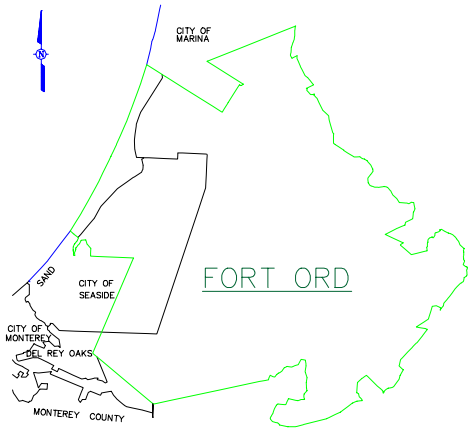
DRAFT REPORT
MARCH 2004 INDOOR AIR SAMPLING
LEXINGTON COURT
FORMER FORT ORD, CALIFORNIA
REVISION C



TOTAL ENVIRONMENTAL RESTORATION CONTRACT
DACW05-96-D-0011
TASK ORDER 11

Submitted to:

Department of the Army
Corps of Engineers, Sacramento
1325 "J" Street
Sacramento, California 95814-2922

Submitted by:

Shaw Environmental, Inc.
#4 All Pro Lane
P.O. Box 1698
Marina (Fort Ord), CA 93933

U.S. ARMY CORPS OF ENGINEERS

Shaw® Shaw Environmental, Inc.

Presidio of Monterey

MACTEC

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May 2004

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LEXINGTON COURT
FORMER FORT ORD, CALIFORNIA

TOTAL ENVIRONMENTAL RESTORATION CONTRACT
CONTRACT NO. DACW05-96-D-0011

Revision C
May 2004

Approved by: Signature on File Date: _____
Peter Kelsall
Project Manager

Approved by: Signature on File Date: _____
Eric Schmidt
Project Chemist

Approved by: Signature on File Date: _____
Tom Ghigliotto
Contractor Quality Control Systems Manager

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List of Acronyms

ADR	Automatic Data Review
Army	U.S. Department of the Army
CDQMP	chemical data quality management plan
CTP	Carbon Tetrachloride Groundwater Plume
DUP	laboratory duplicate
EPA	U.S. Environmental Protection Agency
LCS	laboratory control sample
LDC	Laboratory Data Consultants
MDL	method detection limit
PRG	preliminary remediation goal
QC	quality control
RPD	relative percent difference
SAP	sampling and analysis plan
SGP	soil gas probe
SIM	selected ion monitoring
SVE	soil vapor extraction
VOC	volatile organic compound

1.0 Introduction

Previous investigations have delineated an area of volatile organic compounds (VOCs) detected in soil gas probes (SGPs) in a residential area in the vicinity of Lexington Court and Ready Court, Former Fort Ord (Mactec, 2004). Lexington Court is located in the northern part of the former Fort Ord in the Preston Park housing area (Figure 1-1). A soil vapor extraction (SVE) system has been installed to extract and treat VOCs (primarily carbon tetrachloride), which are a suspected continuing source of groundwater contamination and present a potential vapor intrusion problem into the nearby housing.

This report presents the results of the indoor air and probe monitoring conducted in March 2004 at Building 6277, Lexington Court, which is located above the area where VOCs have been detected in shallow soil gas overlying the carbon tetrachloride groundwater plume (CTP). Shaw Environmental, Inc. (Shaw, formerly IT Corporation) prepared this report for the U.S. Department of the Army (Army) under the Total Environmental Restoration Contract No. DACW05-96-D-0011.

Photograph 1-1 shows the front of the building used for indoor air monitoring. This building was used as Army housing when the base was in operation, but is currently not occupied. An unoccupied building was chosen for this sampling program to minimize interference from activities that may occur in an occupied building and to retain control of sampling conditions.

The sampling and analysis were conducted in accordance with the *Draft Final Sampling and Analysis Plan Indoor Air Sampling, Operable Unit Carbon Tetrachloride Plume, Former Fort Ord, California* (SAP) (Shaw, 2004a). The SAP is provided as Appendix A.

2.0 Sampling Activities

Prior to sampling, the building was inspected to determine the presence/absence of any household materials containing compounds of interest. Since the building has been vacant for a number of years, minor repairs were made in order to bring the building to a condition that was representative of an occupied building (e.g., polyethylene sheeting was placed over the broken windows). A sub-slab probe was installed through the foundation, approximately in the center of the building, following the specifications outlined in the SAP. A new shallow SGP was installed outside and adjacent to the building. This new SGP was required because the nearest existing SGP is approximately 120 feet southeast from the indoor sampling location. This probe was installed following the specifications outlined in the SAP. Locations of each of the sample points are presented in Figure 2-1. Outdoor air samples were collected from a location in the fenced yard on the west side of the building. Photographs 2-1, 2-2, 2-3, and 2-4 show the sampling locations for the indoor air, outdoor air, sub-slab, and exterior probes respectively.

Sampling of the indoor and outdoor air was conducted over a 24-hour period on two separate days, March 8 and March 15, 2004. In addition to the indoor and outdoor air samples that were collected, a sub-slab sample and exterior probe sample (grab samples) were collected during the 24-hour sampling period. As described in Section 3.0, one trip blank sample was also analyzed; this was a SUMMA™ canister which accompanied the samples during transport and sampling (left unopened). All equipment (i.e., SUMMA™ canisters, 24-hour mass flow controllers, sampling canes) used for sampling was certified clean (no presence of the compounds to be analyzed) by the subcontracted laboratory.

Meteorological data was collected for a period two weeks prior to and two weeks following sampling. Both sampling periods were in times of an overall barometric pressure decrease trend. During the 24-hour sampling periods, the pressure generally was stable with the exception of minor diurnal pressure fluctuations, which are typical for the former Fort Ord. Meteorological data was obtained from the Naval Postgraduate Station located at the Marina Municipal Airport. Figure 2-2 presents the barometric pressure plot bracketing both sampling periods.

3.0 Analytical and Data Validation Methods

Air Toxics Limited of Folsom, California, performed all sample analyses. The laboratory was directed to quantify all target analytes down to their respective method detection limits (MDLs) in order to achieve the lowest possible detection limit. Quantification between the MDL and the practical quantitation limit, although estimated, provides additional information regarding any potential low-level concentrations of target analytes that may be present in the samples.

Samples were analyzed using Environmental Protection Agency (EPA) Method TO-15 (EPA, 1999a) in selected ion monitoring (SIM) mode. SIM mode was chosen for analysis because it provides the lowest possible detection limits. The list of compounds analyzed in samples is the same as the SIM list of analytes used for ambient air monitoring at the Operable Unit 2 Landfills at the former Fort Ord (Shaw 2004b), plus trichloroethene and tetrachloroethene. These two compounds were included in the list of compounds to be analyzed because they have been detected in soil gas in the investigation area.

Data review was performed in accordance with the *Chemical Data Quality Management Plan, Former Fort Ord, California* (CDQMP) (IT, 2002) and *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999b). The data validation task was performed by Laboratory Data Consultants (LDC), an independent subcontractor to Shaw. All sample results from the sampling period were subjected to Level III review, which comprises an evaluation of quality control (QC) summary results for sample holding times, initial and continuing calibrations, surrogates, laboratory duplicates (DUP), laboratory control samples (LCS), method blanks, and field duplicate samples. The Level III review was performed using *Automated Data Review Software version 6.1* (ADR) (LDC, 2004), a program developed by LDC.

A Level IV evaluation of the QC summary forms and raw data was performed on 56 percent of the data, to confirm sample quantitation and identification. All data from this sampling event are usable, and no results were rejected. Six 1,4-dichlorobenzene, seven 1,4-Dioxane, and one benzene sample results were qualified as non-detect due to the presence of low-level concentrations of the compounds in the method blank that was analyzed with the samples. Sample results are qualified as non-detect when their concentration for a particular compound is less then five times the concentration of the same compound in the method blank.

One trip blank sample was analyzed. This was a SUMMA™ canister which accompanied the samples during transport and sampling (left unopened). The trip blank results are included in Table 4-1. All compounds were reported as not detected. The reporting limit for carbon

tetrachloride was 0.02 parts per billion by volume, which is significantly lower than each of the concentrations reported from the other samples.

4.0 Analytical Results

All analytical results are presented in Table 4-1. The results between the two separate sampling days at each location are generally consistent and have similar concentrations.

Comparison of the results shows that in general the same chemicals were detected in the indoor ambient air sample as were detected in the sub-slab and exterior probe samples. The VOCs detected in all samples are: benzene, carbon tetrachloride, chloroform, and tetrachloroethene. One VOC, 1,3-butadiene, was detected only in the indoor air samples and not in either the sub-slab or exterior probe samples. A comparison of the VOC concentrations between the probe samples for both days shows that concentrations in the sub-slab probe are generally higher then the exterior probe samples (with the exception of chloroform). This could be the result of 1) the sub-slab location is closer to the center of the soil gas plume; 2) VOCs can collect under the slab; or 3) rainfall at the exterior of the building can suppress the migration of gas.

Table 4-2 presents a comparison of the indoor air and outdoor air concentrations to determine if the VOCs measured inside the building are comparable to the concentrations measured outside. Only detected concentrations for compounds are presented in this table. Relative percent differences (RPDs) have been calculated for a comparison of each compound. RPD is calculated using the following equation:

$$RPD = \frac{\text{Absolute value (Result 1 – Result 2)}}{\text{(Result 1 + Result 2)/2}}$$

All results with one exception have low calculated RPD values which demonstrate a high comparability between the indoor and outdoor air concentrations. A higher RPD is observed for benzene for samples collected on March 15, 2004, due to the higher concentration found in the outdoor sample. It is possible that this could have resulted from human activities in the area during sampling (e.g. automobile exhaust).

With the exception of the March 15 benzene result, concentrations of VOCs in the indoor air sample are within the concentration range of background samples that were collected during the OU2 Landfills ambient air monitoring (Shaw, 2004b). Chloroform and tetrachloroethene results are below their respective 2002 EPA Region IX ambient air preliminary remediation goals (PRGs) (EPA, 2002). The remaining analytes have values above their respective PRGs.

5.0 Evaluation of Johnson and Ettinger Model for Estimating Subsurface Vapor Intrusion into Buildings

Appendix B provides an evaluation of the Johnson and Ettinger subsurface vapor intrusion model to predict indoor air concentrations of VOCs using soil gas data collected at the site. This analysis is provided to answer the following data quality objective from the SAP: Are concentrations of VOCs comparable to the concentrations predicted using the diffusion model? To answer this question, measured indoor air concentrations are compared with indoor air concentrations predicted using the vapor intrusion model and measured soil gas data.

The modeled indoor air concentrations are between two and three orders of magnitude lower than the measured indoor air concentrations for all chemicals. These results indicate that the concentrations of VOCs in indoor air are consistent with expected concentrations from non-point sources in the area and suggest that the subsurface vapors from the carbon tetrachloride plume are not contributing significantly to VOCs in indoor air.

6.0 Conclusions

The concentrations of VOCs present in the indoor air sample are within the range of background concentrations measured during ambient air monitoring activities conducted at the former Fort Ord. These results suggest that the subsurface vapors from the carbon tetrachloride plume are not contributing significantly to VOCs in indoor air.

A SVE system was implemented on April 6, 2004, shortly after the indoor samples were collected. Soil gas concentrations are currently being monitored throughout the affected area. Preliminary data received from this effort show that concentrations of VOCs in soil vapor are being reduced significantly by operation of the SVE.

In accordance with the decision rules presented in the SAP (Appendix A), no further investigation of the indoor air in the vicinity of Lexington Court and Ready Court is required. A risk assessment based on the indoor air results is not presented in this report because the indoor air concentrations do not exceed background. Moreover, the SVE system is already in operation and will reduce the VOC concentrations in the soil gas in the vicinity of the buildings. A risk assessment will be performed in conjunction with the ongoing Remedial Investigation/ Feasibility Study of the Operable Unit CTP.

