DUAL PHASE EXTRACTION PILOT TEST WORK PLAN

CHEVRONTEXACO SERVICE STATION NO. 211577
601 QUEEN ANNE AVENUE
SEATTLE, WASHINGTON

December 1, 2003

Prepared for:

ChevronTexaco

Prepared by:

SAIC®
An Employee-Owned Company

DUAL PHASE EXTRACTION TEST WORK PLAN
CHEVRONTEXACO SERVICE STATION NO. 211577
631 QUEEN ANNE AVE. NORTH
SEATTLE, WASHINGTON

1.0 INTRODUCTION

The former Texaco Queen Anne Service Station No. 211577 was located at 631 Queen Anne Avenue North, at the intersection of West Roy Street, in the City of Seattle, Washington. The property is located in a residential/commercial neighborhood in the Queen Anne District of northwest Seattle. Located within one city block east, west and south of the former facility location are several multi-story apartment buildings, a hotel, several retail and commercial shops and a former Union Oil Company 76 (Unocal) service station located at 700 Queen Anne Avenue North.

The subject property located at 631 Queen Anne Avenue North is currently owned by the Arnolds and is occupied by a deli/convenience store known as the "Manhattan Express".

Recent soil, soil vapor, and groundwater sampling from beneath the apartment building detected high concentrations of BTEX and TPH-g in all three media beneath the building. Indoor air intrusion modeling indicates benzene may pose a risk to human health in the basement of the apartment building.

The Site was reviewed in Phase C on 11/19/02, at which time several data gaps were identified. RSRT recommended restart of the existing SVE system to mitigate potential vapor intrusion pathway. This has been done, and SVE system has been operating at very low recovery rates since April 2003. A residual NAPL smear zone extends offsite and beneath the Monterey apartment complex, with residents living in basement. Sub-slab vapor sampling performed late 2002 documented potential vapor intrusion pathway exposure that has been mitigated by the existing SVE system. However, water table impinges on basement slab in winter, defeating SVE system operation. Both regulatory and sensitive receptor drivers define remediation objectives. RSRT recommends dual-phase extraction pilot testing be performed to evaluate the potential for dewatering smear zone soils underlying the basement. Several logistical steps were discussed and action items assigned. RSRT recommends review of pilot test data with project team prior to performing design work.

2.0 OBJECTIVES

The project team and RSRT believes Dual-Phase Extraction (DPE) is the best technology to achieve remediation objectives. Based on the difficulty of installation at this site, RSRT believes adequate pilot testing is necessary to obtain feasibility and design data. The objective of this investigation is to conduct a 72-hour (minimum) DPE pilot test to collect data necessary to assess the feasibly of the technology and data to complete full-scale system design.

3.0 SCOPE OF WORK

To accomplish these objectives, SAIC proposes to use as much of the existing SVE system infrastructure as feasible. One existing monitoring/vapor extraction well will be re-installed as a DPE well, and three additional monitoring wells (Figure 1) will be installed as monitoring points. The scope of work for this investigation will include the following tasks:

- Locate underground utilities, if present, at the proposed drilling locations;
- Obtain all appropriate well-installation permits required to complete this investigation;
- Using a truck-mounted direct-push probe rig (GeoProbe) install approximately two to three exploratory soil borings. The soil borings will be sampled continuously to a depth where field observations indicate that contamination is no longer present. Soil samples will be field screened for vapors using a FID to evaluate smear zone depth and thickness;
- Using a hollow stem auger drill rig install three soil borings to be completed as groundwater monitoring wells. These new wells will be used to evaluate groundwater conditions in the vicinity of VP-6 and will be used as monitoring points during the DPE pilot test;
- Drill out and re-install VP-6 as DPE-1 (a 4-inch diameter extraction well);
- Collect soil samples from each auger boring at 2.5-foot intervals, using a split-spoon soil sampler;
- Screen all soil samples collected for organic vapors, and note any odors or sheen;
- Analyze selected soil samples from each soil boring for gasoline-range petroleum hydrocarbons (TPH-gas), diesel and oil-range petroleum hydrocarbons (TPH-diesel-extended), and BTEX constituents;
- Survey each new well to establish top-of-casing (TOC) elevations for each based on existing well elevations.
- SAIC and/or the drilling subcontractor will develop the new wells by pumping and surging;
- Collect and analyze groundwater samples from each newly installed wells for TPH-gas, TPH-diesel-ext, and BTEX constituents;
- Install DPE pilot test components as detailed in Attachment A; and
- Conduct a 72-hour DPE pilot test;

4.0 PROCEDURES

4.1 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 locate service. Soil boring locations will be cleared by hand or with an air knife to approximately 8 feet bgs prior to drilling. SAIC will also arrange for coring of concrete (if present) in the areas to be sampled, prior to drilling.

