KELLY AFB
TEXAS

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 3220.20

DEPARTMENT OF THE AIR FORCE
AIR FORCE REAL PROPERTY AGENCY

MAY 0 2 2007

AFRPA/COO-Kelly
143 Billy Mitchell Blvd Ste 1
San Antonio TX 78226-1816

Dear Kelly Restoration Advisory Board Members and Public Participants

The following is an action items report for the 10 April 2007 Kelly Restoration Advisory Board (RAB) meeting.

1. Ms. Esmeralda Camacho, public participant, requested a map be provided to her of the Kelly area plume boundaries depicting street names.

Ms. Camacho was mailed copies of both PCE and TCE plume maps depicting street names Monday, 23 April 2007. These maps are attached.

2. Mr. Lenny Siegel with the Center for Public Environmental Oversight requested AFRPA provide him with electronic links to documents in the online Administrative Record to assist him in locating areas of high contamination levels within the Kelly plume boundaries. Additionally, Mr. Mark Weegar suggested AFRPA assist Mr. Siegel in locating documents related to previous air monitoring studies already conducted in conjunction with the former Kelly AFB cleanup program.

Mr. Siegel was emailed the following information 11 April 2007.

- The initial study "Informal Technical Information Report, Zone 4 OU-2 and S-4 Soil Vapor Monitoring, March 2000" - AR Number 1738. EPA comments on this report are located at AR File 1978, Dec 2000, and the TCEQ comments are found in AR File 2150, Nov 2001. Links to these documents are as follows:
  https://afrpaar.afrpa.pentagon.af.mil/ar/getdoc.aspx?file=KELLY_AR_1738.pdf
  https://afrpaar.afrpa.pentagon.af.mil/ar/getdoc.aspx?file=KELLY_AR_1978.pdf
  https://afrpaar.afrpa.pentagon.af.mil/ar/getdoc.aspx?file=KELLY_AR_2150.pdf

- The sub slab study (Zone 4 Sub-Slab Soil Sampling, Mar 2004) - AR 2295.
  https://afrpaar.afrpa.pentagon.af.mil/ar/getdoc.aspx?file=KELLY_AR_2295.pdf

- "Kelly ITIR Seasonal Variance Zone 4, May 2005" (Provided as an email attachment to Mr. Siegel and included as a hard copy attachment to this action item report)

- Corrective Measures Zone 2 & 3 - Appendix E
  https://afrpaar.afrpa.pentagon.af.mil/ar/getdoc.aspx?file=KELLY_AR_2741.pdf

- PCEH Sub Slab Report – See the website below:

http://www.sanantonio.gov/health/PCEH/projects.asp

3. *Mr. Robert Silvas, public participant, provided AFRPA staff documents related to agent orange, and requested copies be provided to Kelly RAB members.*

The documents provided discuss the storage of agent orange at the Texas Building and Procurement Division, 2103 Ackerman Road, San Antonio, TX 78219-3017, and accusations of the illegal sale of agent orange to a facility in Louisiana. The environmental cleanup program at the former Kelly AFB is within full compliance of state and federal environmental regulations. The subject matter discussed in these documents is outside the scope of the Kelly Restoration Advisory Board. Therefore, the Kelly RAB is not the appropriate venue to discuss this topic. These documents have been returned to Mr. Silvas.

4. *Mr. Nazirite Perez asked to be provided with information specific to the completion of off-base cleanup.*

Based on discussions at this meeting, the next Kelly RAB meeting will discuss off-base cleanup systems and how they are working.

5. *Mr. Rodrigo Garcia requested RAB members be provided an executive summary of the January 2007 Semiannual Compliance Plan Report, which was briefed at the 10 April 2007 RAB meeting. Additionally, Mr. Garcia requested information in layman's terms be provided at the upcoming meeting on the topic of vapor intrusion.*

The executive summary from the January 2007 Semiannual Compliance Plan Report is attached. The entire report can also be found in the online Administrative Record (AR) at: https://afrpaar.afrpa.pentagon.af.mil/ar/docsearch.aspx under Kelly AR # 3198.

Additionally, vapor intrusion will be added to the agenda for the next meeting.

6. *Mr. Brian Skrobarcek asked for future meetings to remain on task and on schedule, and focus on agenda topics.*

The facilitator will make every effort to keep upcoming meetings on schedule and on topic.