7.0 References

EPA, 1999a, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, Compendium Method TO-15, EPA/625/R-96/010b. (http://www.epa.gov/ttn/amtic/airtox.html)

EPA, 1999b, *Contract Laboratory Program, National Functional Guidelines for Organic Data Review*, EPA/540/R-94/012 http://www.epa.gov/oerrpage/superfund/programs/clp/guidance.htm)

EPA, 2002, *Region IX Preliminary Remediation Goals*, (http://www.epa.gov/region09/waste/sfund/prg/index.html)

IT, 2002, *Chemical Data Quality Management Plan, Former Fort Ord, California, Revision 0*

Laboratory Data Consultants, Inc., (LDC) 2004, *Automated Data Review Software*, Version 6.1

Mactec, 2004, *Operable Unit CTP SVE Pilot Study Test Letter Report, January 2004. Mactec Engineering & Consulting, Petaluma, California*

Shaw, 2004a, *Draft Final Sampling and Analysis Plan, Indoor Air Sampling, Operable Unit Carbon Tetrachloride Plume, Former Fort Ord, California, Revision 0*

Shaw, 2004b, *Draft Landfill Gas Ambient Air Monitoring Report, 2003 Monitoring, Operable Unit 2 Landfills, Former Fort Ord, California, Revision C* (scheduled to be issued June, 2004)

Tables

Table 4-1
Analytical Results
Lexington Court Samples, March 2004

LOCATION:	INDOOR AIR	INDOOR AIR	OUTDOOR AIR	OUTDOOR AIR	TRIP BLANK	SUB-SLAB	SUB-SLAB	EXTERIOR PROBE	EXTERIOR PROBE
SAMPLE NUMBER:	CTP-IA-004	CTP-IA-008	CTP-OA-005	CTP-OA-009	CTP-TB-001	CTP-49-002	CTP-49-006	CTP-50-003	CTP-50-007
SAMPLE DATE:	9-Mar-04	15-Mar-04	9-Mar-04	15-Mar-04	9-Mar-04	9-Mar-04	15-Mar-04	9-Mar-04	15-Mar-04
UNITS:	PPBV[1]	PPBV	PPBV	PPBV	PPBV	PPBV	PPBV	PPBV	PPBV
PURPOSE:	REG[2]	REG	REG	REG	QC[3]	REG	REG	REG	REG
	Result	Result	Result	Result	Result	Result	Result	Result	Result
1,1,2,2-TETRACHLOROETHANE	<0.031	<0.037	<0.031	<0.031	<0.020	**0.069**	<0.031	<0.032	<0.031
1,1,2-TRICHLOROETHANE	<0.031	<0.037	<0.031	<0.031	<0.020	<0.032	<0.031	<0.032	<0.031
1,1-DICHLOROETHENE	<0.016	<0.018	<0.016	<0.016	<0.010	<0.016	**0.023**	<0.016	<0.016
1,2-DIBROMOETHANE (EDB)	<0.031	<0.037	<0.031	<0.031	<0.020	**0.017J**[4]	<0.031	<0.032	<0.031
1,2-DICHLOROETHANE	<0.031	<0.037	**0.0095J**	<0.031	<0.020	<0.032	<0.031	<0.032	<0.031
1,2-DICHLOROPROPANE	<0.031	<0.037	<0.031	<0.031	<0.020	<0.032	<0.031	<0.032	<0.031
1,3-BUTADIENE	**0.033J**	**0.029J**	**0.029J**	**0.033J**	<0.10	<0.16	<0.16	<0.16	<0.16
1,4-DICHLOROBENZENE	<0.031U[5]	<0.037U	<0.031U	<0.031U	<0.020	**0.11**	<0.031	<0.032U	<0.031U
1,4-DIOXANE	<0.16U	<0.18U	<0.16U	<0.16U	<0.10	<0.16U	<0.16U	<0.16	<0.16U
ALPHA-CHLOROTOLUENE	<0.16	<0.18	**0.016J**	<0.16	<0.10	**0.077J**	**0.018J**	<0.16	<0.16
BENZENE	**0.22**	**0.24**	**0.22**	**1.4**	<0.05U	**3.9**	**3.1**	**1.1**	**2**
BROMODICHLOROMETHANE	<0.16	<0.18	<0.16	<0.16	<0.10	<0.16	<0.16	<0.16	<0.16
BROMOFORM	<0.16	<0.18	<0.16	<0.16	<0.10	**0.036J**	<0.16	<0.16	<0.16
CARBON TETRACHLORIDE	**0.099**	**0.092**	**0.098**	**0.09**	<0.020	**2.8**	**2.6**	**1.6**	**1.5**
CHLOROFORM	**0.024J**	**0.023J**	**0.024J**	**0.023J**	<0.020	**0.24**	**0.2**	**0.56**	**0.53**
DIBROMOCHLOROMETHANE	<0.16	<0.18	<0.16	<0.16	<0.10	<0.16	<0.16	<0.16	<0.16
HEXACHLOROBUTADIENE	<0.16	<0.18	<0.16	<0.16	<0.10	**0.12J**	<0.16	<0.16	<0.16
TRICHLOROETHENE	**0.052**	<0.037	<0.031	<0.031	<0.020	<0.032	**0.038**	<0.032	<0.031
TETRACHLOROETHENE	**0.013J**	**0.029J**	**0.010J**	**0.020J**	<0.020	**0.18**	**0.18**	**0.076**	**0.089**
VINYL CHLORIDE	<0.016	<0.018	<0.016	<0.016	<0.010	<0.016	<0.016	<0.016	<0.016

Notes:

[1] parts per billion by volume

[2] regular environmental sample

[3] quality control sample

[4] Samples qualified with a "J" are estimated.

[5] Samples qualified with a "U" were qualified as non-detectable

0.024J - Results in bold are positive detections

<0.16 - Results non-detectable to the reporting limit specified

Table 4-2
Comparision of Indoor and Outdoor Air Results
Lexington Court Samples, March 2004

LOCATION:	**INDOOR AIR**	**OUTDOOR AIR**		**INDOOR AIR**	**OUTDOOR AIR**		**MINIMUM BACKGROUND[4]**	**MAXIMUM BACKGROUND**
SAMPLE NUMBER:	CTP-IA-004	CTP-OA-005		CTP-IA-008	CTP-OA-009			
SAMPLE DATE:	9-Mar-04	9-Mar-04		15-Mar-04	15-Mar-04			
UNITS:	PPBV[1]	PPBV		PPBV	PPBV		PPBV	PPBV
PURPOSE:	REG[2]	REG		REG	REG			
	Result	Result	**Day 1 RPD[3]**	Result	Result	**Day 2 RPD**	Result	Result
1,2-DICHLOROETHANE	<0.031	**0.0095J[5]**	NC[6]	<0.037	<0.031	NC	**0.0074**	**1.1**
1,3-BUTADIENE	**0.033**	**0.029**	12.9%	**0.029**	**0.033**	12.9%	**0.019**	**0.064**
ALPHA-CHLOROTOLUENE	<0.16	**0.016J**	NC	<0.18	<0.16	NC	**0.0056**	**0.2**
BENZENE	**0.22**	**0.22**	0.0%	**0.24**	**1.4**	141.5%	**0.034**	**0.69**
CARBON TETRACHLORIDE	**0.099**	**0.098**	1.0%	**0.092**	**0.09**	2.2%	**0.067**	**0.13**
CHLOROFORM	**0.024**	**0.024**	0.0%	**0.023**	**0.023**	0.0%	**0.0088**	**0.77**
TRICHLOROETHENE	**0.052**	<0.037	NC	<0.031	<0.031	NC	**0.019**	**0.38**
TETRACHLOROETHENE	**0.013**	**0.01**	26.1%	**0.029**	**0.02**	36.7%	**0.026**	**4.8**

Notes:

[1] parts per billion by volume

[2] regular environmental sample

[3] relative percent difference

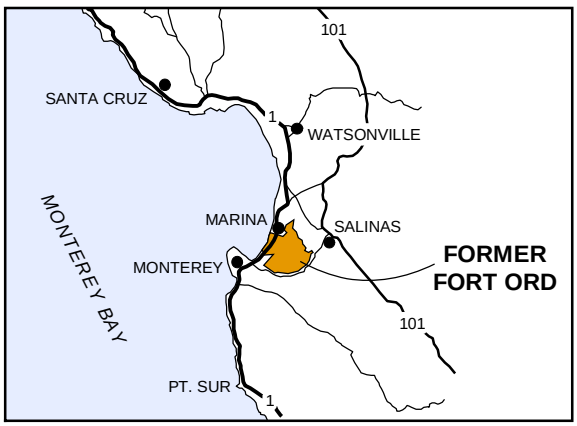
[4] Data from sampling stations at L,Q,O,R,S, and T collected 2000 to 2003 (Shaw 2004b).

[5] Samples qualified with a "J" are estimated.

[6] non-calculable

0.024J	- Results in bold are positive detections
<0.16	- Results non-detectable to the reporting limit specified

Figures



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REVISION	DATE	DESCRIPTION	CHKD	APPR

Shaw® Shaw Environmental, Inc.

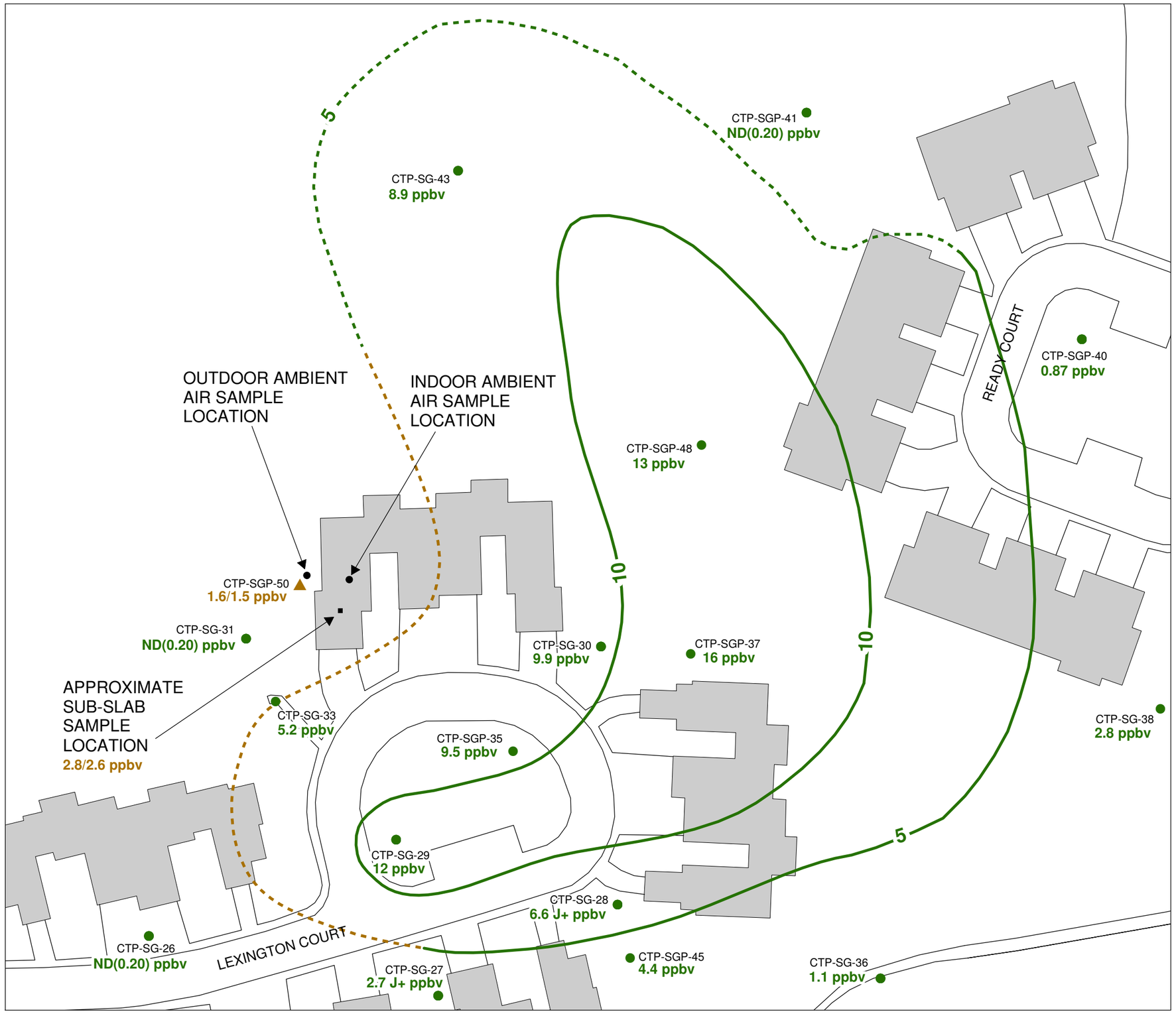
Department of the Army
Sacramento District, Corps of Engineers
Sacramento, California

DESIGNED: P. KELSALL
DRAWN: K. BLACK
CHECKED: P. KELSALL

Figure 1-1
LOCATION MAP
INDOOR AIR SAMPLING
LEXINGTON COURT
Former Fort Ord, California

SUBMITTED: DATE

SCALE: SPEC. No.
SHEET FILE No. Indoor Location.mxd



LEGEND

- 6-FT. PROBE SAMPLED MARCH 2004 (SHAW)
- 6-FT. PROBE SAMPLED MARCH-JUNE 2003 (MACTEC)
- 1.6/1.5 ppbv — CARBON TETRACHLORIDE CONCENTRATION 3/9/04 / CARBON TETRACHLORIDE CONCENTRATION 3/15/04
- 1.1 ppbv — CARBON TETRACHLORIDE CONCENTRATIONS FROM MARCH TO JUNE 2003 (MACTEC, 2003)
- CARBON TETRACHLORIDE CONCENTRATION CONTOURS AT 6-FT. DEPTH (ppbv); DASHED WHERE INFERRED (CONTOURS DEVELOPED BY MACTEC, 2003)
- CONTOUR ADJUSTED BY SHAW FOR MOST RECENT DATA
- BUILDING

NOTES
ppbv = parts per billion volume
J+ = lab qualifier (estimated value)

N

0 60 120 FEET

REVISION	DATE	DESCRIPTION	CHKD	APPR

Shaw Shaw Environmental, Inc.