4.Obtain Permits

The drilling subcontractor will procure the appropriate start card permits prior to drilling. Permission to drill on-site will be obtained from the property owner.

4.3 Soil Boring for Groundwater Monitoring Wells

SAIC will subcontract Cascade Drilling Co. to drill two soil borings and install three groundwater monitoring wells. In addition, vapor well VP-6 will be drilled out and reinstalled as a 4-inch diameter well See Figure 1 for proposed soil boring/well locations. Soil samples from each monitoring well boring will be collected using a split-spoon soil sampler driven ahead of the drill stem. Samples will be collected at 2.5-foot intervals down to the bottom depth of the well. Each soil boring will be logged by an SAIC environmental scientist/geologist in accordance with the Unified Soil Classification System ("USCS") Visual-Manual Procedure (American Society for Testing and Materials Method D2488). Soil samples will be collected continuously from the probe borings.

Soil from each boring will undergo headspace vapor screening for the presence of hydrocarbons using a flame-ionization detector (FID). The results of the headspace vapor screening will be recorded on the soil boring logs. Soil samples will be selected by SAIC for laboratory analysis based on headspace screening concentrations, sheen, odor, depth to groundwater, and other field observations. In most cases, soil samples collected from the groundwater interface in each boring will be submitted for laboratory analysis. Additional samples may be submitted for laboratory analysis from any soil samples collected near or above the groundwater interface that exhibit headspace vapor concentrations greater than approximately 100 parts per million. The project manager will decide if any additional samples will be analyzed. All collected soil samples, whether intended for analysis or archiving, will be retained in laboratory-supplied glass jars with Teflon-lined lids and placed on ice for transport to Lancaster Laboratories in Lancaster, Pennsylvania.

4.4 Soil 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 portable gas analyzer equipped with a flame ionization detector (FID). Headspace vapor screening will be performed on all the soil samples using a separate container than the samples to be sent to the laboratory.

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 allowed to equilibrate with the soil sample for several minutes at ambient air temperature prior to FID measurement. The bag is punctured or slightly unsealed, and the FID 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.

4.5 Monitoring Well Installation

Each of the completed monitoring wells will be installed using 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 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 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-feet bgs and a locking well plug installed. A traffic-rated waterproof well monument set in concrete will be installed at each well location flush with the surrounding surface.

The re-completed VP-6 (now labeled DPE-1) will be installed using 4-inch diameter schedule 40 PVC casing with 0.010-inch slotted screen. The total depth of the well will extend slightly into the clay layer underlying the site. The screen will extend to the top of the smear zone as evaluated by the geoprobe boring samples. The screen will not extend any further that 5 feet above the groundwater table. To minimize the potential for short-circuiting, the annular space above the screened interval will be filled with grout up to the depth of the well casing. DPE-1 will be installed with an oversized well vault and reconnected to the existing SVE system.

4.6 Monitoring Well Development

Each new monitoring well will be developed by first surging with a metal bailer, then over pumping with an electric down-well pump (Whale pump). The development procedure consists of lowering the metal bailer into the bottom of the well. The bailer 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 bailer 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. The bailer is then removed from the well and the whale pump is lowered to the well bottom. Water containing this particulate material is then removed from the well by the pump. After approximately 3 well volumes of water have been removed, or the water begins to clear of particulate matter, the pump is removed from the well, and the entire process is repeated by surging with the metal bailer. This alternating of surging with a bailer, then pumping is continued until approximately 10 casing volumes of water have been removed.

Purged groundwater produced during well development will be placed into the batch tank and run through the existing groundwater treatment system.

4.7 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.

5.0 Data Quality Assurance

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

5.1 Monitoring Equipment Calibration

The portable FID 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 isobutylene gas standard. The FID may also need to be re-calibrated during the course of the day.

5.2 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 by washing 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.

5.3 Chain-of-Custody Procedures

Chain-of-custody (COC) protocols will be followed throughout the duration of this project. Each sample cooler (or batch of coolers) containing laboratory samples will contain a fully completed COC form. The field personnel will retain a copy of the COC form, and the original will be sent with the samples to the laboratory.

6.0 Storage and Disposal of Residuals

Residual soil from this investigation will be contained in 55-gallon DOT approved drums on-site temporarily storage while awaiting laboratory results. Following receipt of laboratory analytical data, arrangements will be made for transport of all sampling residuals for eventual treatment and disposal at TPS in Vancouver, Washington.

