethylene bailer. Groundwater samples collected for laboratory analysis will be collected in laboratory-supplied sample containers, recorded onto a Chain of Custody form, and immediately placed in an ice chest for storage prior to transport to the analytical laboratory (Lancaster Laboratories in Lancaster, Pennsylvania) under standard chain-of-custody procedures. Samples will be analyzed for gasoline-range hydrocarbons (Method NWTPH-Gx) diesel-range hydrocarbons (Method NWTPH-Dx ext. w/ silica gel cleanup, and BTEX (EPA Method 8021).

Following the completion of site remediation, a groundwater monitoring schedule will be developed. These activities will be detailed in a separate work plan.

6.0 DATA QUALITY ASSURANCE

The following quality assurance and quality control procedures will be utilized during this field project to ensure accurate and reproducible data reflective of actual subsurface conditions.

The quality assurance objective for this project is to ensure that chemical and physical data of known and acceptable quality is produced. To achieve this objective, all samples will be analyzed in accordance with EPA, state, or equivalent protocols. An analytical laboratory certified and approved by the state of Washington will perform all analyses.

6.1 Monitoring Equipment Calibration

The portable PID used for screening soil vapor headspace will be calibrated at the beginning of each day according to the manufacturer's recommended procedure using a laboratory-certified calibration gas. The instrument may also need to be re-calibrated during the course of the day.

6.2 Sample Designation

The following section describes designations assigned to each individual component of the Work Plan. The sample designation protocols will be adhered to during the sample collection procedures to maintain sample data integrity. Specific sample information such as location number and depth will be maintained in the field logs.

6.2.1 Soil Sample Designation

Soil samples collected from the excavation will be numbered sequentially. For example, the first sample collected from the excavation sidewall will called EXS-1. If the second sample is collected from the excavation base it would be designated EXB-2.

Soil samples collected from borings will be designated with the name of the boring and the depth at which the sample was collected.

Example: A sample from the boring for Well MW-6 collected 10 feet below grade would be called: MW-6-10.0

6.2.2 Groundwater Sample Designation

When collected, groundwater samples from proposed or existing monitoring wells will be labeled according to the monitoring well ID.