Department of the Army
Sacramento District, Corps of Engineers
Sacramento, California

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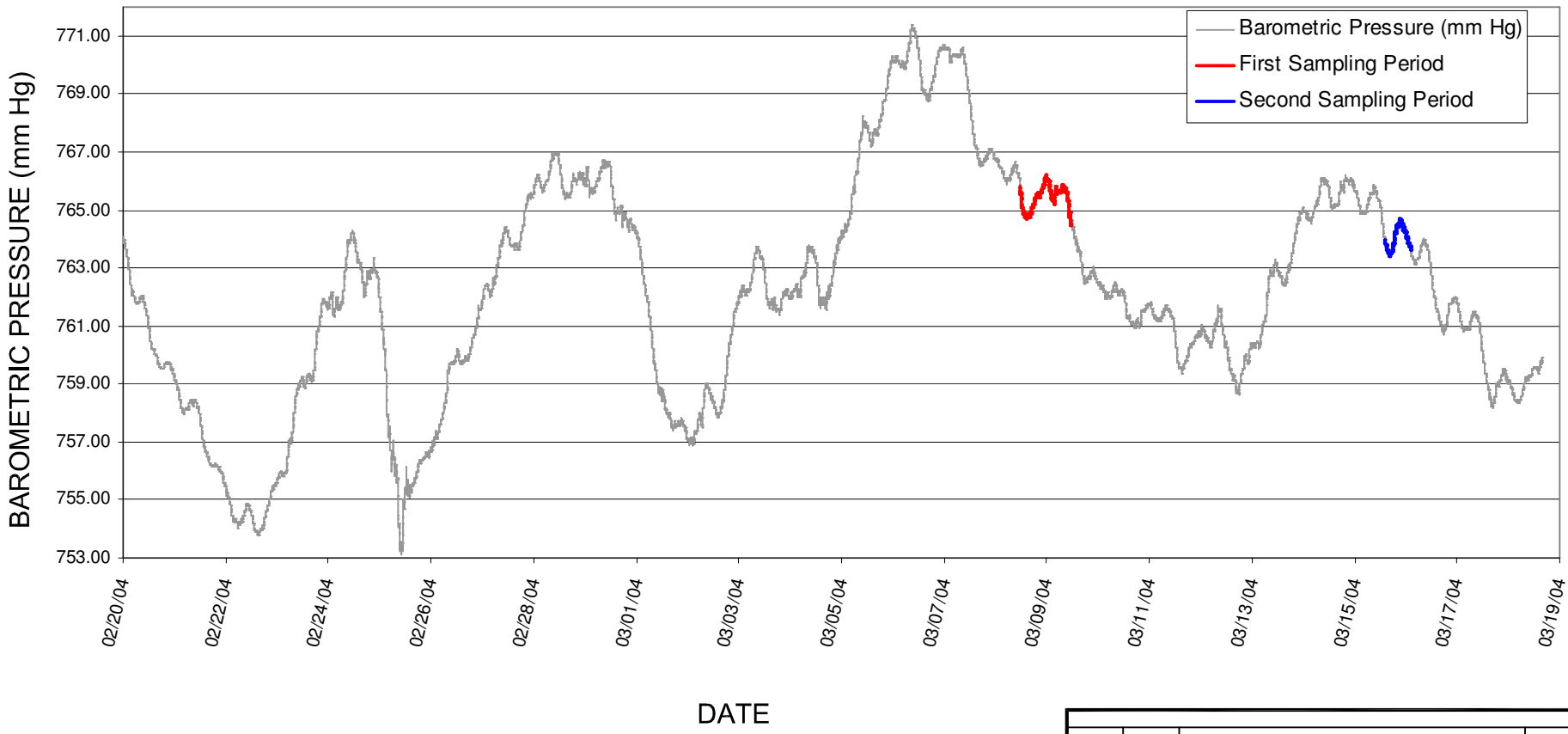
Figure 2-1
INDOOR SAMPLING SITE MAP
LEXINGTON COURT
Former Fort Ord, California

SUBMITTED: DATE
SCALE: SPEC. No.
SHEET FILE No. CTPsite2.mxd



REVISION	DATE	DESCRIPTION	CHKD	APPR

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DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: E. SCHMIDT
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FIGURE 2-2
BAROMETRIC PRESSURE PLOT
CARBON TETRACHLORIDE INDOOR AIR SAMPLING

FORMER FORT ORD, CALIFORNIA

SUBMITTED: DATE APPROVED:

SCALE: SPEC. No.
SHEET -
FILE No. 783751SJ-A143

Photographs

Photograph 1-1
Building 6277, Lexington Court

Shaw® Shaw Environmental, Inc.

Photograph 2-1
Indoor air sample location

Photograph 2-2
Outdoor air sample location

Photograph 2-3
Sub-slab probe sampling

Photograph 2-4
Exterior probe sampling

Appendix A
Sampling and Analysis Plan
Indoor Air Sampling

DRAFT FINAL SAMPLING AND ANALYSIS PLAN
INDOOR AIR SAMPLING
OPERABLE UNIT CARBON TETRACHLORIDE PLUME
FORMER FORT ORD, CALIFORNIA

TOTAL ENVIRONMENTAL RESTORATION CONTRACT
DACW05-96-D-0011

Submitted to:

Department of the Army
Corps of Engineers, Sacramento
1325 “J” Street
Sacramento, California 95814

Submitted by:

Shaw Environmental, Inc.
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Marina, California 93933

Revision 0
March 2004

Issued to:_____ Date:_____

DRAFT FINAL SAMPLING AND ANALYSIS PLAN
INDOOR AIR SAMPLING
OPERABLE UNIT CARBON TETRACHLORIDE PLUME
FORMER FORT ORD, CALIFORNIA

TOTAL ENVIRONMENTAL RESTORATION CONTRACT
DACW05-96-D-0011

Revision 0
March 2004

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1.0 Introduction

This Sampling and Analysis Plan (SAP) describes the sampling and analytical methods that will be implemented during indoor air sampling associated with the carbon tetrachloride plume (CTP) in groundwater at the former Fort Ord. Indoor sampling will be conducted to measure the concentration of volatile organic compounds (VOCs) inside a house located in an area in which VOCs have been detected in shallow soil gas overlying the CTP.

This SAP was prepared for the U.S. Department of the Army (Army) by Shaw Environmental, Inc. (Shaw, formerly IT Corporation) under the Total Environmental Restoration Contract II No. DACW05-96-D-0011.

Indoor sampling will be performed following the guidance of *Draft Guidance For Evaluating The Vapor Intrusion to Indoor Air Pathway From Groundwater And Soils (Subsurface Vapor Intrusion Guidance)* (EPA, 2002), *Indoor Air Sampling and Evaluation Guide, WSC POLICY #02-430, Office of Research and Standards (*Massachusetts Department of Environmental Protection [MDEP], 2002), the *Standard Quality Procedures/Standard Operating Procedures Manual*, *Former Fort Ord, California* (SQP/SOP) (IT, 2002).

A specific Job Safety Analysis (JSA) will be conducted prior to any sampling and/or other work at the site.

This SAP establishes the data quality objectives (DQOs), sampling design, analytical methods, and sampling procedures that will be used in collecting data.

2.0 Problem Definition and Background

Previous investigations have delineated an area of VOCs detected in soil gas probes (SGPs) in a residential area in the vicinity of Lexington Court and Ready Court (Mactec, 2004). A soil vapor extraction (SVE) system will be installed to extract and treat VOCs, (primarily carbon tetrachloride) which are a suspected continuing source of groundwater contamination and present a potential vapor intrusion problem into the nearby housing.

A risk assessment based on the maximum concentration of carbon tetrachloride in the shallow soil gas in the housing area determined that the risk from indoor air over a 30-year period may slightly exceed a 10^{-6} risk threshold level. It is expected that the soil gas concentrations will decline substantially when the SVE is implemented scheduled for March 2004. The regulatory

agencies have recommended that the Army should supplement the SVE with a limited sampling of indoor air in the housing area, to be conducted prior to starting the SVE. The agencies have verbally agreed that two indoor air samples should be collected from one of the houses, approximately one week apart.

This SAP is intended to outline the sampling and analysis that will occur to measure VOC concentrations in indoor air. In addition to the indoor samples, the Army will collect concurrent samples from below the concrete foundation slab of the building, and from a shallow SGP installed outside near the indoor air sampling location.

The primary chemicals of concern (COCs) will be four VOCs that have been detected in the soil gas and the underlying groundwater plume:

- Carbon Tetrachloride
- Chloroform
- Trichloroethene
- Tetrachloroethene

3.0 Data Quality Objectives

Data generated from the sampling and analysis activities for this project will be verified against established DQOs to determine if the data are of sufficient quality to be used in meeting the primary end-use requirements. The DQO process is designed to provide a means to determine what type of data need to be collected, as well as to ensure that the data collected are scientifically sound, defensible, and of known, acceptable documented quality. The DQO process is established in accordance with the procedures outlined in the *Guidance for Planning for Data Collection in Support of Environmental Decision Making using Data Quality Objectives Process* (EPA, 1994).

The DQO process consists of the seven steps outlined below:

- State the problem
- Identify the decisions
- Identify inputs to decisions
- Define the study boundaries
- Develop decision rules
- Specify tolerable limits on decision errors
- Optimize investigation design for obtaining data.

3.1 State the Problem

The risk assessment for exposure to VOCs in indoor air has been based on calculated indoor concentrations derived using the measured concentrations at 6-foot depth in the soil gas and a diffusion model. Direct measurements of concentration of VOCs in the indoor air are needed to verify the diffusion model results. If the measured and calculated concentrations are comparable, the diffusion model can be used with confidence to predict concentrations and associated risk at other locations based on known soil gas concentrations.

VOCs detected in the indoor air may be derived from sources other than the CTP, including household materials and regional background. The sampling program should provide data to determine the source of any VOCs found in the indoor air.

3.2 Identify the Decisions

The following decisions are associated with this sampling and analysis:

1. Does the indoor air contain VOCs derived from the CTP? This decision will be based on comparing the indoor concentrations against those recorded in samples collected concurrently from beneath the foundation (sub-slab) and from a SGP located adjacent to the building.

2. Are the concentrations of VOCs measured inside the building comparable to the concentrations measured in ambient air outside the building? This decision will be based on comparing the indoor concentrations against concentrations measured in samples collected concurrently outside the building.

3. Are the concentrations of VOCs comparable to the concentrations predicted using the diffusion model? This decision will be based on comparing the indoor concentrations against concentrations predicted applying the diffusion model to the soil gas concentrations measured near the building, primarily in the new SGP.

4. Does the indoor air contain VOC concentrations that significantly exceed background? This decision will be based on comparing the indoor concentrations against existing background ambient air data.

3.3 Identify Inputs to Decisions

The primary data required to resolve these decisions are concentrations of COCs from four concurrent samples: indoor and outdoor air, sub-slab, and a shallow soil gas probe adjacent to the building. Laboratory analytical measurements are needed to verify the concentration of COCs in the samples. Samples will be analyzed in the laboratory for VOCs via SIM using EPA TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)* (EPA, 1999). The VOCs analyzed are the same list analyzed via SIM for ambient air samples collected in 2003.