7.0 DPE PILOT TEST

DPE System Components

The DPE Pilot Test system will include a downhole pneumatic (Solo II) pump for groundwater extraction, and use for concurrent vapor extraction at moderate vacuum. Vapor effluent will be treated with the existing Catox unit. Extracted groundwater will be processed through a flow meter to the existing batch tank and tray stripper prior to discharge to the sanitary sewer.

Groundwater measurements will also be taken at predetermined interval as described in the DPE Pilot Test SOP.

The DPE pilot test will be conducted over a 72-hour period. Data will be recorded and summarized in a report that will be used for full-scale system design if DPE proves feasible. Details of the pilot test procedures are presented in Attachment A (DPE Pilot Test SOP).

If the system performs as expected during the pilot test phase the newly installed DPE well will be remain operational through the design and modification of the full-scale system. This will provide additional interim cleanup in the vicinity of VP-6.

9/23/03 RSRT Meeting
Notes, Recommendations, & Action Items

Former Texaco Station #211577 Queen Anne, Seattle, WA (Brett Hunter/SAIC) Phase E, Recycle to C; Evaluate DPE system

RSRT Attendees:

Tom Peargin, ChevronTexaco Energy Research Company, trpe@chevrontexaco.com
Mark Lafferty, Chevron Environmental Management Company, laff@chevrontexaco.com
Bill Brasher, Secor International, Inc., bbrasher@secor.com
David Watts, Science Applications International Corp., JOHN.D.WATTS@saic.com
Scott MacLeod, Cambria Environmental, smacleod@cambria-env.com

Non-RSRT Attendees:

Don Wyll, SAIC, 425-482-3315, wylld@saic.com
Tom Dube, SAIC, 425-482-3325, dubet@saic.com
Brett Hunter, Chevron Environmental Management Company, blhu@chevrontexaco.com

Executive Summary

Site was reviewed in Phase C on 11/19/02. The Remediation System Review Team (hereinafter the "RSRT") recommended restart of the existing SVE system to mitigate potential vapor intrusion pathway. This has been done, and SVE system has been operating at very low recovery rates since April 2003. A residual NAPL smear zone extends offsite and beneath the Monterey apartment complex, with residents living in basement. Sub-slab vapor sampling performed late 2002 documented potential vapor intrusion pathway exposure which has been mitigated by the existing SVE system. However, water table impinges on basement slab in winter, defeating SVE system operation. Both regulatory and sensitive receptor drivers define remediation objectives. RSRT recommends dual-phase extraction pilot testing be performed to evaluate the potential for dewatering smear zone soils underlying the basement. Several logistical steps were discussed and action items assigned. RSRT recommends review of pilot test data with project team prior to performing design work.

RSRT Conclusions

- Site was reviewed at Phase C (11/19/02)
- Sub-slab vapor sampling show high concentrations. During winter months, WT rises to base of slab. Sensitive receptor and regulatory drivers require post-remediation source removal such that probability of a complete vapor intrusion pathway is minimized.
- RSRT believes Dual-Phase Extraction is the best technology to achieve remediation objectives. Based on the difficulty of installation at this site, RSRT believes appropriate pilot testing is necessary to obtain feasibility and design data:
    1. Recommend Geoprobe core data collection to estimate smear zone depth (headspace technique)

2. Create scale cross section of wells alongside Monterey Apts. to evaluate possible short circuiting routes (existing SVE wells evidence of short circuiting)
3. None of the existing SVE wells were constructed for the purpose of DPE testing. Recommend recompleting existing well as DPE recovery well for pilot testing (unless step #2 suggests wells are too close to building).
4. Minimum 4" diameter extraction well deep enough to adequately dewater well and accommodate pump. TD of well should be scaled to smear zone base. Well TD should extend beneath smear zone and include adequate sump for pump.
5. Screen should extend only ~5 ft. above WT or less (subject to step #2).
6. Install piezometers to measure dewatering and vacuum distribution (lateral distances of 5-10 ft., 10-20 ft., >20 ft.)
7. Select well with high dissolved GW concentrations or NAPL
8. Select well connected to SVE system
9. Reactivate Metro discharge permit (if possible) for discharge of treated water during DPE testing, and for full-scale system.
10. Perform DPE pilot test:
    - Recommend test be performed near remediation target (Monterey Apts) to evaluate dewatering
    - Water treatment, transfer, and disposal logistic to be established by project team. However, water recovery rates must not be compromised.
    - Refer to Draft DPE Operating Standard for pilot test protocols. Suggest work plan be reviewed by RSRT via email prior to testing (forward to T. Peargin for distribution)
    - Duration should be adequate to evaluate stabilized dewatering characteristics (suggested 72-hr minimum)

- Once DPE pilot testing has been completed, recommend RSRT review with project team prior to performing design work.