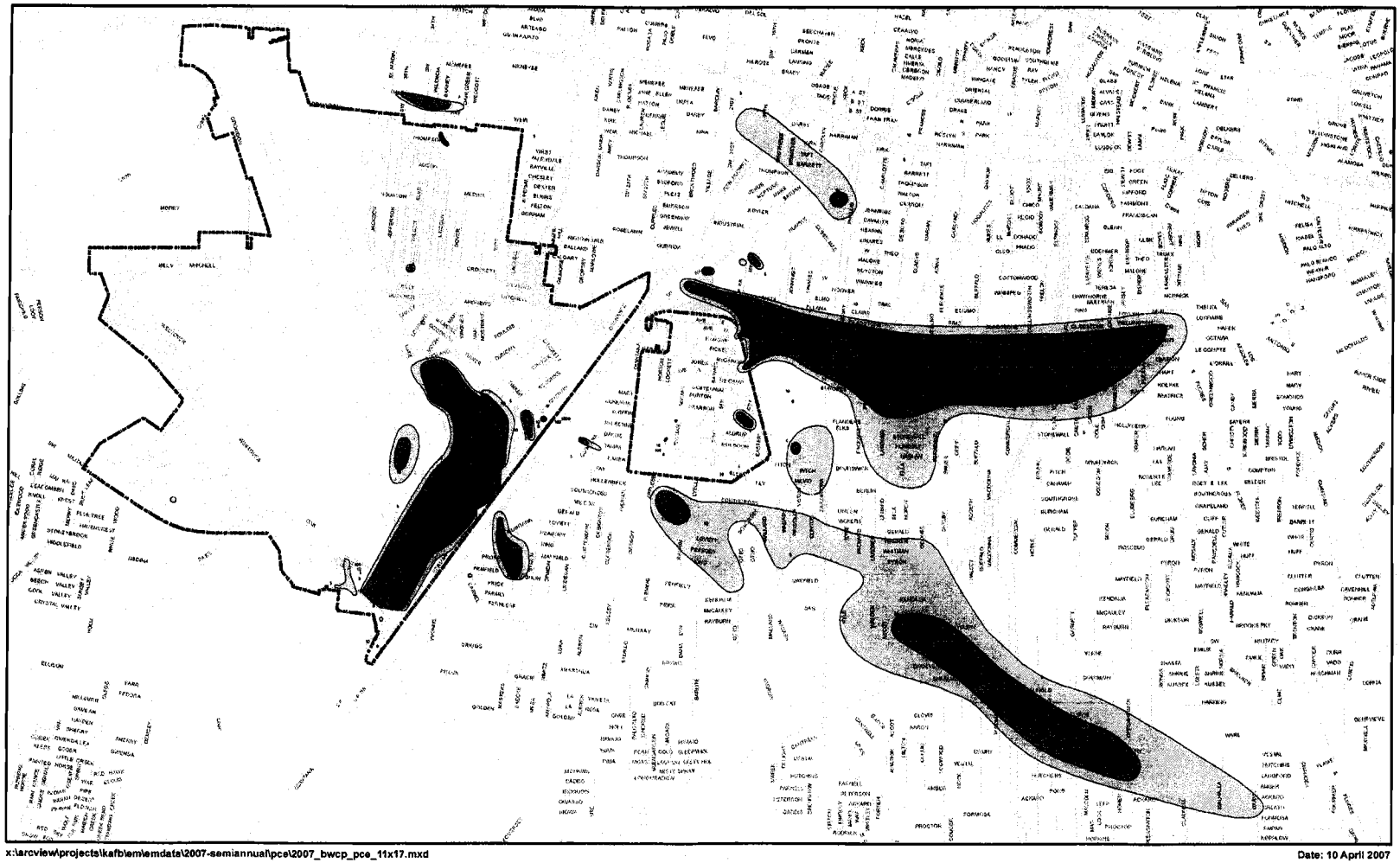
Thank you for your continued interest in the Kelly environmental restoration program.

Sincerely

ADAM G. ANTWINE
Senior Representative

Attachments:
1. 2007 (2006 data) PCE/TCE Plume maps w/street names
2. Kelly ITIR Seasonal Variance Zone 4, May 2005
3. Executive Summary – January 2007 Semiannual Compliance Plan Report

2007 PCE Basewide Compliance Plan (2006 Well Sample Data)



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Date: 10 April 2007

Legend

- 5 parts per billion
- 10 parts per billion
- 100 parts per billion
- 1000 parts per billion