Example: Groundwater from monitoring well No. 5 will be labeled MW-5

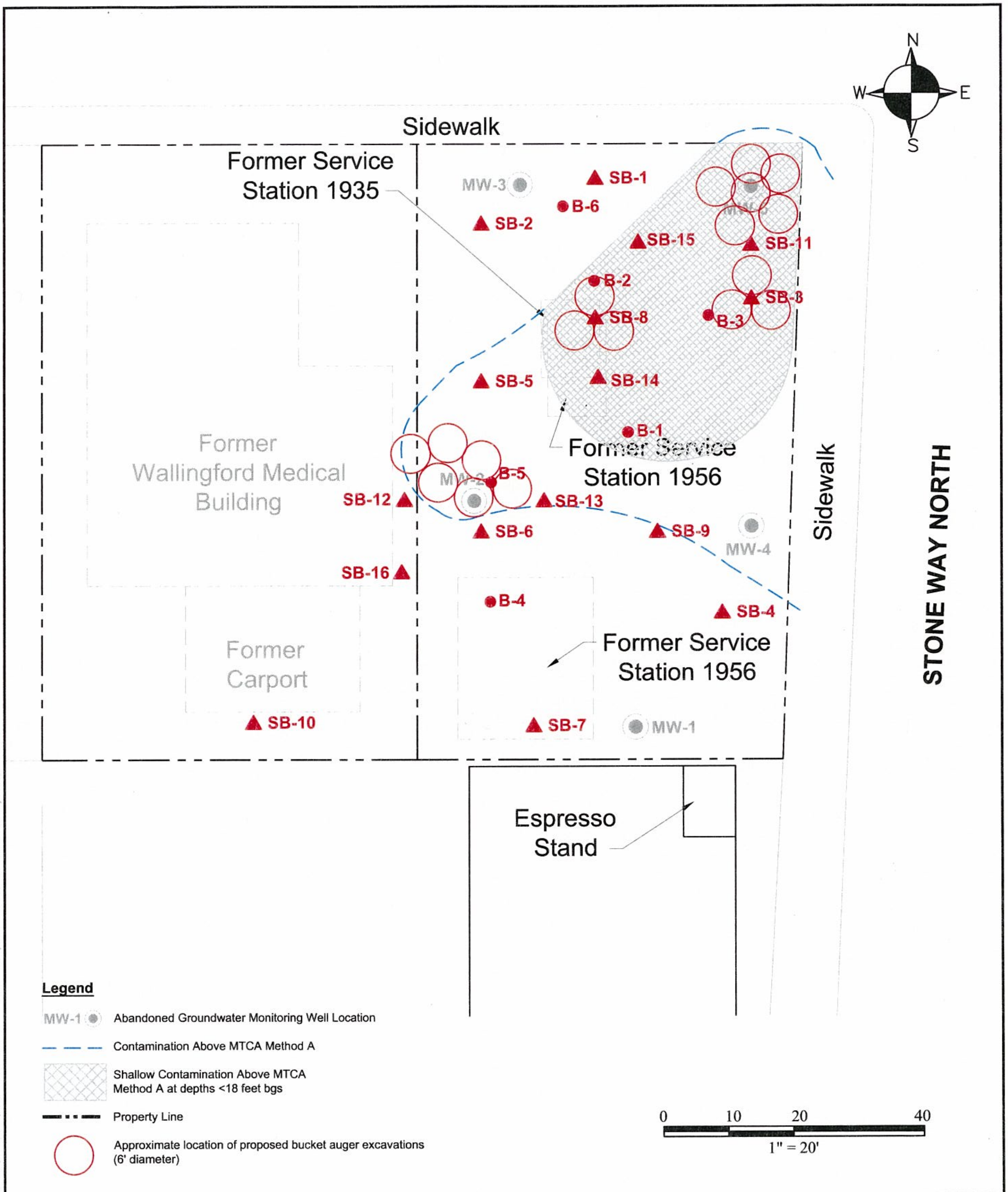
6.3 Decontamination Procedures

Equipment that is not directly used for sampling (i.e. drilling steel) will be cleaned between each sampling location using a high-pressure water wash. Soil sampling equipment (i.e. hand augers, spoons and scoops) will be cleaned with non-phosphate detergent (e.g. Alconox, Liquinox) and water, rinsing with clean tap water, and rinsing with deionized or distilled water. Water level indicators will be washed with detergent and water and then rinsed with tap water and distilled water before use, between each sampling or measurement location and prior to storage.

Disposable nitrile gloves, bailers, sampling pump tubing, peristaltic pump tubing and any other form of disposable sampling equipment will be discarded after use at each sampling location.

6.4 Sample Storage, Packing, and Shipment

All soil and groundwater samples will be stored in an ice chest while at the site and during transportation to the laboratory. Samples will be sub-packed by sample location in new Ziploc plastic bags and stored in the dark at approximately 4°C. A temperature compliance vial (provided by laboratory) will accompany each cooler to verify that proper holding temperatures were maintained during transport.



ChevronTexaco	Site Map	FIGURE
SAIC®	Chevron Service Station 209335 1225 North 45th Street Seattle, Washington	1
	Date: August 11, 2004	

APPENDIX A

Science Applications International Corporation
An Employee-Owned Company

MEMORANDUM

To: Paul Fitzgerald – Seattle Housing Authority
Vaughn McLeod – Housing Resources Group

From: Don Wyll

Date: 26 May 2005

Re: Vapor Modeling, ChevronTexaco Site No. 20-9335
Future Stone Way Apartments Building

This memo details the revised Johnson and Ettinger vapor intrusion modeling information for the former ChevronTexaco facility located on Stone Way and 45th Avenue in Seattle, Washington. The vapor model was completed to estimate the potential soil vapor intrusion impacts in the proposed sub-grade parking garage of the new building. The following memo and attachment present the input data used in the model, the assumptions made, and the resulting incremental risk calculations.

Previous soil sampling and analytical testing reveal that subsurface contamination exists on the property above MTCA Method A cleanup levels. The area of contamination is limited mainly to the northeast corner of the property (approximately 11% of the building footprint); however, model risk calculations were performed assuming the contaminated layer underlies the entire building footprint. The highest concentrations of petroleum constituents detected onsite were used as model input (Toluene = 48 mg/kg, Ethylbenzene = 61 mg/kg, and total xylenes = 320 mg/kg). These values are from soil sample SB-8-37.5 collected 37.5 feet below ground surface (bgs). Benzene was not detected in any soil samples collected onsite. As such, benzene does not contribute to any potential indoor air inhalation risk. However, to run the model in a conservative manner, a non-detect value of benzene (representative of site-wide analytical results, < 0.26 mg/kg) was input into the model.

Soil physical parameters have not been analytically tested, so the pertinent model values for observed soil types were used. Soils beneath the site have been described in previous investigations as sand and gravelly sand. Sand was used as the soil type based on these previous investigations and on anticipated backfill material.

The depths to the top and bottom of the contaminated zone were based on previous analytical data and the proposed depth of the remedial excavation. Incremental risk calculations were performed assuming an excavation depth of 18 feet bgs and subsequent backfilling with clean fill, and a resultant contaminated zone extending from 18 to 45 feet bgs.

The depth below grade of the enclosed floor space and building dimensions were obtained from the architectural drawings of the proposed building. The building design drawings show the garage basement floor at ten feet bgs. The garage will extend across the entire building footprint. The building width is shown as 92 feet, and the building length is shown as 310.28 feet. A basement ceiling height of 9 feet was input into the model.