Remediation drivers:

Regulatory:

- Remediation will be required until Separate Phase Hydrocarbon (SPH) is removed and any existing indoor air risks to adjacent properties have been appropriately mitigated .
- The site is currently being managed under the Washington State Department of Ecology's (WDOE) Voluntary Cleanup Program (VCP). A Draft RI has been submitted, the Final RI will be submitted soon. Ecology has indicated that a system must be operational by the end of 1st Qtr 2004.
- Water is not potable
- The State has indicated that the drivers for this site are the vapor (inhalation) pathway and direct contact with soil.

Legal:

- The current site owner (Arnolds) have not yet been brought into cost sharing.

Sensitive receptors:

- Vapor and odor complaints from tenants in the basement level of the adjacent Monterey Apartments triggered investigations and responses from the Seattle Fire

Department during the late 1970's and through the 1980's. No complaints have been made since 1987.

- SPH is currently present beneath the western end of the Monterey Apartments and in one or more wells on the former site.
- Recent soil, soil vapor, and groundwater sampling from beneath the apartment building detected high concentrations of BTEX and TPH-g in all three media beneath the building. Indoor air intrusion modeling indicates benzene may pose a risk to human health in the basement of the apartment building. No indoor air sampling has been performed.
- The Site is located near Puget Sound (approx ½ mile), but contamination does not reach surface water.
- Groundwater is not potable.

Remediation objectives:

What is remediation trying to accomplish? How will it satisfy drivers?

- The remediation objectives are to reduce concentrations of contaminants in soil and groundwater to close the subsurface to indoor air pathway. The soil – direct contact pathway will remain open. It is not feasible – given the layout of the off-site area – to close the soil direct contact pathway at this time. There is a high likelihood that future development in the area will allow for access to the contaminated soil.
- A negotiated period of compliance monitoring will be required following active remediation.

What data will be collected to indicate remediation is progressing successfully

- Soil vapor samples will be collected from existing vapor points inside the basement of the Monterey Apartments assuming access can be maintained.
- Groundwater monitoring will continue on a quarterly schedule.
- System monitoring to calculate removal rates.
- Continued weekly bailing of product.

What are shut-down criteria?

- The active remediation system will be shut down when the concentrations of gasoline-range hydrocarbons, BTEX constituents and chlorinated hydrocarbons are reduced to levels that will eliminate the potential for vapor intrusion into the Monterey Apartments. Shut down criteria are the elimination of NAPL and vapors under the basement.

What are post-remediation success criteria?

- The removal of the NAPL and the reduction of hydrocarbons, chlorinated solvents (not caused by service station operations) and benzene in the soil beneath the Monterey Apartments in order to close the soil vapor to indoor air pathway should allow for minimal future effort. The residual soil contamination can be addressed in the future when/if site redevelopment occurs.

Site History:

The former Texaco Queen Anne Service Station No. 211577 was located at 631 Queen Anne Avenue North, at the intersection of West Roy Street, in the City of Seattle, Washington. The property is located in a residential/commercial neighborhood in the Queen Anne District

of northwest Seattle. Located within one city block east, west and south of the former facility location are several multi-story apartment buildings, a hotel, several retail and commercial shops and a former Union Oil Company 76 (Unocal) service station located at 700 Queen Anne Avenue North.

The subject property located at 631 Queen Anne Avenue North is currently owned by the Arnolds and is occupied by a deli/convenience store known as the "Manhattan Express".

A gasoline service station has been operated by various parties in various configurations at this location for approximately 66 years, ending in 1993. Texaco Refining and Marketing Inc. operated a service station at the site from 1954 through 1977 when it sold the site. In early 1978, residents of the Monterey Apartments notified the Seattle Fire Department of the presence of hydrocarbon odors in the basement laundry room and lower apartments. After the odors apparently abated in March 1978, no complaints were documented until January 1984 when Monterey Apartments residents complained of gasoline odors. Investigation identified the presence of separate phase hydrocarbons (SPH) in a sump at the Monterey Apartments. The Arnold Property (former Texaco service station site) and Unocal station were suspected as the likely sources.

Previous Investigations

Since the first reported hydrocarbon vapor complaints at the Monterey Apartments in February 1978, various agencies, consultants and contractors have conducted a number of separate investigations and sampling events at the Monterey Apartments and the Arnold Property. Several remedial actions have also been performed; with varying levels of success. This section provides a brief summary of the documented environmental activities. Much of the investigation has been documented in reports, although several phases of work are described only with field notes and other incomplete documentation. Several remedial actions have also been performed with varying levels of success.