0 1,300 2,600 5,200 Feet

Air Force
Real Property Agency
Former Kelly AFB, Texas

N W E S

2007 TCE Basewide Compliance Plan (2006 Well Sample Data)

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Date: 10 April 2007

Legend

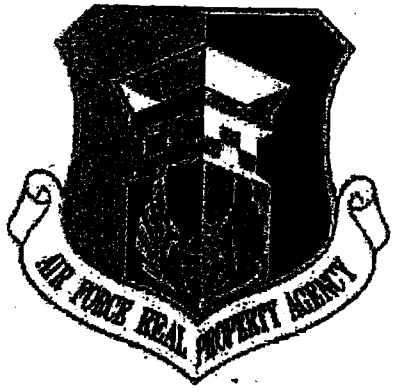
- 5 parts per billion
- 10 parts per billion
- 100 parts per billion
- 1000 parts per billion
- 10000 parts per billion

0 1,500 3,000 6,000 Feet

Air Force
Real Property Agency
Former Kelly AFB, Texas

N W E S

Informal Technical Information Report (ITIR)
Zone 4 OU-2 Assessment of Seasonal Variation of Soil Vapor Data



Air Force Real Property Agency
at the former
Kelly Air Force Base

May 2005

DEPARTMENT OF THE AIR FORCE
AIR FORCE REAL PROPERTY AGENCY
Certified Mail: 7004 2890 0002 6411 6749

AFRPA/DK
143 Billy Mitchell Blvd., Suite 1
San Antonio, Texas 78226

10 May 2005

Mr Mark Weegar
Corrective Action Section
Remediation Division
TCEQ
P.O. Box 13087, (MC 127)
Austin, TX 78711-3087

RE: EPA ID No. TX 2571724333; Industrial Waste Registration No. 31750
Zone 4 OU-2 Assessment of Seasonal Variation of Soil Vapor Data
Zone 4

Dear Mr Weegar,

Two copies of the Zone 4 OU-2 Assessment of Seasonal Variation of Soil Vapor Data are being submitted for comment and approval. The purpose of the report is to present an analysis of seasonally dependent factors of the migration of vapor phase volatile organic compounds.

Please feel free to Mr Walter Peck at (210) 925-3100 ext. 206 if you have any questions.

Sincerely

DONALD BUELTER
Chief, Environmental Restoration

Attachment:
Zone 4 OU-2 Assessment of Seasonal Variation of Soil Vapor Data

cc: US EPA, (G. Miller)
TCEQ, Region 13 (A. Power)
CoSA, (David Newman)
PCEH, (Kyle Cunningham)

Informal Technical Information Report (ITIR)
Zone 4 OU-2 Assessment of Seasonal Variation of Soil Vapor Data
May 2005

I. Introduction and Background

The purpose of this ITIR is to present an analysis of the affect of seasonally dependent factors on the migration of vapor phase volatile organic compounds (VOCs) from groundwater to the ground surface in the vicinity of Installation Restoration Program (IRP) Zone 4 at the former Kelly Air Force Base (AFB). Data were collected specifically for this ITIR during April and September/October 2002. The data collection was specifically designed to evaluate the potential for seasonal variation of vapor migration and the associated risk.

The Air Force Real Property Agency Division C-Kelly (AFRPA) has conducted previous sampling activities and studies of the vapor intrusion pathway to address community concerns relating to the possible transport of volatile groundwater contaminants to indoor air. The previous sampling activities include groundwater and soil gas sampling in March 2000 and sub-slab soil gas sampling and analysis in 2003. The 2000 data is documented in the *Informal Technical Information Report Zone 4 OU-2 and Site S-4 Soil Vapor Monitoring* by CH2MHill, dated March 2000 and the 2003 data are documented in *Technical Memorandum Zone 4 Sub-Slab Soil Gas Sampling* by CH2MHill, dated 2004.

Soil vapor wells were initially installed and sampled in 2000 at locations where potential risk from vapor intrusion was estimated to be the highest based on the groundwater monitoring data and the most sensitive parameters defined by the 1999 version of the Johnson and Ettinger (J&E) Model. Consequently soil vapor wells were co-located with groundwater monitoring wells exhibiting the highest concentrations of VOCs in groundwater. Other required model parameters such as depth and thickness of the affected zone were also considered during placement of the vapor wells.

The 2000 CH2MHILL ITIR concluded indoor air inhalation risks to be below the acceptable threshold of 10^{-6}. However, in an effort to identify the effects of seasonal variation in the vapor intrusion pathway, select soil vapor wells and their associated groundwater monitoring wells (**Figure 1**) were sampled again in April and October/September 2002.

II. Parameters with Seasonal Variation that May Impact Vapor Migration

The following parameters were identified as being sensitive to seasonal variation: temperature; water-filled porosity in the capillary and unsaturated zones (soil moisture content); and vertical distance for diffusive transport (USEPA, 2003).