Two compounds, trichloroethene and tetrachloroethene are added to the OU2 Landfill list because they are COCs for the present investigation. The other two COCs, carbon tetrachloride and chloroform were included in the OU2 Landfill list.

The location selected for indoor air sampling is Building 6277, Lexington Court, which is located above the area in which carbon tetrachloride has been detected in the soil gas (Figure 1). This building was used as Army housing when the base was in operation, but is currently not occupied. An unoccupied building is preferred for sampling to minimize interference from other uses of the building and to retain control of sampling conditions. A probe will be installed through the foundation slab for collection of sub-slab samples. A new shallow SGP will be installed outside and adjacent to the building. This new SGP is required because the nearest existing SGP is approximately 120 feet southeast of the proposed indoor sampling location. The depth of the shallow SGP will be approximately 6 feet to correspond to the existing SGPs. Outdoor air samples will be collected from a location in the fenced yard on the west side of the building.

Two sets of samples (indoor and outdoor air, sub-slab, SGP) will be collected from these locations approximately 1 week apart. Two sets of samples will be collected to provide comparability between samples collected at different times. In addition one field (trip) blank will be analyzed.

Background ambient air data will be obtained from the ambient air data collected at Fort Ord by Shaw periodically since October 2000. This data set includes over 100 samples from various locations. Samples were analyzed by the same SIM method proposed for the samples covered by this plan.

Meteorological data will be collected during the sampling and for periods 2 weeks in advance and 2 weeks following. Sampling will be conducted during a period of falling or steady barometric pressure. Rising atmospheric pressure will be avoided because soil gas emissions may be inhibited at these times. Meteorological data will be obtained from the Naval Postgraduate Station located at the Marina Municipal Airport.

3.4 Define Study Boundaries

The spatial boundaries for the indoor sample are limited to the building, outdoor air sampling location, and adjacent probe, which are located above the affected soil gas. This location is believed to be representative of other houses in Lexington Court and Ready Court. Sub-slab and indoor samples will be collected from two different rooms within the building.

The temporal boundaries for this sampling are that samples are required to be collected approximately within a one-week time frame. At least one of the two sampling events will occur prior to the implementation of the SVE.

3.5 Develop Decision Rules

Results from the samples are required to assess the risk, if any, associated with the indoor air and to determine if additional evaluation is required. The decision rules are as follows:

1. If indoor air does not contain VOC concentrations that significantly exceed background concentrations, then no further investigation will be required

2. If a comparison of the results from the risk assessment performed on the indoor air sample results, and the calculated concentration obtained using the diffusion model (with sub-slab results as input to the model) are not shown to be statistically different, then no further investigation is required.

3. If indoor air contains VOC concentrations that significantly exceed background concentrations, then further investigation may be required.

4. If the outdoor ambient air contains VOC concentrations that significantly exceed background concentrations, then further investigation may be required.

5. If the comparison of the results from the risk assessment performed on the indoor air sample results, and the calculated concentration obtained using the diffusion model (with sub-slab results as input to the model) are shown to be statistically different, then further investigation may be required.

Soil vapor extraction will be implemented shortly after the indoor samples are collected. Soil gas concentrations will be monitored throughout the affected area. It is expected that concentrations of VOCs will be reduced significantly by operation of the SVE and the potential source of indoor COCs from the CTP will be eliminated. Therefore, a final decision regarding the need for additional investigation will be made after implementation of the SVE.

3.6 Specify Tolerable Limits on Decision Errors

Since decisions are predominantly based on analytical data and the sampling protocols, decision errors may result from the limits of the analyses. To limit decision errors, analytical method requirements have been established. Sampling and analysis will follow the EPA Draft Guidance (EPA, 2002), and the guidance provided by the MDEP as stated above in order to provide the most representative data of the concentration of COCs in the indoor air.

Samples will be collected for this project using SIM certified clean 6-Liter SUMMA™ canisters. These canisters will be certified clean by the subcontracted laboratory for all compounds listed in Table 3. A sampling cane and 24-hour mass flow controller will be used in conjunction with the SUMMA™ canister during the collection of the indoor air sample. Since all these components are required for the sample collection, all components will be considered a sample train, and certified clean by the subcontracted laboratory.

3.7 Optimize Design for Obtaining Data

The following sections describe the optimization of design for each type of sample that will be collected for this project.

3.8 Indoor ambient air samples

Indoor ambient air samples will be collected from a room in the house, preferably a room designed as a living area. Prior to indoor air sampling, an inspection of the sampling area will be conducted in order to adequately identify the presence of any possible indoor air emission sources of (or occupant activities that could generate) target VOCs in the dwelling. This evaluation will be a simple walk-through evaluation during which time observations can be made about potential indoor sources of VOCs or about other influencing factors. A checklist for the evaluation is provided as Table 1. A list of items that need to be completed prior to sampling is presented in Table 2.

The indoor samples will be integrated samples collected during a 24-hour period using a mass-flow controller and stainless steel sampling cane. The 24-hour mass flow controller contains a flow restrictor that uses a critical orifice to regulate the airflow into the negatively pressured canister. The orifice is designed to allow for a regulated airflow over a 24-hour sample period, and at the end of the period allowing the canister to have a slightly negative pressure (2-5 inches mercury). The cane will be of a length such that when the canister, flow controller, and cane are connected the overall height is approximately 3 feet above the surface. Two indoor samples will be collected at two separate 24-hour sampling periods approximately 1 week apart. The indoor air sample will not be collected from the same room used for sub-slab sampling.

During the sampling period and for at least 48 hours prior to sampling, windows and doors to the sampling area will be closed. The building will be repaired as necessary prior to sampling. Minor repairs may be conducted in order to simulate the conditions of an occupied building (e.g., cover broken windows).

3.9 Outdoor ambient air samples

Outdoor ambient air samples will be collected from a secure location adjacent to the house.

The outdoor samples will be integrated samples collected during a 24-hour period using a mass-flow controller and stainless steel sampling cane similar to the indoor samples previously discussed. The cane will be of a length such that when the canister, flow controller, and cane are connected the overall height is approximately **5** feet above the surface (at the approximate midpoint of the ground story level of the building). Two outdoor samples will be collected at two separate 24-hour sampling periods approximately 1 week apart.

3.10 Sub-Slab Samples

A probe will be installed through the concrete foundation as follows:

1. Determine area that is near center of the building for probe placement. A location close to the center of the building will be optimal to minimize dilution affects towards the exterior of the building. The probe will not be installed in the same room to be used for indoor air sampling.

2. Drill a 1.5-inch hole with a hand held drill and bit capable of effectively penetrating concrete (diamond tip).

3. Drill to a depth below the slab foundation (approximately 6 inches).

4. Place stainless steel or copper tubing through the drilled hole; the screened portion should be below the foundation.

5. Place bentonite or equivalent grouting around the probe to make an airtight seal with the concrete.

6. Attach sampling port to end of the probe.

Figure 2 presents a schematic drawing for the placement and use of this sub-slab probe. At present it is assumed that the screen will be positioned in a granular bedding material below the concrete. The configuration may be modified depending on the actual conditions observed below the concrete. After this sampling event, the probe will be left in place for potential future sampling that may occur.

The sampling port will remain sealed (except as noted below) at all times during indoor air sampling. The only time the port will be opened during indoor sampling will be when the sub-slab sample is collected, and the port will be opened only when an airtight connection is made with the SUMMA™ canister. One sub-slab sample will be collected during each of the two 24-hour indoor air-sampling periods.

3.11 Soil Gas Probe Samples

A shallow SGP will be installed adjacent to building 6277 in Lexington Court. The probes will be hand augered to 6 to 7 feet below grade. The well will be constructed of ¾" stainless steel with 1 foot of 0.010 slotted screen. Pea gravel will be placed 4.5 to 6 feet below grade, bentonite will be added from 3.5 to 4.5 foot, and grout will be added from the surface to 3.5 feet below grade. A surface completion will be performed consistent with the previous SGP installations. Figure 3 presents a schematic drawing for the placement of the shallow SGP. One grab sample will be collected during each of the two 24-hour indoor air-sampling periods.

4.0 Sampling/Analytical Methods Requirements

The following table provides a summary of the samples to be collected for this project:

Sample Type	Number of Samples	Sample Methods	Analytes
Probe	2	TO-15 (SIM)	See Table 3
Indoor Air	2	TO-15 (SIM)	See Table 3
Outdoor Air	2	TO-15 (SIM)	See Table 3
Sub-slab	2	TO-15 (SIM)	See Table 3
Field (Trip) Blank	1	TO-15 (SIM)	See Table 3

Gas samples will be collected in accordance with the SQP/SOP Manual (IT, 2002). Applicable SOPs, which can be found in Appendix C, are as follows:

SOP No.	SOP Title
1.1	Chain of Custody
2.1	Sample Handling, Packaging, and Shipping
17.1	Sample Labeling
19.1	Onsite Sample Storage

EPA Method TO-15 (EPA, 1999) SIM is a procedure for sampling and analysis of low-level VOCs in ambient air. The VOCs are separated by gas chromatography and measured by a mass spectrometer or by multi-detector techniques. Selective Ion Monitoring mode sets the mass detector to repeatedly scan a few selected ions rather than a full spectrum. In the acquisition

method the selected ions can be changed to reflect the desired compound to be detected. Each compound will fragment in the mass spectrometer according to its molecular structure and each fragment has a given structure and mass-to-charge ratio. The detector scans for a primary, secondary, and tertiary ion set unique to the compound of interest in a particular retention time window. The method presents procedures for sampling into canisters to final pressures both above and below atmospheric pressure (respectively referred to as pressurized and sub-atmospheric pressure sampling).

One clean sampling device (i.e., canister) will accompany the samples to the field and back to the laboratory to serve as a field blank. The canister is taken to the field and back to the laboratory without opening it. The field blanks should not contain any target analyte at greater than its corresponding reporting limit and should not contain additional compounds with elution characteristics and mass spectral features that would interfere with identification and measurement of a method analyte. If a blank is found to be contaminated as described above and the analyte is also found in associated samples, those sample results will be "flagged" during data review and validation processes.

Analysis of samples will be performed per the requirements presented in Tables 3 – 9. Air Toxics Ltd., Folsom, California, will perform analyses.

5.0 Risk Assessment

A preliminary cumulative risk will be calculated for the indoor air concentrations, including COCs that are present in the soil gas measured in the sub-slab or SGP samples. An exposure time input value that represents a realistic period of occupancy of the housing will be used in the risk calculation (e.g., 8 years).

The preliminary risk assessment will be conducted by Mactec in accordance with U.S. Environmental Protection Agency (EPA), California Environmental Protection Agency-Department of Toxic Substances Control (Cal/EPA-DTSC), USACE, California Integrated Waste Management Board (CIWMB), and Monterey Bay Unified Air Pollution Control District (MBUAPCD) guidance as appropriate.