Environmental Reports & Other Documentation

The known, available reports include the following:

- GeoEngineers, 1986, Report of Hydrogeological Services, Subsurface Fuel Contamination Problem, Queen Anne District, Seattle, Washington, prepared for the Washington State Department of Ecology.
- Washington State Department of Ecology, March 1989, Monterey Apartments, Internal Report prepared by David South of Ecology (referenced in E&E 1991).
- Washington State Department of Ecology, March 17, 1989, Request for Proposal to Provide Technical Services at the Monterey Apartments, Queen Anne District.
- Ecology & Environment, September 11, 1990, Monterey Apartments Site - Soil-Gas Pilot Study Summary (draft, also referenced in other documents as "Trip Report").
- Ecology & Environment August 1991, Phase I Remedial Investigation Report, Monterey Apartments, Seattle, Washington.

- SAIC, 1993, Baseline Groundwater Monitoring Report, Monterey Apartments. Washington State Department of Ecology, May 1998, Monterey Apartments Ground Water Monitoring, October 1995 - November 1997.
- Farallon Consulting, January 11, 2000, December 1999 Groundwater Sampling Analytical Results, Queen Anne Texaco, Seattle, Washington.
- Farallon Consulting, July 21, 2000, December 1999 and June 2000 Groundwater Summary Report, Queen Anne Texaco, Seattle, Washington.
- Farallon Consulting, July 19, 2000, Pilot Test Summary Report, Queen Anne Texaco, Seattle, Washington.

Additional actions referenced in field notes or other unpublished documentation include:

- The initial vapor response activities conducted in 1978;
- Excavation and removal of the underground storage tanks (USTs) on the Arnold Property;
- Recovery of SPH from wells RW-1 and RW-2 in the Monterey Apartments vicinity;
- Installation of three additional SPH recovery wells: RW-3, RW-4, and RW-5;
- Abandonment of recovery well RW-1;
- Installation of an air monitoring system within the basement of the Monterey Apartments;
- Installation and operation of a soil vapor and groundwater extraction and treatment system at the Arnold property.

Summary of Activities

The following section summarizes the activities and findings presented in each report; reports are referred to by author and date. The reference to well numbers is based on the information provided in the reports. There has been inconsistent nomenclature used for the wells throughout this project. Recent work by Farallon has assigned a consistent well nomenclature.

City of Seattle Fire Department, 1978. During an investigation of odor complaints at the Monterey Apartments, SPH was identified within a sump that is apparently connected to the footing drainage system for the building. A sample of the SPH was collected and analyzed and found to be a petroleum hydrocarbon, which "falls in the range of being a gasoline". Product samples were collected from both the Texaco and Unocal service stations for comparison purposes. Neither of the samples were a positive match.

GeoEngineers, 1986. GeoEngineers' installed MW-2 through MW-10. Five wells (MW-2 through MW-5 and MW-7) were installed at or near the Monterey Apartments; three wells (MW-6, MW-9, and MW-10) were installed at the Arnold Property.
Well MW-6 contained two feet of SPH that was noted as "clear and fresh". Additionally, a trace amount of SPH was noted in well MW-7 on November 3, 1986. Groundwater mapping indicated a groundwater flow direction of west-southwest across the investigation area.

Washington State Department of Ecology, 1989.
Ecology identified several existing or former petroleum product USTs in the immediate vicinity. The USTs identified by Ecology included heating oil USTs at the Monterey Apartments, the Del Roy Apartments, the Queen Anne Apartments (also known as the Lindberg Apartments), the Alvena Apartments, and the Marqueen Apartments.

Ecology noted that previous activities associated with the Monterey Apartments study included the installation of two recovery wells RW-1 (installed by Crowley Environmental Services for the Arnolds in November, 1986 and RW-2 (installed by Ecology in July, see Figure 3). Both wells were considered ineffective and were inactivated after removing between 75 and 150 gallons of SPH.

Ecology & Environment, September 11, 1990. E&E was retained by Ecology to perform a pilot soil-gas study at the Monterey Apartments. Other properties included in the soil-gas study included the Arnold Property, the Queen Anne counterbalance; Unocal; the Del Roy Apartments; the Lindberg Apartments; and the Alvena Vista Apartments. E&E conducted the soil-gas survey during July, 1990, and completed the following activities: depth to groundwater measurements in the existing monitoring wells, collection and analysis of soil-gas samples from specific locations, collection and analysis of SPH samples, building inspections, and resident interviews.

E&E inspected the properties and interviewed residents to identify areas potentially impacted by petroleum product vapors. *E&E reported that the Lindberg Apartments' basement had an uncovered, exposed soil surface and that there was one complaint of frequent gasoline odors.* No other problems in the investigation area were noted.

SPH was measured in wells MW-6, MW-8, RW-1, and RW-2.