Temperature change has an effect on soil vapor concentrations just above the groundwater source area, since vapor pressure and water solubility are temperature dependent. However, temperature variations decrease with depth in the soil column and are unlikely to have a large influence on concentrations at five feet below grade or greater (LUSTLine, October 2002). This is evidenced by the relatively small range of temperature variation in groundwater observed between the two sampling events in 2002 **(Table 1).** Although the maximum variation in average air temperature between the summer and winter months can be quite significant, the groundwater temperature remains fairly constant, as evidenced by empirical data readily available and observed in samples collected during basewide groundwater sampling events. Additionally, the degree of attenuation through the unsaturated zone is not very sensitive to the change in Henry's Law Constant (HLC) due to temperature change (USEPA, 2003). The greater effect of temperature on concentrations of VOCs on indoor air is due to convective transport and is directly affected by changes in ventilation and heating/cooling systems in buildings during the summer and winter months.

Vapor migration is sensitive to soil moisture (USEPA, 2003). Soil moisture is seasonally dependent because it can change significantly after rainfall events. Soil moisture sampling is not routinely conducted during groundwater or soil gas sampling and was not conducted during the sampling events in 2002. However, since the J&E model uses an average value of soil moisture based on the site specific soil type, soil moisture is corrected in the model based on site specific conditions. The model corrects for soil moisture using conservative assumptions and satisfies the requirements of this ITIR.

A sensitivity analysis performed on the J&E model using Zone 4 parameters shows that depth to groundwater has a moderate impact on the predicted concentrations in indoor air (CH2MHill, 2000). Groundwater fluctuations in areas with the shallowest water table affect the fluctuation in soil vapor concentrations more than any other seasonally dependent factor, with a rise in the water table corresponding to a rise in soil vapor concentrations. Water table depths rose from 1.53 ft to 5.16 ft between the April and October 2002 sampling events **(Table 1).**

III. Soil Gas and Groundwater Sampling and Analysis

Soil gas and groundwater samples were collected and analyzed at the former Kelly AFB following the methodology outlined in the 2000 ITIR Report (CH2MHill, 2000). Tetrachloroethylene (PCE) and trichloroethylene (TCE) were identified as the constituents of concern (COCs) during the 2002 sampling effort (**Table 2**). Cis-1,2-dichloroethylene (DCE) and vinyl chloride (VC) were excluded from further analysis in 2002 due to their very low or nondetections in soil gas (**Table 2**).

IV. Analysis of Sampling Data and Respective Attenuation Factors

The analytical data for groundwater and soil gas collected in 2002 at individual sampling locations are included in **Table 3** for PCE and **Table 4** for TCE. The data in the tables show an increase in soil vapor concentrations for PCE and TCE at seven out of nine locations from April 2002 to October 2002. Groundwater VOC concentrations measured in 2002 were generally lower than values measured and reported in 2000. **Table 2** lists the maximum concentrations observed during the 2000 as well as 2002 sampling events. Groundwater VOC concentrations continue to decrease throughout Zone 4. The tables also show that changes in soil gas concentration 5 feet below ground surface (bgs) are not consistent with the changes in groundwater concentrations.

Direct comparison of measured soil gas concentrations does not provide an accurate assessment of the effect of seasonal variation on vapor migration if the variation of COC concentrations in groundwater is not accounted for as well. Changes in groundwater concentrations for PCE and TCE were eliminated from concern by calculating the attenuation factor (defined below) and comparing the change in attenuation factors over two seasons to changes in other seasonally affected parameters as defined in **Section II** of this ITIR.

The attenuation factor is a measure of the potential for vapor transport between two measuring points. For the purposes of this investigation, the attenuation factor is a measure of the degree of attenuation of the soil vapor from the source to a direct measuring point within the unsaturated zone 5 feet bgs. The attenuation factor represents the degree of attenuation of soil vapor as it migrated from just above the water table through the capillary fringe and unsaturated zone to the soil vapor sampling point 5 ft bgs. The attenuation factor is a function of the physical and chemical properties of the contaminants,

subsurface geotechnical properties, and biodegradation. Biodegradation is typically not significant for chlorinated solvents in the unsaturated zone.

The attenuation factor is calculated as the ratio of the concentration of contaminant in air at 5 feet bgs to the concentration of contaminant in air just above the water table. The variation of the calculated attenuation factor at a given location between two sampling periods is used as a measure of the impact of seasonal variation in vapor transport within the subsurface during the two sampling periods. The variation in the degree of attenuation provides an assessment of seasonally dependent variations in soil gas migration through the capillary and unsaturated zones irrespective of changes in groundwater concentrations for the constituents of concern.