6.0 References

EPA, 1994, Guidance for Planning for Data Collection in Support of Environmental Decision Making using Data Quality Objectives Process

EPA, 1999, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, 2nd Edition, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS) EPA/625/R-96/010b

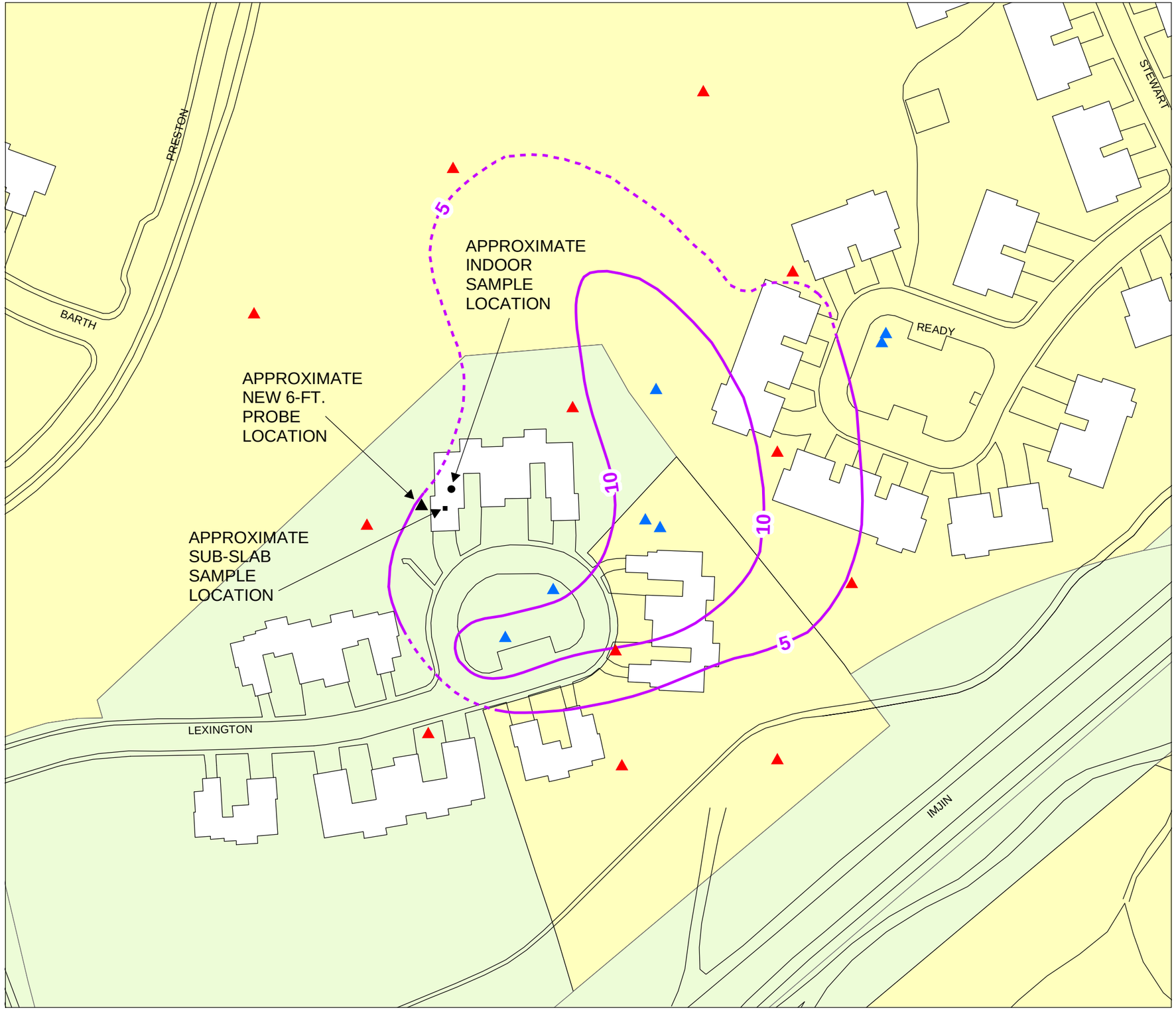
EPA, 2002, Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater And Soils (Subsurface Vapor Intrusion Guidance)

IT Corporation (IT), 2002, IT Standard Quality Procedures and IT Standard Operating Procedures, Revision 5, Concord, California.

Mactec, 2004, OU CTP SVE Pilot Study Test Letter Report, January 2004. Mactec Engineering & Consulting, Petaluma, California

MDEP, 2002, Indoor Air Sampling and Evaluation Guide, WSC POLICY #02-430, Office of Research and Standards

FIGURES



LEGEND

- EXISTING WELL/PROBE
- PROPOSED WELL/PROBE
- CARBON TETRACHLORIDE CONCENTRATION CONTOURS (ppbv); DASHED WHERE INFERRED

PARCEL TRANSFER STATUS

- NOT STARTED
- TRANSFERRED
- BUILDING

NOTE:
Basemap from C. Stiebel, USACE; contours from MACTEC, Carbon Tetrachloride Concentrations in Soil Gas at 6 feet (Sept. 2003)

N

0 100 200 FEET

REVISION	DATE	DESCRIPTION	CHKD	APPR

Shaw® Shaw Environmental, Inc.

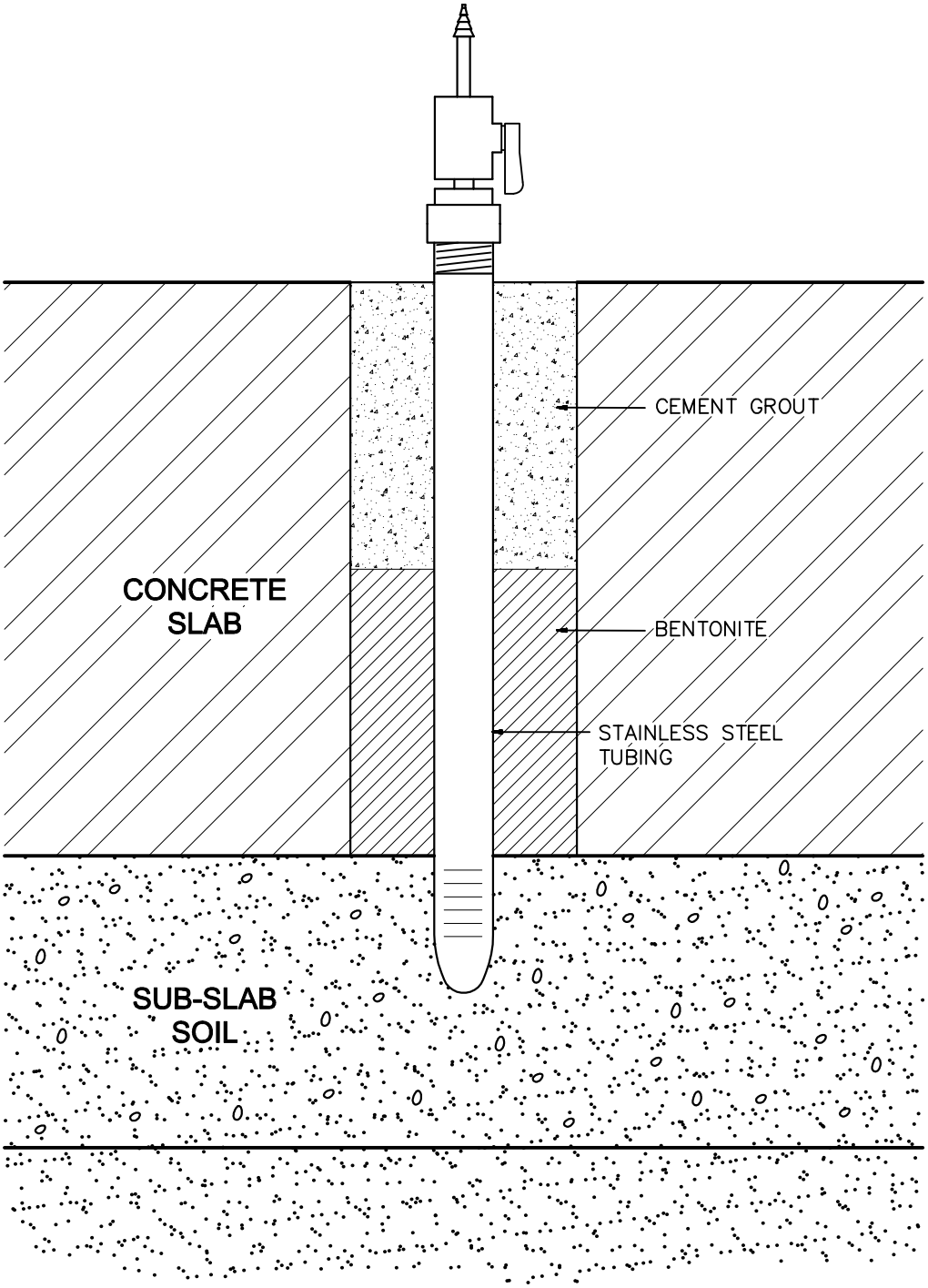
Department of the Army
Sacramento District, Corps of Engineers
Sacramento, California

DESIGNED: E. SCHMIDT
DRAWN: K. BLACK
CHECKED: P. KELSALL

Figure 1
INDOOR SAMPLING LOCATION
Former Fort Ord, California

SUBMITTED: DATE

SCALE: SPEC. No.
SHEET FILE No. CTPsite.mxd



REVISION	DATE	DESCRIPTION	CHKD	APPR

Shaw™ Shaw Environmental, Inc.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: E. SCHMIDT
DRAWN: K. BLACK
CHECKED: P. KELSALL

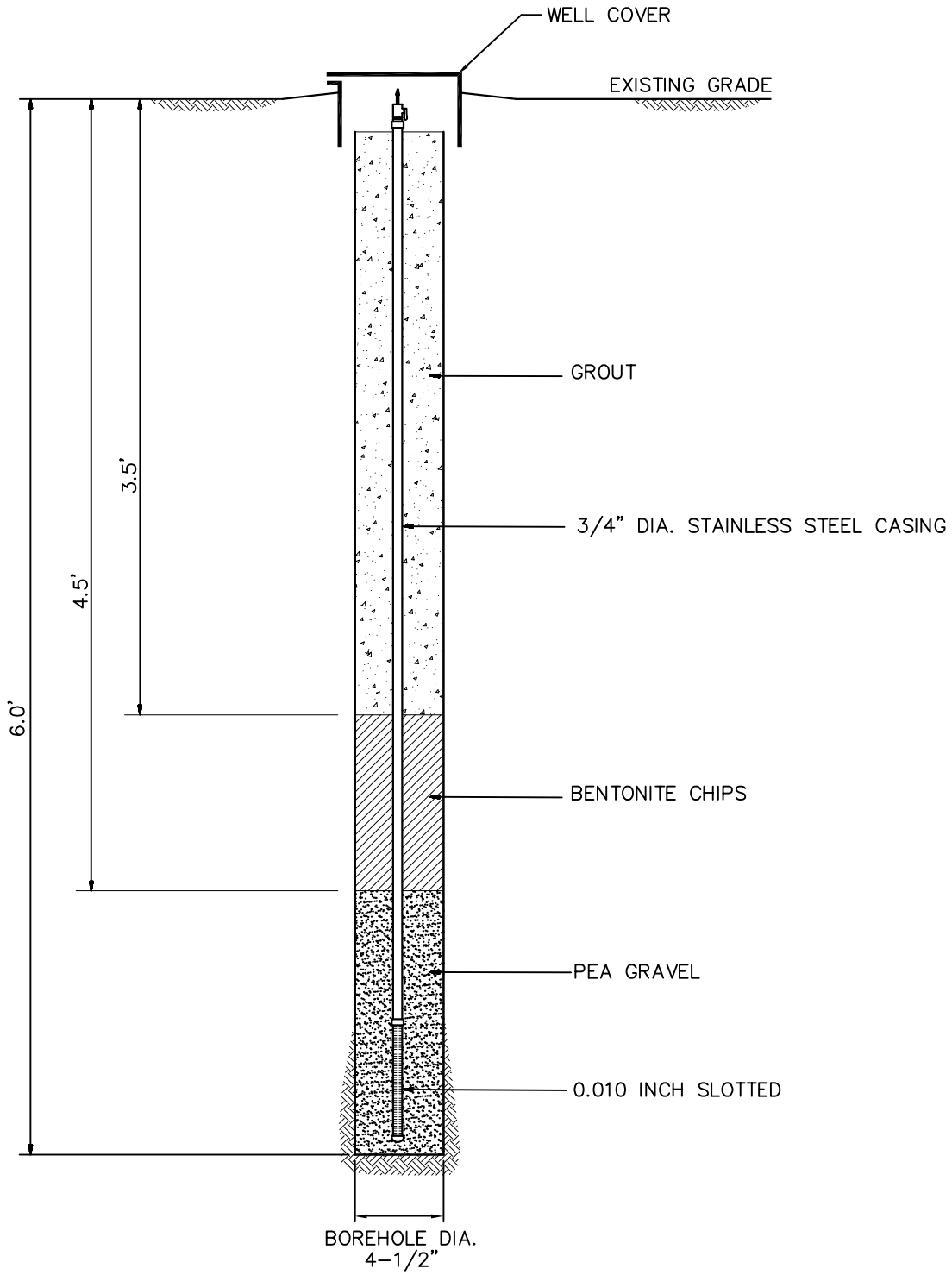
FIGURE 2
SCHEMATIC FOR INSTALLATION OF SUB-SLAB VAPOR PROBE

FORMER FORT ORD, CALIFORNIA

SUBMITTED: _____ DATE APPROVED: _____

SCALE: | SPEC. No.

SHEET - OF - | FILE No. 783751SLA141



REVISION	DATE	DESCRIPTION	CHKD	APPR

Shaw Environmental, Inc.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: E. SCHMIDT
DRAWN: K. BLACK
CHECKED: P. KELSALL

FIGURE 3

SCHEMATIC FOR INSTALLATION OF SOIL GAS PROBE

FORMER FORT ORD, CALIFORNIA

SUBMITTED: _____ DATE APPROVED: _____

SCALE: | SPEC. No.