Ecology & Environment, August 1991. E&E performed the first phase of a remedial investigation (Phase I) in March and April 1991 under contract to Ecology. Tasks completed by E&E during this phase of work included collection and analysis of groundwater samples, completion of aquifer tests, a soil-gas survey, a terrain conductivity survey, sewer line/storm drain locate, and UST tightness testing. E&E concluded that the concentrations of petroleum hydrocarbons that persisted beneath the Arnold Property were the point source for petroleum hydrocarbon vapors that were observed in the Monterey Apartments and that an impacted groundwater plume extended westward at least 300 feet beyond First Avenue West. E&E suggested that the spill had persisted since at least 1986 and noted that mobilization of petroleum contaminants increased during seasonally high water table elevations and precipitation events. E&E also noted that the vapors would persist indefinitely unless reduced or removed but that the water quality was degraded for several reasons that made it unlikely to be classified as a drinking water source.

SAIC/Glacier Field Notes, 1993. No report documenting the 1993 UST closures at the Arnold Property is available. The only information pertaining to tank closures was obtained from Ecology was a file entitled "Construction Overview File" which contained copies of various pages of some on-site personnel log books, unlabeled photographs (no photo log) and

draft drawings with analytical information. The available documentation suggests that significant soil impacts were identified in the vicinity of the eastern dispenser island. According to the field notes, impacted soil was placed back into the excavation as backfill material.

SAIC/Glacier installed recovery wells and a spray aeration vapor extraction (SAVE) system, which operated for a short time before it was determined inadequate for site conditions.

Groundwater Technologies, Inc., 1996. In April 1996, GTI replaced the SAVE unit with a catalytic oxidizer in conjunction with the vapor extraction wells. The vapor extraction system operated intermittently between September 1996 and December 1997, when it was shut-down. Following review of the file at both Texaco and Ecology, no reports related to the operation of this system could be located. (NOTE: This system was recently restarted and is currently in operation)

Washington State Department of Ecology, May 1998. Ecology collected groundwater samples periodically between October 1995 to November 1997 from seven wells on the Monterey Apartments property to define the distribution and concentrations of petroleum hydrocarbons. Ecology reported that the SPH thickness in well MW-6 averaged one foot and attained a maximum of three feet during the sampling period.

Farallon Consulting, 2000. Farallon, on behalf of Texaco, prepared a quarterly groundwater summary report on behalf of Texaco for all accessible wells (with the exception of the recovery wells), which were sampled in December 1999 and June 2000. Farallon tabulated groundwater sampling results from the recent samplings as well as those presented in the E&E (1991) and Ecology (1998) reports. These tables are included in this report as Table 1.

Farallon noted that concentrations of TPH as gasoline and BTEX detected in groundwater have not decreased significantly since 1995 and that the concentrations in wells VP-7 and MW-4 were consistently the highest of the wells sampled. Farallon stated that wells VP-1, VP-4 and MW-6 were not sampled in December 1999 due to the presence of SPH and that wells VP-1 and VP-6 were not sampled in June 2000 due to the presence of SPH. Farallon placed absorbent socks in wells VP-1, VP-4, VP-6, MW-6, and RW-2 to recover SPH after the December 1999 monitoring event. The absorbent socks were changed out monthly.

Delta Environmental RI - 2002

The RI included the following:

- Installation of two vapor sampling points in the basement of the Monterey Apartments,
- Drilling seven geoprobe borings on the Arnold property, and
- Drilling eleven soil borings and installation of six monitoring wells

Monterey Property

This section summarizes the information concerning the history of contamination problems at Monterey Apartments, the nature and distribution of impacts and the potential factors contributing to the occurrences (including sources, preferential pathways and drainage structure).

Property History

The Monterey Apartments are located at 622 First Avenue West. The apartments were constructed in 1905 and consist of 21 units in a three-story building. The building is 10-13 feet lower than any of the other buildings in the area, and has a basement with a concrete floor and a tile drainage system connected to two basement sumps and several window wells. This drainage system reportedly dates back to the early 1900's, and is used to collect water from the northeast side of the apartment building. The apartment building has a utility room in the basement directly east of the laundry room (Figure 16).

Background / History of Hydrocarbon Vapor Occurrences

This section provides summaries of the documentation regarding hydrocarbon vapors detected at the Monterey Apartments property.