The attenuation factor as defined in this ITIR does not reflect seasonal variation in vapor transport from the subsurface into overlying buildings through convective transport. Vapor transport from the subsurface into overlying buildings was addressed in a previous document (CH2MHILL, 2004).

The depths to water table during the two sampling events in 2002, which reflects the length of diffusive transport between the two measuring points, are shown in **Table 1**. The degree of attenuation through the unsaturated zone is not very sensitive to the change in the HLC due to temperature change, even with a fairly large change in temperature (USEPA, 2003).

Tables 3 and 4 include attenuation factors at locations with detectable concentrations of VOCs.

The concentration of soil vapor above the water table partitioning from dissolved phase groundwater in the absence of any free product was calculated using the equation

$$C_{source} = HLC * C_{gw} * 1000.$$

Where

C_{source}= soil gas concentration above water table in $\mu g/m^3$

C_{gw}=groundwater concentration in $\mu g/L$

HLC=dimensionless Henry's Law constant (HLC)

1000=unit conversion factor (L to m^3)

In order to capture the effect of temperature variation between the two sampling events, the groundwater temperature measured in the monitoring wells in April and October 2002 were used to calculate the HLC for PCE and TCE

during the two sampling events. The temperature measurements and depth to static water level taken during the two groundwater sampling events are presented in Table 1. Values of HLC as a function of temperature were calculated using USEPA's online calculator available at

http://www.epa.gov/athens/learn2model/part-two/onsite/esthenry.htm .

The source vapor concentration was converted from $\mu g/m^3$ to parts per billion by volume (ppbv).

Finally, the attenuation factor was calculated as the ratio of soil vapor measured at 5 ft bgs and calculated soil vapor concentrations from just above the water table. The calculated attenuation factors for PCE and TCE are included in **Tables 3 and 4** respectively. Detailed equations for diffusive transport of soil vapor can be found in the user's manual for J&E model (USEPA, 2003).

V. Risk-Based Screening

The soil vapor and groundwater concentration data collected in 2000 were screened for possible adverse impact to indoor air. The groundwater and soil vapor screening values were revised in 2001 using the updated J&E model released in 2001 and assuming more conservative soil type (more permeable) in the unsaturated zone. The maximum measured soil vapor and groundwater concentrations in 2002, along with the screening values established using the J&E Model, are listed in **Table 5**. The methodology and assumptions used in developing the screening values and the results were presented at the Former Kelly AFB BRAC Cleanup Team (BCT) meeting on December 12, 2001. All measurements in both soil gas and groundwater were below the screening levels established in 2001. The maximum measured concentrations in both soil gas and groundwater for both PCE and TCE were at least an order of magnitude below the screening level corresponding to a 10^{-6} risk from inhalation of indoor air by residents.

VI. Results and Conclusions

Figures 2 and 3 graphically show the attenuation factors for PCE and TCE at the vapor monitoring wells during the two sampling events. The results show that for PCE, out of the five locations where the attenuation factor could be calculated during both sampling events, the attenuation factor was higher in April at two locations and was higher at the remaining three locations in October. Of all the locations included in the analysis, the water table was the shallowest at location SS052MW213/SS052MW288. Although the attenuation factor was impacted the most at location SS052MW213/SS052MW288, boring

and completion logs for monitoring well SS052MW213 are indicative of a semi-confined aquifer. Therefore, the increase in separation of the attenuation factor (Figure 2) may be related to some aquifer leakage caused by groundwater head pressure or some other relationship of lithology and aquifer pressure. In other words the attenuation separation is not caused by the shallow potentiometric surface of what is essentially an aquifer confined to a much greater depth than the peisometeric surface of 6 feet bgs. The variation of the attenuation factor at the other locations is not significant and can not be attributed to any one parameter or combination of parameters.

The data at SS052MW526/SS052MW214 show the attenuation factor to be closer to or greater than one which indicates the possibility of additional sources of VOCs in soil or highly permeable soils in the unsaturated zone. The soil boring log for SS052MW214 shows the location to have layers of gravel and clayey gravel soil in the unsaturated zone that likely contribute to the increased vapor migration. The analysis of the attenuation factors for TCE was less robust, since for TCE, data limitations restricted calculation of attenuation factors to two locations. The variations at these two locations however are consistent with the data for PCE.