SHEET - OF - | FILE No. 783751S LA140

TABLES

Table 1
Evaluation Check List

Evaluation performed by:_____ **Date:**_____

Type	Description	Y/N	Comments
Indoor Sources	Use of sprays, solvents, pesticides, personal products?		
	Storage/emissions of paints or other hobby supplies?		
	Indicators of tobacco smoking in premises?		
	Combustion sources?		
	Freshly dry-cleaned clothing?		
	Is there a solvent storage area?		
	Other pollutant-generating activity occurring in the building?		
Building Sources	New construction/remodeling/painting?		
	New carpeting or other furnishings?		
	Type of foundation (eg., slab on ground, crawl space)?		
	Cracks in the foundation in contact with soil?		
	Utilities (electrical, sewer, pipes) come through slab?		
	Building have an attached garage?		
	Forced hot air heating system?		
Outdoor Sources	Building near outdoor stationary sources?		
	Building near outdoor mobile sources (eg., airports, highways)?		
	Any pollutant-generating activities in the vicinity (eg., asphalting, painting, etc.)		

Other Comments

Table 2
List of Implementation Items
(to be implemented atleast 48 hours prior to sampling)

1. Place visqueen over broken windows. Attach with staple gun.

2. Close any windows that are open

3. Close any heating/cooling vents that are open

4. Do not operate ventilation fans or air conditioning

5. Remove any items that might be present that could produce chemicals of concern

Table 3
Practical Quantitation Limits for Volatile Organics
by U.S. Environmental Protection Agency Method TO-15[a]
in Selected Ion Monitoring Mode

Parameter	Method	Analyte[b]	Air Reporting Limit (ppbv[c])
Volatile Organic Compounds	TO-15 SIM[d]	1,1,2,2-Tetrachloroethane	0.02
		1,1,2-Trichloroethane	0.02
		1,1-Dichloroethene	0.01
		1,2-Dibromoethane (EDB)	0.02
		1,2-Dichloroethane	0.02
		1,2-Dichloropropane	0.02
		1,3-Butadiene	0.1
		1,4-Dichlorobenzene	0.02
		1,4-Dioxane	0.1
		alpha-Chlorotoluene	0.1
		Benzene	0.05
		Bromodichloromethane	0.1
		Bromoform	0.1
		Carbon Tetrachloride	0.02
		Chloroform	0.02
		Dibromochloromethane	0.1
		Hexachlorobutadiene	0.1
		Trichloroethene	0.02
		Tetrachloroethene	0.02
		Vinyl Chloride	0.01

Notes:

[a] U.S. Environmental Protection Agency, 1997, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, 2nd Edition, EPA/624/R-96/0106

[b] Control will be maintained on all analytes

[c] Parts per billion by volume

[d] Selected Ion Monitoring

Table 4
Bromofluorobenzene Key Abundance Criteria for Volatile Organics
by U.S. Environmental Protection Agency Method TO-15[a]

Mass	Ion Abundance Criteria
50	15 to 40 percent of mass 95
75	30 to 60 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5 to 9 percent of mass 95
173	<2 percent of mass 174
174	>50 percent of mass 95
175	5 to 9 percent of mass 174
176	>95 percent but <101% of mass 174
177	5 to 9 percent of mass 176

Notes:

[a] U.S. Environmental Protection Agency, 1997, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, 2nd Edition, EPA/624/R-96/0106

Table 5
Laboratory Control Limits for Surrogate Spikes for Volatile Organics by U.S. Environmental Protection Agency Method TO-15[a]

Analytical Method	Spiking Compounds	Percent Recovery (%)
TO-14A SIM	1,2-dichloroethane-d_4	70-130
	Toluene-d_8	70-130
	4-Bromofluorobenzene	70-130

Notes:

[a] U.S. Environmental Protection Agency, 1997, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, 2nd Edition, EPA/624/R-96/0106

Table 6
Laboratory Control Limits for Internal Standards for Volatile Organics by U.S. Environmental Protection Agency Method TO-15[a]

Analytical Method	Internal Standard	Percent Recovery (%)[b]
TO-15 SIM	Bromochloromethane	50-200
	1,4-Difluorobenzene	50-200
	Chlorobenzene-d_5	50-200

Notes:

[a] U.S. Environmental Protection Agency, 1997, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, 2nd Edition, EPA/624/R-96/0106

[b] Internal standard area counts must not vary by more than a factor of two (-50 percent to +100 percent) from the associated 12hr calibration standard (per EPA Functional Guidelines), however, if the recovery is high, and samples are non-detectable then no corrective action is required.

Table 7
Control Limits for Laboratory Control Samples for Volatile Organics by U.S. Environmental Protection Agency Method TO-15[a]

Analytical Method	Spiking Compounds[b]	Percent Recovery (%)
TO-15 SIM	1,1,2,2-Tetrachloroethane	70-130
	1,1,2-Trichloroethane	70-130
	1,1-Dichloroethene	70-130
	1,2-Dichloroethane	70-130
	1,2-Dichloropropane	70-130
	1,3-Butadiene	70-130
	1,4-Dichlorobenzene	70-130
	1,4-Dioxane	60-140
	Benzene	70-130
	Bromodichloromethane	70-130
	Bromoform	60-140
	Carbon Tetrachloride	70-130
	Chloroform	70-130
	Dibromochloromethane	70-130
	1,2-dibromoethane (EDB)	70-130
	Hexachlorobutadiene	70-130
	Trichloroethene	70-130
	Tetrachloroethene	70-130
	Vinyl Chloride	70-130

Notes:

[a] U.S. Environmental Protection Agency, 1997, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, 2nd Edition, EPA/624/R-96/0106

Table 8
Summary of Calibration Procedures for Volatile Organics
by U.S. Environmental Protection Agency Method TO-15[a]

Method	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
TO-15 SIM	Volatile Organics	Check instrument tuning	Every 12 hours criteria using BFB[b]	Refer to Table 4	1) Retune instrument 2) Repeat BFB analysis
		Multipoint Calibration	Initially and as required (minimum 5 points) (ICAL)[c]	%RSD[d] $\leq$ 30%	1) Evaluate system 2) Recalibrate
		Continuing calibration	Every 12 hours check standard (CCV)[e]	%Difference $\leq$ 30%	1) Evaluate system 2) Repeat calibration check 3) Recalibrate 4) Reanalyze affected samples

Notes:

[a] U.S. Environmental Protection Agency, 1997, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, 2nd Edition, EPA/624/R-96/0106
[b] Bromofluorobenzene
[c] Initial calibration
[d] Relative Standard Deviation
[e] Continuing calibration verification

Table 9
Summary of Internal Quality Control Procedures for Volatile Organics
by U.S. Environmental Protection Agency Method TO-15[a]

Method	Parameter	QC Element	Frequency	Acceptance Criteria	Corrective Action
TO-15 SIM	Volatile Organics	Method blank	1/batch; batch is not to exceed 20 samples	< PQL[b]	1) Check calculations 2) Inspect system 3) Reanalyze blank
		Laboratory duplicate	5 percent of the project samples	RPD[c] < 25% for detections >5 times the detection limit	1) Reanalyze sample 2) Inspect system for anomalies 3) Flag data
		Surrogate spike	Every sample and the method blank	Refer to Table 5	1) Check calculations 2) Evaluate batch for adverse trends 3) If no interference is evident, digest/reanalyze 4) Narrate any outliers 5) Reanalyze affected samples
		Internal standard (IS)	Every continuing calibration standard and sample	Retention time must be within 30 seconds of the CCV[d]; IS area in the sample must be within factor of 2 of the IS in the CCV (Table 6)	1) Check sensitvity of instrument 2) Evaluate data 3) Reanlayze sample or standard once 4) Narrate any outliers
		Laboratory Control Standard	1/batch; not to exceed 20 samples	Refer to Table 7	1) Check calculations 2) Reanalyze LCS; if passes, report 3) Reanalyze samples as needed 4) Narrate any outliers

Notes:

[a] U.S. Environmental Protection Agency, 1997, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air* , 2nd Edition, EPA/624/R-96/0106
[b]Practical Quantitation Limit
[c]Relative Percent Difference
[d]Continuing Calibration Verification standard

Appendix A
Responses to Agency Comments

Responses to Agency Comments

Draft Final Sampling and Analysis Plan, Indoor Air Sampling, Operable Unit Carbon Tetrachloride Plume, Former Fort Ord, California

Comments Received from USEPA, February 18, 2004

1. *The decision rule/plan depends too much on agreement with modeled concentrations. Our experience in Mountain View is that indoor concentrations are sporadic and not predictable.*

Response: The scope of the proposed testing was developed in consultation with the BCT. As discussed with the BCT, the Army is proceeding with soil vapor extraction independent of the decisions associated with the indoor sampling.

2. *A field or trip blank should be included.*

Response: A trip blank has been added.

3. *As stated before, an outdoor upwind ambient air background sample should be included.*

Response: An outdoor ambient air background sample has been included for each of the sampling events. By verbal agreement with Mr. Stralka of EPA, the upwind samples will be collected in the fenced yard of the building where the indoor samples will be collected, not necessarily upwind.

4. *As stated before, with soil gas measurements, as a quality control measure, please include O2, CO2 and CO, to determine if we are seeing short circuiting in the air sample.*

Response: The Army understands EPA's concern about the possibility of short-circuiting during collection of samples from soil gas probes; however, the Army has determined that short circuiting is unlikely to be a significant issue. The sub slab and outdoor probe samples will be collected with Summa canisters, which have volume of 6 liters. Allowing for porosity, this volume is equivalent to a sphere of soil with a radius of approximately 13 inches. For the outdoor probe, with a 12-inch screen at six feet below ground surface (bgs), there is no mechanism for ambient air to be pulled into the sample. For the sub slab probe, the sample volume is equivalent to a half sphere below the slab with a radius of approximately 15 inches. Since the slab extends at least 10 feet laterally from the probe location in every direction, there is no mechanism for outdoor ambient air to be pulled into the sample. While testing for atmospheric gases may provide useful information at other sites, it would be expected that the void space in the sandy soil around the shallow probes at this site is occupied by atmospheric gases at concentrations similar to outdoor ambient air. As such, detection of these gases would not provide definitive evidence of short circuiting. In

addition, an appropriate alternative methodology for assessing short circuiting at the probe locations has not been established. Because of time constraints relative to start-up of the SVE system, the Army will proceed with sampling without assessing for short circuiting; however, if evaluation of the analytical results merits it, the Army will further investigate appropriate methods for such an assessment.

Comments Received from DTSC, February 20, 2004

1. *We find the sampling plan acceptable. The plan accurately reflects prior agreements made among the sampling team. Sampling an unoccupied residence over some of the highest concentrations of CCl4 in groundwater and shallow soil gas should be representative of the potential worst case conditions in other nearby residences.*

Response: Comment noted.

2. *Under "decision Rules" on page 3-4, the Army states that they will look for "statistically significant differences" between indoor and outdoor air. We doubt that the two samples each collected from indoor air, soil gas, and sub-slab soil gas will permit meaningful statistical comparisons, such as formal testing of hypotheses. Nonetheless, simple comparisons among indoor air, soil gas and ambient air will provide useful information.*

Response: Comment noted. The Army will take this comment into consideration in evaluation of the data to be collected.

tc

TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE
(Read Instructions on the reverse side prior to initiating this form)

DATE: March 09, 2004

TRANSMITTAL NO.: 004

Section I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS *(This Section will be initiated by the contractor)*

TO: Doug Stanley
U.S. Army Corps of Engineers
1325 "J" Street
Sacramento, CA 95814-2922

FROM: Peter Kelsall
Shaw Environmental, Inc.
P.O. Box 1698
Marina, CA 93933-1698

CONTRACT NO.
DACW05-96-D-0011

T.O. # 011 WAD # 12

CHECK ONE:
X THIS IS A NEW TRANSMITTAL

THIS IS A RESUBMITTAL OF TRANSMITTAL

SPECIFICATION NO. (Cover only one section with each transmittal)

PROJECT TITLE AND LOCATION: FORMER FORT ORD, CALIFORNIA

ITEM NO a.	DESCRIPTION OF ITEM SUBMITTED *(Type, size, model number, etc.)* b.	MFG. OR CONTR. CAT., CURVE DRAWING OR BROCHURE NO. *(See Instruction No. 8)* c.	NO. OF COPIES d.	CONTRACT REFERENCE DOCUMENT SPEC. PARA. NO. e.	CONTRACT REFERENCE DOCUMENT DRAWING SHEET NO. f.	FOR CONTRACTOR USE CODE g.	VARIATION *(See Instruction No. 6)* h.	FOR C E USE CODE i.
001	DRAFT FINAL SAMPLING AND ANALYSIS PLAN, INDOOR AIR SAMPLING, OPERABLE UNIT CARBON TETRACHLORIDE PLUME, FORMER FORT ORD, CALIFORNIA, REVISION 0 (For Government Review Only)	N/A	13	SOP17		A		
002	DRF for the DRAFT FINAL SAMPLING AND ANALYSIS PLAN, INDOOR AIR SAMPLING, OPERABLE UNIT CARBON TETRACHLORIDE PLUME, FORMER FORT ORD, CALIFORNIA, REVISION 0 (For Your Information Only)	N/A	13	SOP17		F		

REMARKS
cc: See Distribution List

CONTRACTOR QUALITY CONTROL SYSTEMS MANAGER
Shaw Environmental, Inc.
✓ Approved
_____ Approved with corrections as noted on submittal data and/or attached sheet(s).