MTCA standard exposure assumptions were used as model input for exposure duration and averaging times for carcinogens and noncarcinogens (WAC 173-340-750). Johnson and Ettinger default values for floor wall crack seam width were increased from 0.1 cm to 0.5 cm to account for the expansion joints in the garage floor. Per the building design, the slab thickness was set at four inches and model defaults were used for differential pressure. A reasonable maximum exposure frequency was calculated assuming an individual spent a half hour in the garage per day, 365 days per year.

The final model input affecting the risk to human health is the indoor air exchange rate in the garage. The garage will contain a mechanically operated fan (26,155 CFM) that is operated by a carbon monoxide sensor. This fan will operate only if carbon monoxide concentrations are detected by the attached sensor unit. A smaller volume ventilation system (1,300 CFM) will operate continuously to meet local building codes. This lower volume exchange rate (calculated at 2.7 exchanges per hour) was used in model calculations. In reality the exchange rate will likely be much higher over each 24 hour period as the main exhaust fan is occasionally triggered by automobile exhaust.

The Johnson and Ettinger worksheet results show that insignificant incremental risk to human health will be present in the proposed sub-grade parking garage of the Stone Way Apartments building. This determination was reached with conservative assumptions, including that the soils beneath the proposed building are continuously contaminated from 18 to 45 feet bgs at the highest level of contamination detected onsite, across the entire footprint of the building. In actuality, contamination is limited to one corner of the building and the most heavily contaminated deep soil hot spots will be removed during site development by bucket auger borings. The model inputs also assume that contaminated soil will be excavated to 18 feet below ground surface, the total air exchange rate in the garage area is 2.7 exchanges per hour, and that individuals will spend 30 minutes everyday, 365 days per year in the garage. The model results are as follows:

- The total carcinogenic incremental risk: 1.7×10^{-7}
- The total non-carcinogenic incremental risk: 8.0×10^{-8}

Based on these resulting incremental risk calculations, we believe that the planned excavation of contaminated soil to 18 feet bgs and the planned removal of contaminated soil by bucket auger borings will effectively mitigate the soil vapor intrusion pathway and be protective of human health in the proposed parking garage.

Enclosures

SL-ADV
Version 3.0; 02/03

Reset to Defaults

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

YES [ ]

OR

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

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
71432	2.60E+02	Benzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (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 A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	304.8	457	1372	320.04	136.96	0	S		

Totals must add up to value of L_t (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
S	1.66	0.375	0.054	0.002	S	1.66	0.375	0.054	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	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)
10.16	40	9457.33	2804.16	274.32	0.5	2.7	

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)
75	6	30	7.6	1.0E-06	1

Used to calculate risk-based soil concentration.

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	3.20E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.7E-07	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

SL-ADV
Version 3.0; 02/03

Reset to Defaults

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

YES [ ]

OR

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

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
108883	4.80E+04	Toluene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) 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 A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	304.8	457	1372	320.04	136.96	0	S		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
S	1.66	0.375	0.054	0.002	S	1.66	0.375	0.054	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	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)
10.16	40	94557.33	2804.16	274.32	0.5	2.7	

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)
75	6	6	7.6	1.0E-06	1

Used to calculate risk-based soil concentration.

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (μg/kg)	Indoor exposure soil conc., noncarcinogen (μg/kg)	Risk-based indoor exposure soil conc., (μg/kg)	Soil saturation conc., C_{sat} (μg/kg)	Final indoor exposure soil conc., (μg/kg)
NA	NA	NA	2.25E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	5.3E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

SL-ADV
Version 3.0; 02/03

Reset to Defaults

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

YES [ ]

OR

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

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
100414	6.10E+04	Ethylbenzene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (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 A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	304.8	457	1372	320.04	136.96	0	S		

Totals must add up to value of L_t (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
S	1.66	0.375	0.054	0.002	S	1.66	0.375	0.054	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	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)
10.16	40	9457.33	2804.16	274.32	0.5	2.7	

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)
75	6	6	7.6	1.0E-06	1

Used to calculate risk-based soil concentration.

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (μg/kg)	Indoor exposure soil conc., noncarcinogen (μg/kg)	Risk-based indoor exposure soil conc., (μg/kg)	Soil saturation conc., C_{sat} (μg/kg)	Final indoor exposure soil conc., (μg/kg)
NA	NA	NA	1.34E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.7E-06	2.0E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

SL-ADV
Version 3.0; 02/03

Reset to Defaults

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

YES [ ]

OR

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

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
106423	3.20E+05	p-Xylene

MORE ↓

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (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 A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
15	304.8	457	1372	320.04	136.96	0	S		

Totals must add up to value of L_t (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
S	1.66	0.375	0.054	0.002	S	1.66	0.375	0.054	0.002					

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	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)
10.16	40	9457.33	2804.16	274.32	0.5	2.7	

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)
75	6	6	7.6	1.0E-06	1

Used to calculate risk-based soil concentration.

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	NA	NA	1.56E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	6.6E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based soil concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

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I have reviewed the above referenced document and have given final document approval.

Project manager: Lynn Brennan by Bailey
(Designee)

Date: 5/26/05