As expected, the variation in temperature is fairly small below five feet from ground surface, and the effect of temperature change on vapor transport is not significant. Even with a rise of the water table, a significant increase in attenuation factor, defined as increase of an order of magnitude or higher, was only observed at location SS052MW213. At that location, the interaction between the complex lithology and the greater head pressure is causing a greater than expected change in the attenuation factor.

In conclusion, the results and analyses show that there is no consistent pattern of seasonal variation in the degree of vapor transport within the unsaturated zone in Zone 4 of the former Kelly AFB. This observation is consistent with published studies (USEPA, 2002) that have established that seasonal variation in indoor air concentrations of volatile contaminants originating from subsurface sources are due to variation in building air exchange rates that vary widely by season and climatic region, rather than seasonal changes in subsurface conditions that impact vapor intrusion to indoor air.

VII. References

CH2MHill, March 2000. Informal Technical Information Report Zone 4 OU-2 and Site S-4 Soil Vapor Monitoring.

CH2MHill, 2004. Technical Memorandum Zone 4 Sub-Slab Soil Gas Sampling.

LUSTline Bulletin 42, October 2002. How to Collect Reliable Soil-Gas Data for Risk-based Applications.

USEPA, 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils.

USEPA, 2003. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings.

Table 1. Depth to Groundwater and Water Temperature in April and October 2002

Monitoring Well Location	Date Measured	Water Temp. (°C)	Static Water Depth (ft)	Rise in Water Table (ft)
SS037MW079	15-Apr-02	23.94	18.13	1.53
SS037MW079	17-Oct-02	25.13	16.6	
SS040MW041	15-Apr-02	23.92	24.4	5.16
SS040MW041	17-Oct-02	23.86	19.24	
SS052MW213	11-Apr-02	23.22	9.44	3.09
SS052MW213	17-Oct-02	25.94	6.35	
SS052MW214	10-Apr-02	23.97	15.57	3.76
SS052MW214	17-Oct-02	26.41	11.81	
SS052MW314	08-Apr-02	26.24	26.45	2.1
SS052MW314	17-Oct-02	25.4	24.35	
SS052MW200	23-Apr-02	25.15	19	3.98
SS052MW200	17-Oct-02	25.14	15.02	

Table 2. Maximum Detected Soil Gas and Groundwater Concentrations

	Groundwater (µg/L)			Soil Gas (ppbv)		
Vapor Well ID	March 2000	April 2002	October 2002	March 2000	April 2002	September 2002
PCE	134	33.4	43.6	2100	1610	2050
TCE	90	90.1	74	115	8.6	41.5
Cis-1,2-DCE	225	86.8	118	86.7	ND	1.5
VC	4.12	1.9	1.04	ND	ND	ND

µg/L=micrograms per liter

ppbv=parts per billion by volume

Table 3. Analysis of Groundwater and Soil Gas Data for PCE, April and September/October 2002

		April 2002				September/October 2002			
Vapor Well ID	Monitoring Well ID	Soil Gas at 5 ft bgs (Rppbv)	Groundwater (µg/L)	Equivalent Soil Gas at Water Table (ppbv)	Attenuation Factor	Soil Gas at 5 ft bgs (ppbv)	Groundwater (µg/L)	Equivalent Soil Gas at Water Table (ppbv)	Attenuation Factor
SS037MW193	SS037MW079	295	33.4	3570	8.3E-2	343	25.3	2830	1.2E-1
SS040MW044	SS040MW041	3.7	14.4	1542	2.4E-3	47.9	30.7	3420	1.4E-2
SS052MW284	SS052MW629	1610	NS	-	-	2050	43.6	4859	4.2E-1
SS052MW287	SS052MW200	ND	0.24	25	-	57	8.8	985	5.8E-2
SS052MW365	SS052MW314	54	21.8	2330	2.3E-2	27	24.4	2732	9.9E-3
SS052MW363 (SS037MW195)	SS037MW128	29.4	NS	-	-	67.2	NS	-	-
SS052MW288	SS052MW213	1.6	1(ND)	107	1.5E-2	47.6	1 (ND)	112	4.2E-1
SS052MW526	SS052MW214	1430	8.11	867	1.6E+0	458	4.99	561	8.2E-1
SS052MW364	SS052MW591	34.7	NS	-	-	96.9	25.4	2847	3.4E-2

µg/L=micrograms per liter ppbv=parts per billion by volume

NS: Not Sampled ND: Non Detect

An empty (dashed) box is indicative of a value that could not be calculated.