SIGNATURE: Signature on File
TITLE: CONTRACTOR QUALITY CONTROL SYSTEM MANAGER

I certify that the above submitted items have been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated.

Shaw Environmental, Inc.

Signature on File /PETER KELSALL
NAME AND SIGNATURE OF CONTRACTOR

Section II - APPROVAL ACTION

ENCLOSURES RETURNED (List by Item No.)	NAME, TITLE AND SIGNATURE OF APPROVING AUTHORITY	DATE

Shaw Environmental, Inc.

DOCUMENT REVIEW AND RELEASE FORM

Client: USACE	Authors: Shaw Environmental, Inc.	Submittal Register Item No.: 002	Date: March 9, 2004

Document Title:	FINAL SAMPLING AND ANALYSIS PLAN, INDOOR AIR SAMPLING, OPERABLE UNIT CARBON TETRACHLORIDE PLUME, FORMER FORT ORD, CALIFORNIA	Revision: 0	T.O. # 011	WAD# 12

Reviewer (*print*)	Reviewer Initial & Date	Technical	Project Manager	CQC	Health and Safety Manager	Task Manager	Chemistry	UXO	Construction	Reviewer Comments Resolved (*Signature & Date)*
Peter Kelsall			X							Signature on File
Tom Ghigliotto				X						Signature on File
Eric Schmidt							X			Signature on File
Same as Technical Reviewer above		X	Topic outline with objectives for each section submitted prior to Rev. A							

Program Reviewer's Acceptance for Document Submittal	Signature	Yes	No
1) A 4025 (as applicable) prepared and submitted with document?		X	
2) Technical Conclusions adequately supported by text and data?		X	
3) Tables and Figures are in the proper format and checked and approved?		X	
4) The Table of Contents consistent with text information?		X	
5) Technical Reviewers are qualified and accepted by Project Manager?		X	
6) A document Distribution List been prepared and submitted with document?		X	

Recommended
4025 Code A

Signature on file
Project Manager

Signature on File
Contractor Quality Control Systems Manager

FORT ORD

DISTRIBUTION LIST FOR: **DRAFT FINAL SAMPLING AND ANALYSIS PLAN, INDOOR AIR SAMPLING, OPERABLE UNIT CARBON TETRACHLORIDE PLUME, FORMER FORT ORD, CALIFORNIA, REVISION 0**

No. of CDs	No. of Paper	Name	Company	Address	City and State	Zip Code	Controlled Yes or No
	1	Doug Stanley	Department of the Army, USACE	1325 "J" Street	Sacramento, CA	95814-2922	Yes
1		Derek Lieberman	DENR	BRAC, Bldg. #4463 Gigling Road	Monterey, CA	93944-5004	Yes
1		Glenn Mitchell	Department of the Army, USACE	1325 "J" Street	Sacramento, CA	95814-2922	Yes
1		Peter Kelsall	Shaw Environmental, Inc.	9201 East Dry Creek Road	Centennial, CO	80112	Yes
1		Eric Schmidt	Shaw Environmental, Inc.	PO Box 1698	Marina, CA	93933	Yes
	1	Tom Ghigliotto	Shaw Environmental, Inc.	PO Box 1698	Marina, CA	93933	Yes
1		Ed Ticken	Mactec	5341 Old Redwood Hwy; Suite 300	Petaluma, CA	94954	No
1		John Christopher	California Department of Toxic Substances Control	8800 California Center Drive	Sacramento, CA	95826	Yes
1		Roman Racca	California Department of Toxic Substances Control	8800 California Center Drive	Sacramento, CA	95826	Yes
1		Grant Himebaugh	California Regional Water Quality Control Board	81 Higuera Street, Suite 200	San Luis Obispo, CA	93401-5414	No
1		John Chesnutt	U.S. Environmental Protection Agency	75 Hawthorne Street, Mail SFD-8-3	San Francisco, CA	94105	Yes
1		Daniel Stralka	U.S. Environmental Protection Agency	75 Hawthorne Street, Mail SFD-8-3	San Francisco, CA	94105	Yes
1		Kelly Buettner	Air Toxics	180 Blue Ravine Road; Rev B	Folson, CA	95630	Yes
	3	Mary Bakan	Administrative Records	BRAC, Bldg #4463 Gigling Road	Monterey, CA	93944-5004	No
1		Sandy Reese	Administrative Records	BRAC, Bldg #4463 Gigling Road	Monterey, CA	93944-5004	No
	1	LeVonne Stone	Environmental Justice Network	P.O. Box 361	Marina, CA	93933	No
	1	Christine Bettencourt	Temple Health/Life 2000	PO Box 1852	Greenfield, CA	93921	No
1		Curt Gandy	Fort Ord Toxic Project	PO Box 1904	Monterey, CA	93942	No
	1	Mike Weaver		52 Corral De Tierra Road	Salinas, CA	93908	No
	1	Nat Rojanasathira		802 Sunset Drive; Apt G	Pacific Grove, CA	93950	No
1	1	Project File	Shaw Environmental, Inc.	PO Box 1698	Marina, CA	93933	Yes
1		Program File (Kathy Grider)	Shaw Environmental, Inc.	4005 Port Chicago Highway	Concord, CA	94520-1120	Yes

15 10

Approved: Signature on File
Glen Mitchell, USACE
Project Manager

Appendix B
Evaluation of Johnson and Ettinger Model for Estimating Subsurface Vapor Intrusion into Buildings

MEMORANDUM

To: Peter Kelsall, Fort Ord Project Manager
Shaw Environmental, Inc.

From: Genevieve DiMundo, Senior Environmental Scientist
Edward Ticken, MACTEC Fort Ord Project Manager

Date: May 6, 2004

Subject: Draft
Evaluation of Johnson and Ettinger Model for Estimating Subsurface Vapor Intrusion into Buildings
Carbon Tetrachloride Indoor Air Report
Former Fort Ord, California

Project Number: 4087040802-00112

This Memorandum provides an evaluation of the subsurface vapor intrusion model to predict indoor air concentrations of volatile organic compounds (VOCs) in residential structures in the vicinity of the carbon tetrachloride plume using soil gas data collected at the site. This analysis is provided to answer the following data quality objective (DQO) from the Indoor Air Sampling and Analysis Plan (SAP) (*Shaw, 2004*): Are concentrations of VOCs comparable to the concentrations predicted using the diffusion model? To answer this question, measured indoor air concentrations are compared with predicted indoor air concentrations which were modeled using the vapor intrusion model with measured soil gas data.

Indoor air concentrations of VOCs resulting from volatilization from the subsurface into indoor air can been estimated using the *Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (Revised)* (*USEPA, 2000*), modified by the California Environmental Protection Agency, Department of Toxic Substances Control (Cal/EPA-DTSC) and contained in the soil gas screening model software available at the Cal/EPA-DTSC website: http://www.dtsc.ca.gov/ScienceTechnology/JE_Models.html. This screening-level model incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from soil gas into indoor spaces located directly above the source of contamination.

The measured soil gas data from the new 6-foot soil gas probe (SGP) probe and the 0.5-foot sub-slab probe were input into the model, along with site-specific parameters, to obtain estimated indoor air concentrations. All Cal/EPA-DTSC default values were used in the model, except for the following site-specific inputs:

- Depth below grade to bottom of enclosed-space floor: 15 centimeters (cm), which is the default value for slab-on grade. All of the residential structures in the area of the carbon tetrachloride plume are slab-on grade.

MACTEC
MACTEC Engineering and Consulting, Inc.
5341 Old Redwood Hwy., Suite 300
Petaluma, CA 94954 - (707) 793-3800 – FAX (707) 793-3900

- Soil gas sampling depth below grade: 183 cm for the 6-foot SGP probe and 15 cm for the 0.5-foot sub-slab probe.

- Vadose zone soil type: Sand. The soils in the area are predominantly sandy.

The predicted indoor air concentrations from the Johnson and Ettinger model from both the 6-foot SGP probe and 0.5-foot sub-slab probe are summarized in Table 1 along with the measured indoor air concentrations from the indoor air sampling within the building. The model was run for carbon tetrachloride, benzene, chloroform, and tetrachloroethene, which are the only four chemicals that were detected in both soil gas and indoor air samples collected at the site. The Johnson and Ettinger model worksheets are also attached for reference purposes.

As shown in Table 1, the modeled indoor air concentrations are between two and three orders of magnitude lower than the measured indoor air concentrations for all chemicals. Also, the 0.5-foot sub-slab modeling predicted higher indoor air concentrations than the 6-foot SGP modeling. The relative percent differences (RPDs) between the measured and modeled concentrations ranged from 174 to 199 percent (%). The correlation between the modeled indoor air concentrations using the 6-foot SGP data and the 0.5 foot sub-slab data was also low, with RPDs ranging from 16 to 170%.

As discussed in the Indoor Air Sampling Report (prepared by Shaw), the measured indoor air concentrations at the site are within the concentration range of background samples collected during the Fort Ord ambient air monitoring and are comparable with concentrations measured in the outdoor air sample collected at the site. The measured indoor air concentrations also significantly exceed the modeled indoor air concentrations predicted using the subsurface vapor intrusion model. These results indicate that the concentrations of VOCs in indoor air are consistent with expected concentrations from non-point sources in the area and suggest that the subsurface vapors from the carbon tetrachloride plume are not contributing significantly to VOCs in indoor air of the building.

Please call Edward Ticken at (707) 793-3882 if you have any questions.

Enclosures:
Table 1 – Summary of Modeled and Measured Indoor Air Concentrations
Attachment – Example Johnson and Ettinger Model Spreadsheets

References

Shaw Environmental, Inc. (Shaw), 2004. *Draft Final Sampling and Analysis Plan, Indoor Air Sampling, Operable Unit Carbon Tetrachloride Plume, Former Fort Ord, California*. Revision 0. March.