- **1978:** Shortly after installation of drains on the northeast side of the building, tenants of the Monterey Apartments noticed petroleum odors within the building's basement-level units. The Seattle Fire Department responded to the complaint and conducted an investigation. SPH was identified within a sump that is apparently connected to the footing drainage system for the building.
- **1984:** In January 1984, the Seattle Fire Department conducted an inspection and noted a faint odor in the basement.
- **1985:** In May 1985, visible product and vapors were reported in the basement level sump. The Seattle Fire Department responded and took readings with an explosimeter throughout the building and in the drain opening. The Fire Department set up an exhaust fan to dissipate the fumes. The laundry room was barricaded and the building manager instructed to prohibit its use until further notice.
- **May 1986:** During installation of a new pipe in the basement window, the apartment manager reported being overcome by gasoline fumes.
- **September 1986:** Ecology initiated action at the property following notice from the King County Public Health Department that apartment residents had experienced problems with hydrocarbon odors for approximately 8 years. The Seattle Fire Department confirmed that they had responded to several complaints of odors since 1978. Between 1/4 and ½-inch of gasoline was noted on the water in the catch basin. According to Fire Department notes, "Until 9 months ago, problem was intermittent only appeared during rain storms. Since then, it has become more unpredictable, occurring during dry periods as well, there is no longer a pattern. Vapor alarms were installed within the basement of the apartment building.
- **1987:** In April 1987, odor problems were reported increasing again.

- **1989:** In January and February 1989, the vapor alarms installed by the Fire Department went off, and a notation was made to the Seattle Fire Department

Nature and Extent of Hydrocarbon Impacts

Historic information regarding the nature and extent of petroleum hydrocarbons in soil and groundwater at the Monterey Apartments is complex and not entirely consistent. This section provides a review of the available data with respect to these issues.

Two SPH samples were collected from the footing drain sump adjacent to the apartment building. EPA analysis of the first sample collected in 1978 sample identified the product as "falling in the range of a gasoline". Samples collected from the footing drain in 1986 were identified as being a mixture of 45% gasoline, 45% No. 1 diesel, and 10% No. 2 diesel.

The composition of the product sample collected in 1986 indicates the presence of other potential sources. This is based on the presence of No.1 diesel fuel (also marketed as kerosene, stove oil, or Jet A fuel). No.1 diesel fuel is not a product that was distributed at service stations. The diesel fuel that is distributed at service stations as a motor fuel is No. 2 diesel. No. 1 diesel is a product that has historically been used as heating oil, particularly up until the 1930s. Furthermore, this SPH mixture is inconsistent with the composition of SPH found in MW-6, the presumed source of the Monterey Apartment impacts, which contained 80% of relatively fresh gasoline and 20% #2 diesel fuel. This mixture is consistent with products known to have been distributed at the Arnolds Texaco Station.

Concentrations of dissolved hydrocarbons in groundwater at the Monterey Apartments vary significantly in their composition. Well VP-1, located between the Monterey and Del Roy buildings, contains higher concentrations of diesel-range hydrocarbons than gasoline-range hydrocarbons. However, dissolved hydrocarbons in well MW-4, located approximately 15 feet west (down gradient) of well VP-1, contains primarily gasoline range hydrocarbons. Given the proximity of wells MW-4 and VP-1 to one another, the presence of diesel range hydrocarbon in VP-1 is likely the result of leaks from a heating oil UST. Based on a WDOE drawing entitled 'Monterey Apartments Vicinity Map' and adapted from Miller, 1986, well VP-1 is located within a few feet of a heating oil tank. Furthermore, SAIC's drawing of the piping for the VES system installed in 1993, noted that the piping had to be diverted to avoid an "abandoned heating oil UST" on the north side of the Monterey Apartments immediately adjacent to VP-1 and VP-2 (Figure 18). In the most recent groundwater sampling, wells VP-1 and VP-2 contained a substantially higher amount of diesel-range hydrocarbons than gasoline-range. The diesel in well VP-1 is almost certainly the result of leaks from the heating oil UST, diesel in well VP-2 however is probably due to releases from the former Texaco station. Well VP-8, located approximately 55 feet northeast of well VP-5, also contains higher levels of diesel range than gasoline range hydrocarbon. Again, the WDOE drawing depicts a second heating oil tank on the west side of the Queen Anne (now Lindberg) Apartments 25-30 feet north of the southwest building corner, very close to where VP-8 is located. The diesel range petroleum in this well is also likely the result of heating oil releases from or overfills of this tank.

Building Drainage Structure / Preferential Pathways

Several of the investigations performed have focused on the potential role of preferential pathways in the subsurface migration of hydrocarbons to the Monterey Apartments. Such an evaluation is significantly complicated due to the geologic conditions present, the age of development in the area, and the absence of accurate and complete construction records. Nevertheless, enough information has been obtained to demonstrate that preferential pathways are critical to understanding the sources and migration of hydrocarbon impacts at this location. This section discusses some of the available information regarding preferential pathways.