Table 4. Analysis of Groundwater and Soil Gas Data for TCE, April and September/October 2002

Vapor Well ID	Monitoring Well ID	April 2002				September/October 2002			
		Soil Gas at 5 ft bg (ppbv)	Ground Water (µg/L)	Equivalent Soil Gas at Water Table (ppbv)	Attenuation Factor	Soil Gas at 5 ft bg (ppbv)	Ground Water (µg/L)	Equivalent Soil Gas at Water Table (ppbv)	Attenuation Factor
SS037MW193	SS037MW079	5.8	90.1	6837	8.5E-4	4.3	27.5	2172	2.0E-3
SS040MW044	SS040MW041	ND	10.1	766	-	ND	20.9	1643	-
SS052MW284	SS052MW629	ND	NS	-	-	41.5	28.5	2242	1.9E-2
SS052MW287	SS052MW200	ND	0.2	15	-	1	35.2	2780	3.6E-4
SS052MW365	SS052MW314	2.8	85.2	6516	4.3E-4	ND	74	5850	-
SS052MW363 (SS037MW195)	SS037MW128	ND	NS	-	-	1.2	NS	-	-
SS052MW288	SS052MW213	ND	ND	-	-	ND	ND	-	-
SS052MW526	SS052MW214	8.6	10.2	774	1.1E-2	6.4	7.17	569	1.1E-2
SS052MW364	SS052MW591	ND	NS	-	-	1.4	20.4	1614	8.7E-4

NS: Not Sampled

ND: Non Detect

An empty (dashed) box is indicative of a value that could not be calculated.

Table 5. Risk-based Screening of Groundwater and Soil Gas Results

Chemical	Indoor Air Risk Level	Kelly Target Soil Gas Concentration 5 ft bgs (ppbv) 2001	Maximum Measured Soil Gas Conc. 5 ft bgs (ppbv)		Kelly Target Groundwater Conc (µg/L) 2001	Maximum Measured Groundwater Conc. (µg/L)	
			April 2002	September 2002		April 2002	October 2002
PCE	1×10^{-6}	14,000	1610	2050	662	33.4	43.6
TCE	1×10^{-6}	5,500	8.6	6.4	357	90.1	35.2