U.S. Environmental Protection Agency (EPA), 2000, *User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (Revised)*. December. Cal/EPA-DTSC Modified. (http://www.dtsc.ca.gov/ScienceTechnology/JE_Models.html)

Table 1. Summary of Modeled and Measured Indoor Air VOC Concentrations
Carbon Tetrachloride Indoor Air Report
Former Fort Ord, California

Chemical	Sampling Date	Exterior Probe Soil Gas Concentration - 6 foot deep (ppbv)	Modeled Indoor Air Concentration from 6-foot Probe (µg/m^3) (a)	Modeled Indoor Air Concentration from 6-foot Probe (ppbv)	Measured Indoor Air Concentration (ppbv)	RPD Between 6-foot Probe Modeled and Measured Indoor Air Concentration
Carbon tetrachloride	3/9/2004	1.6E+00	6.5E-03	1.0E-03	9.9E-02	196%
Carbon tetrachloride	3/15/2004	1.5E+00	6.1E-03	9.6E-04	9.2E-02	196%
Benzene	3/9/2004	1.1E+00	2.5E-03	7.7E-04	2.2E-01	199%
Benzene	3/15/2004	2.0E+00	4.5E-03	1.4E-03	2.4E-01	198%
Chloroform	3/9/2004	5.6E-01	2.2E-03	4.4E-04	2.4E-02	193%
Chloroform	3/15/2004	5.3E-01	2.1E-03	4.2E-04	2.3E-02	193%
Tetrachloroethene	3/9/2004	7.6E-02	3.2E-04	4.6E-05	1.3E-02	199%
Tetrachloroethene	3/15/2004	8.9E-02	3.7E-04	5.4E-05	2.9E-02	199%

Chemical	Sampling Date	Sub-slab Probe Soil Gas Concentration - 0.5 foot deep (ppbv)	Modeled Indoor Air Concentration from 0.5-foot Sub-slab Probe (µg/m^3) (a)	Modeled Indoor Air Concentration from 0.5-foot Sub-slab Probe (ppbv)	Measured Indoor Air Concentration (ppbv)	RPD Between 0.5-foot Sub-slab Probe Modeled and Measured Indoor Air Concentration
Carbon tetrachloride	3/9/2004	2.8E+00	4.3E-02	6.8E-03	9.9E-02	174%
Carbon tetrachloride	3/15/2004	2.6E+00	4.0E-02	6.3E-03	9.2E-02	174%
Benzene	3/9/2004	3.9E+00	3.1E-02	9.5E-03	2.2E-01	184%
Benzene	3/15/2004	3.1E+00	2.4E-02	7.5E-03	2.4E-01	188%
Chloroform	3/9/2004	2.4E-01	2.9E-03	5.8E-04	2.4E-02	190%
Chloroform	3/15/2004	2.0E-01	2.4E-03	4.9E-04	2.3E-02	192%
Tetrachloroethene	3/9/2004	1.8E-01	7.5E-04	1.1E-04	1.3E-02	197%
Tetrachloroethene	3/15/2004	1.8E-01	7.5E-04	1.1E-04	2.9E-02	199%

Chemical	Sampling Date	Modeled Indoor Air Concentration from 6-foot probe (ppbv)	Modeled Indoor Air Concentration from 0.5-foot Sub-slab probe (ppbv)	RPD Between 6-foot Probe and 0.5-foot Sub slab Probe Modeled Indoor Air Concentrations
Carbon tetrachloride	3/9/2004	1.0E-03	6.8E-03	148%
Carbon tetrachloride	3/15/2004	9.6E-04	6.3E-03	147%
Benzene	3/9/2004	7.7E-04	9.5E-03	170%
Benzene	3/15/2004	1.4E-03	7.5E-03	137%
Chloroform	3/9/2004	4.4E-04	5.8E-04	28%
Chloroform	3/15/2004	4.2E-04	4.9E-04	16%
Tetrachloroethene	3/9/2004	4.6E-05	1.1E-04	81%
Tetrachloroethene	3/15/2004	5.4E-05	1.1E-04	68%

VOC Volatile organic compound.
RPD Relative percent difference.
µg/m3 Micrograms per cubic meter.
ppbv Parts per billion by volume.
(a) Modeled using the Johnson and Ettinger model, as described in text.

ATTACHMENT

EXAMPLE JOHNSON AND ETTINGER MODEL SPREADSHEETS

DATA ENTRY SHEET

SG-SCREEN
Version 2.0; 04/03

Reset to Defaults

DTSC / HERD
Version 2.0-mod3; 11/1/03
Default for Fine Soil

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
56235			1.50E-03	Carbon tetrachloride

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (^oC)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	183	20	S		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.59	0.399	0.148	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)
70	30	30	350

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. ($\mu g/m^3$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
168	0.251	0.275	1.01E-07	0.680	6.87E-08	4,000	9.59E+00	3.39E+04

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. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	7,757	2.43E-02	1.01E+00	1.78E-04	4.91E-03	168

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	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., $C_{building}$ ($\mu g/m^3$)
15	9.59E+00	1.25	8.33E+01	4.91E-03	5.00E+03	5.52E+14	6.38E-04	6.12E-03

Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
4.2E-05	4.0E-02

END

DATA ENTRY SHEET

SG-SCREEN
Version 2.0; 04/03

Reset to Defaults

DTSC / HERD
Version 2.0-mod3; 11/1/03
Default for Fine Soil

Soil Gas Concentration Data

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., C_g ($\mu g/m^3$)	OR	ENTER Soil gas conc., C_g (ppmv)	Chemical
56235			2.60E-03	Carbon tetrachloride

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Soil gas sampling depth below grade, L_s (cm)	ENTER Average soil temperature, T_S (^oC)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	15	20	S		

MORE ↓

ENTER Vandose zone SCS soil type (Lookup Soil Parameters)	ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q_{soil} (L/m)
S	1.59	0.399	0.148	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)
70	30	30	350

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_T (cm)	Vadose zone soil air-filled porosity, θ_a^V (cm^3/cm^3)	Vadose zone effective total fluid saturation, S_{te} (cm^3/cm^3)	Vadose zone soil intrinsic permeability, k_i (cm^2)	Vadose zone soil relative air permeability, k_{rg} (cm^2)	Vadose zone soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. ($\mu g/m^3$)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
1	0.251	0.275	1.01E-07	0.680	6.87E-08	4,000	1.66E+01	3.39E+04

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. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, D^{eff}_V (cm^2/s)	Diffusion path length, L_d (cm)
1.00E+06	5.00E-03	15	7,757	2.43E-02	1.01E+00	1.78E-04	4.91E-03	1

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	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., $C_{building}$ ($\mu g/m^3$)
15	1.66E+01	1.25	8.33E+01	4.91E-03	5.00E+03	5.52E+14	2.42E-03	4.02E-02

Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
4.2E-05	4.0E-02

END

TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE
(Read Instructions on the reverse side prior to initiating this form)

DATE: May 19, 2004

TRANSMITTAL NO.: 007

Section I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS *(This Section will be initiated by the contractor)*

TO: Doug Stanley
U.S. Army Corps of Engineers
1325 "J" Street
Sacramento, CA 95814-2922

FROM: Peter Kelsall
Shaw Environmental, Inc.
P.O. Box 1698
Marina, CA 93933-1698

CONTRACT NO.
DACW05-96-D-0011

T.O. # 011 WAD # 12

CHECK ONE:
X THIS IS A NEW TRANSMITTAL

THIS IS A RESUBMITTAL OF TRANSMITTAL

SPECIFICATION NO. (Cover only one section with each transmittal)

PROJECT TITLE AND LOCATION: FORMER FORT ORD, CALIFORNIA

ITEM NO a.	DESCRIPTION OF ITEM SUBMITTED *(Type, size, model number, etc.)* b.	MFG. OR CONTR. CAT., CURVE DRAWING OR BROCHURE NO. *(See Instruction No. 8)* c.	NO. OF COPIES d.	CONTRACT REFERENCE DOCUMENT SPEC. PARA. NO. e.	CONTRACT REFERENCE DOCUMENT DRAWING SHEET NO. f.	FOR CONTRACTOR USE CODE g.	VARIATION *(See Instruction No. 6)* h.	FOR C E USE CODE i.
005	DRAFT REPORT, MARCH 2004 INDOOR AIR SAMPLING, LEXINGTON COURT, FORMER FORT ORD, CA, REVISION C (For Government Review Only)	N/A	31	SOP17		A		
006	DRF for the DRAFT REPORT, MARCH 2004 INDOOR AIR SAMPLING, LEXINGTON COURT, FORMER FORT ORD, CA, REVISION C (For Your Information Only)	N/A	31	SOP17		F		

REMARKS
cc: See Distribution List

CONTRACTOR QUALITY CONTROL SYSTEMS MANAGER
Shaw Environmental, Inc.

___✓___ Approved
_____ Approved with corrections as noted on submittal data and/or attached sheet(s).

SIGNATURE: Signature on File
TITLE: CONTRACTOR QUALITY CONTROL SYSTEM MANAGER

I certify that the above submitted items have been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated.

Shaw Environmental, Inc.

Signature on File /PETER KELSALL
NAME AND SIGNATURE OF CONTRACTOR

Section II - APPROVAL ACTION

ENCLOSURES RETURNED (List by Item No.)	NAME, TITLE AND SIGNATURE OF APPROVING AUTHORITY	DATE

Shaw Environmental, Inc.

DOCUMENT REVIEW AND RELEASE FORM

Client: USACE	Authors: Shaw	Submittal Register Item No.: 006	Date: May 19, 2004

Document Title:	Draft Report, March 2004 Indoor Air Sampling, Lexington Court, Former Fort Ord, California	Revision: C	T.O. # 011	WAD# 12

Reviewer (*print*)	Reviewer Initial & Date	Technical	Project Manager	CQC	Health and Safety Manager	Task Manager	Chemistry	UXO	Construction	Reviewer Comments Resolved (*Signature & Date*)
Peter Kelsall			X							Signature on File
Tom Ghigliotto				X						Signature on File
Eric Schmidt							X			Signature on File
Same as Technical Reviewer above		X	Topic outline with objectives for each section submitted prior to Rev. A							

Program Reviewer's Acceptance for Document Submittal	Signature	Yes	No
1) A 4025 (as applicable) prepared and submitted with document?	Signature on File	X	
2) Technical Conclusions adequately supported by text and data?	Signature on File	X	
3) Tables and Figures are in the proper format and checked and approved?	Signature on File	X	
4) The Table of Contents consistent with text information?	Signature on File	X	
5) Technical Reviewers are qualified and accepted by Project Manager?	Signature on File	X	
6) A document Distribution List been prepared and submitted with document?	Signature on File	X	

Recommended
4025 Code A

Signature on File
Project Manager

Signature on File
Contractor Quality Control Systems Manager

FORT ORD

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1		Dave Eisen	Department of the Army, USACE	BRAC, Bldg. #4463 Gigling Road	Monterey, CA	93944-5004	Yes
1		Fred Hart	Department of the Army, USACE	1325 "J" Street	Sacramento, CA	95814-2922	Yes
1		Glen Mitchell	Department of the Army, USACE	1325 "J" Street	Sacramento, CA	95814-2922	Yes
	1	Marc Edwards	Department of the Army, USACE	Project Office	Presidio of Monterey, CA	95814-2922	Yes
1		Gail Youngblood	DENR	BRAC, Bldg. #4463 Gigling Road	Monterey, CA	93944-5004	Yes
1		Derek Lieberman	Department of the Army	BRAC, Bldg. #4463 Gigling Road	Monterey, CA	93944-5004	Yes
1	1	Peter Kelsall	Shaw Environmental, Inc.	9201 East Dry Creek Road	Centennial, CO	80112	Yes
	1	Jen Moser/ Tom Ghigliotto/ Eric Schmidt	Shaw Environmental, Inc.	PO Box 1698	Marina, CA	93933	Yes
1		Ed Ticken	Mactec	5341 Old Redwood Hwy; Suite 300	Petaluma, CA	94954	Yes
1		Genevieve DiMundo	Mactec	5341 Old Redwood Hwy; Suite 300	Petaluma, CA	94954	Yes
	1	John Christopher	California Department of Toxic Substances Control	8800 California Center Drive	Sacramento, CA	95826	Yes
	1	Roman Racca	California Department of Toxic Substances Control	8800 California Center Drive	Sacramento, CA	95826	Yes
	1	Grant Himebaugh	California Regional Water Quality Control Board	81 Higuera Street, Suite 200	San Luis Obispo, CA	93401-5414	Yes
	1	Jeff Raines	Tech Law, Inc.	90 New Montgomery Street; Suite 1010	San Francisco, CA	94105	Yes
1	1	Claire Trombadore	U.S. Environmental Protection Agency	75 Hawthorne Street, Mail SFD-8-3	San Francisco, CA	94105	Yes

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	1	Sandy Reese	Administrative Records	BRAC, Bldg #4463 Gigling Road	Monterey, CA	93944-5004	Yes
	1	Peter deFur	TAG Consultant	11223 Fox Meadow Drive	Richmond, VA	23233	Yes
	1	Lance Houston		PO Box 2177	Seaside, CA	93955	Yes
	1	LeVonne Stone	Environmental Justice Network	P.O. Box 361	Marina, CA	93933	Yes
	1	Christine Bettencourt	Temple Health/Life 2000	PO Box 1852	Greenfield, CA	93921	Yes
1		Curt Gandy	Fort Ord Toxics Project	PO Box 1904	Monterey, CA	93942	Yes
	1	Mike Weaver		52 Corral De Tierra Road	Salinas, CA	93908	Yes
	1	Nat Rojanasathira		802 Sunset Drive; Apt G	Pacific Grove, CA	93950	Yes
	1	Project File	Shaw Environmental, Inc.	PO Box 1698	Marina, CA	93933	Yes
1		Program File (Kathy Grider)	Shaw Environmental, Inc.	4005 Port Chicago Highway	Concord, CA	94520-1120	Yes

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Approved: Signature on File
Glen Mitchell, USACE
Project Manager