The hydrocarbon vapors identified within the Monterey Apartments are believed to result from SPH accumulating or collecting in the footing drain system for the building. However, the construction details of the footing drain system are not well understood. It is believed that the sump located at the base of the outside stairwell along the northeast portion of the building is connected to this drainage system. However, less clear is where this drainage system discharges and how seasonal groundwater fluctuations affect the operation of this drainage system.

The basement of the Monterey Apartments, at approximately 13 feet bgs, has been identified as being in contact with shallow groundwater. E&E has hypothesized that seasonal and storm-related complaints of odors and observations of SPH in wells adjacent to the basement wells indicate that the basement likely acts as a barrier to west-southwestward migration of groundwater and SPH when the water table is higher than the basement slab.

Additionally, numerous other known and unknown utilities and other subsurface structures are located in the area. Many of these are located at depths that will facilitate the preferential migration or otherwise alter the normal migration of contaminants through the subsurface.

The occurrences of SPH in the basement and stair well drain sumps and the incidence of gasoline vapors at the Monterey Apartments during the late 1970's and through the 1980's may also be a result of free-phase and residual SPH within and on top of the groundwater beneath the apartment building. Seasonal and storm induced fluctuations in groundwater elevation beneath the apartment building would tend to force any SPH present on the groundwater surface upward into the more permeable backfill around the stairwell and basement drains and their associated piping. Ultimately, the SPH would be forced into the drain sumps or piping; through seams or cracks, and would accumulate in the drain sumps. Based on the 1999 and 2000 groundwater samplings performed by Farallon, the distribution of SPH in wells on the Monterey Apartments property is wide spread. This would indicate that preferential pathways -although perhaps important with regards to vapor infiltration and the presence of SPH in the drain sumps of the apartment building are not a primary factor in the transport and occurrences of SPH at this location.

Current Site Conditions

Subsurface Conditions

Soils

Soils encountered during this investigation consisted of medium dense to very dense sand and silty sand from ground surface to between approximately 17.5 and 31 feet below grade (bg). A stiff to very hard, low to moderate plasticity clay was encountered beneath the sand in the borings. A moderate-plasticity clay was observed in boring DB-11 from the surface to approximately 7 feet bg. Boring DB-11 was located on 1st Avenue West at the southwest side of the area of investigation. The clay was underlain by a very dense clayey sand at a maximum depth of 10 feet bg, and refusal was encountered at approximately 12 feet bg. Clay was not encountered in boring DB-1 to the total depth of 17 feet bg, or in the bottom of boring DB-10 at the total depth of 34 feet bg, although a thin lens of clay was observed in DB-10 at 33 feet bg.

Two cross sections were prepared for this report. Cross section A-A' extends from boring DB-8 in the southwest portion of the area investigated (in front of the Alvena Apartments) to boring DB-2 at the northeast area of investigation on the Arnold's property depicts the locations of both cross-sections). Cross section B-B' extends east-west across the Arnold's property from boring DB-3 in the west to boring DB-2 in the east. As shown on the cross-sections, the area of investigation consists mostly of sand and silty-sand predominantly underlain by clay. The clay layer was not verified under the western parking area between the Monterey and Alvena Vista Apartments, or beneath well MW-12 located on Queen Anne Avenue North. Data from this investigation indicates that the clay layer slopes to the west or southwest, as it was encountered at deeper intervals as the investigation continued in this direction. It is unclear if the clay encountered in boring DB-11 is a continuation of the same clay layer, or an isolated lens of soil.

Soil contamination is depicted on Figure 2.

Hydrogeology

Groundwater occurs a few feet above the clay at depths ranging from 10 to 20 feet bgs. Based on a review of the available boring logs and descriptions from previous reports, the shallow groundwater in the area appears to be perched in discontinuous lenses and layers of fill, silty sand and sand that overlies the basal clay. Previous studies have indicated that the natural groundwater flow direction is towards the west-southwest.

The fill likely has a highly variable permeability that is more permeable than the underlying native soils. The native soils, which are saturated, may be of low permeability, as suggested by previous aquifer tests, well dewaterings, and the local presence of impermeable glacial till. The sand that is interbedded with glacial till, silts and clay, are relatively more permeable, and are expected to be laterally discontinuous and variable. Pathways in native soil of varying permeability's are expected to exist in the subsurface. Farallon indicated that groundwater beneath the Arnold property may be comprised of multiple shallow water-bearing zones each with unique flow directions and rates.

Pump tests conducted on MW-7 and MW-9 indicated that each well yields less than 0.20 gpm. Monitoring well MW-4 yielded approximately 0.5 gallons per minute.
The latest groundwater monitoring data is attached.