µg/L=micrograms per liter

ppbv=parts per billion by volume

bgs = below ground surface

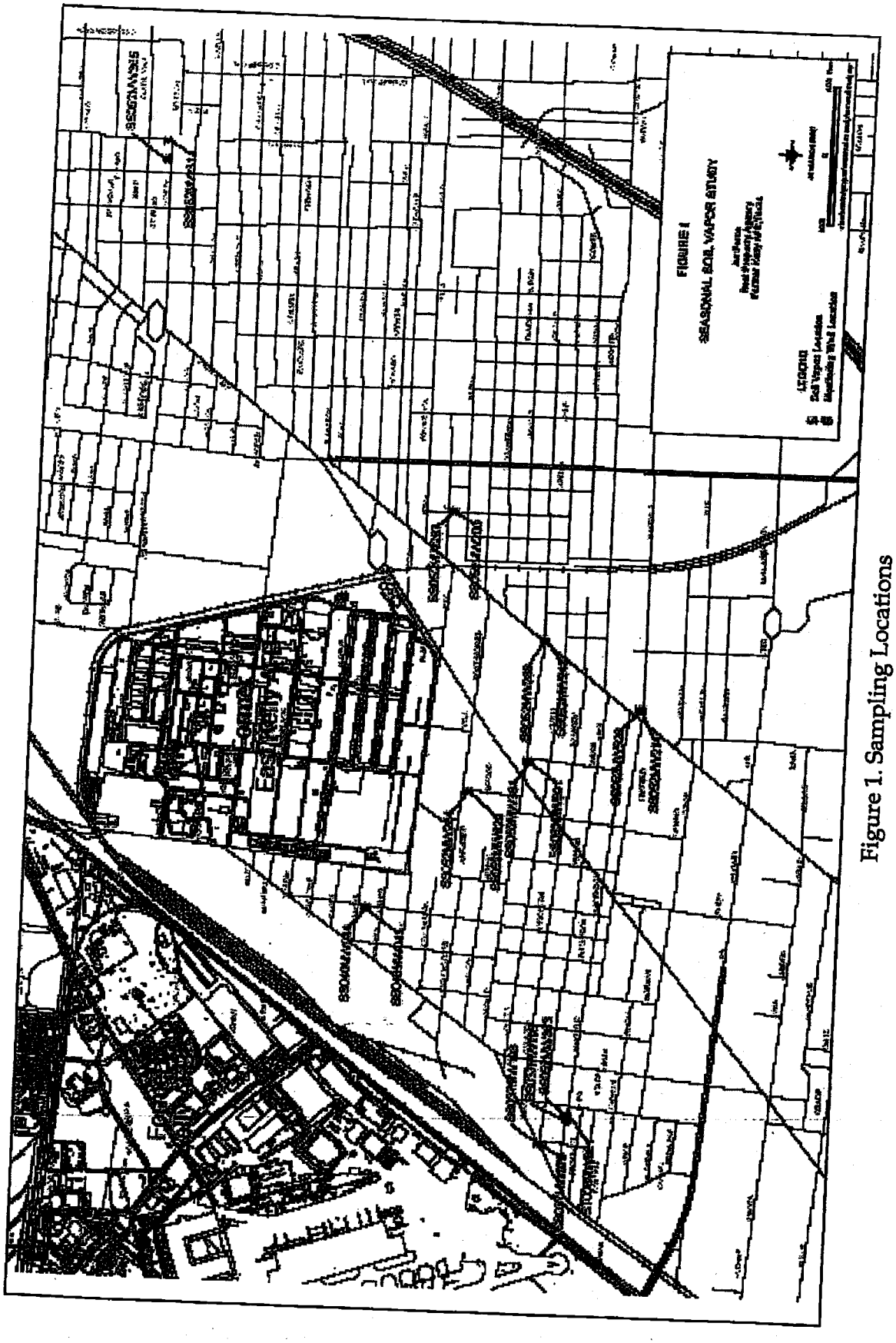


Figure 1. Sampling Locations

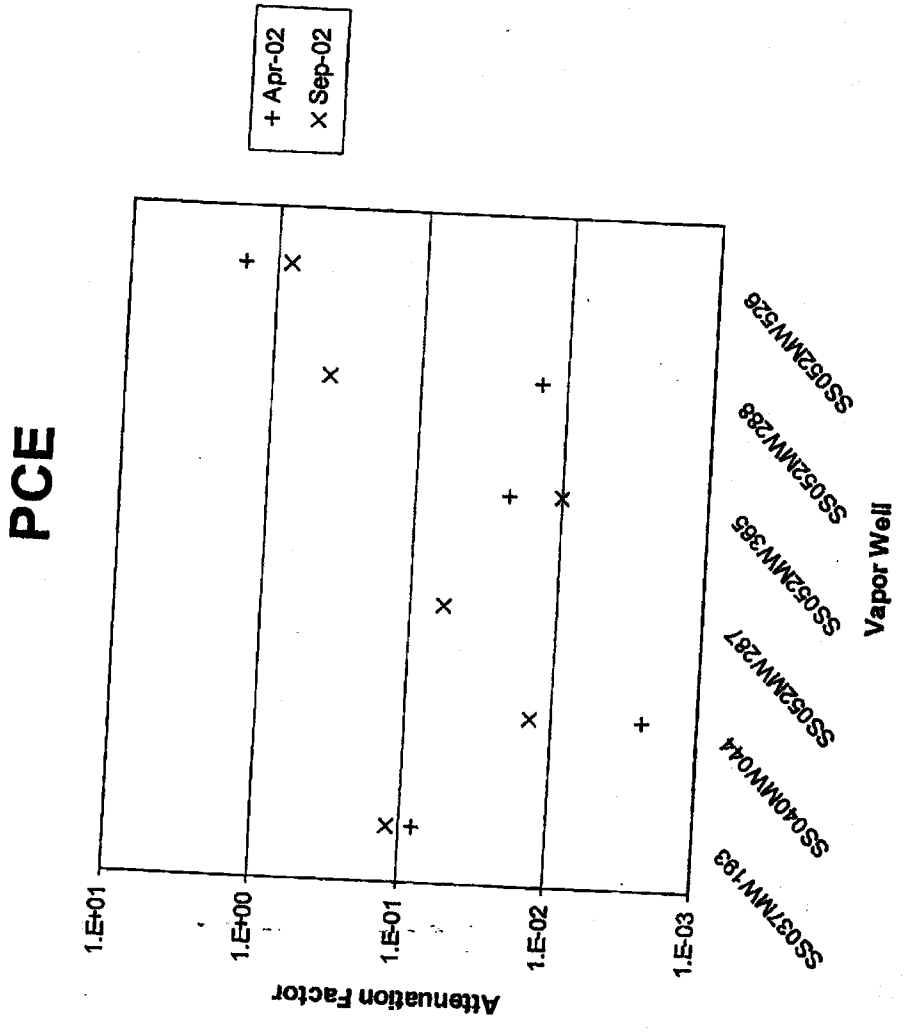


Figure 2. Soil Vapor Attenuation of PCE

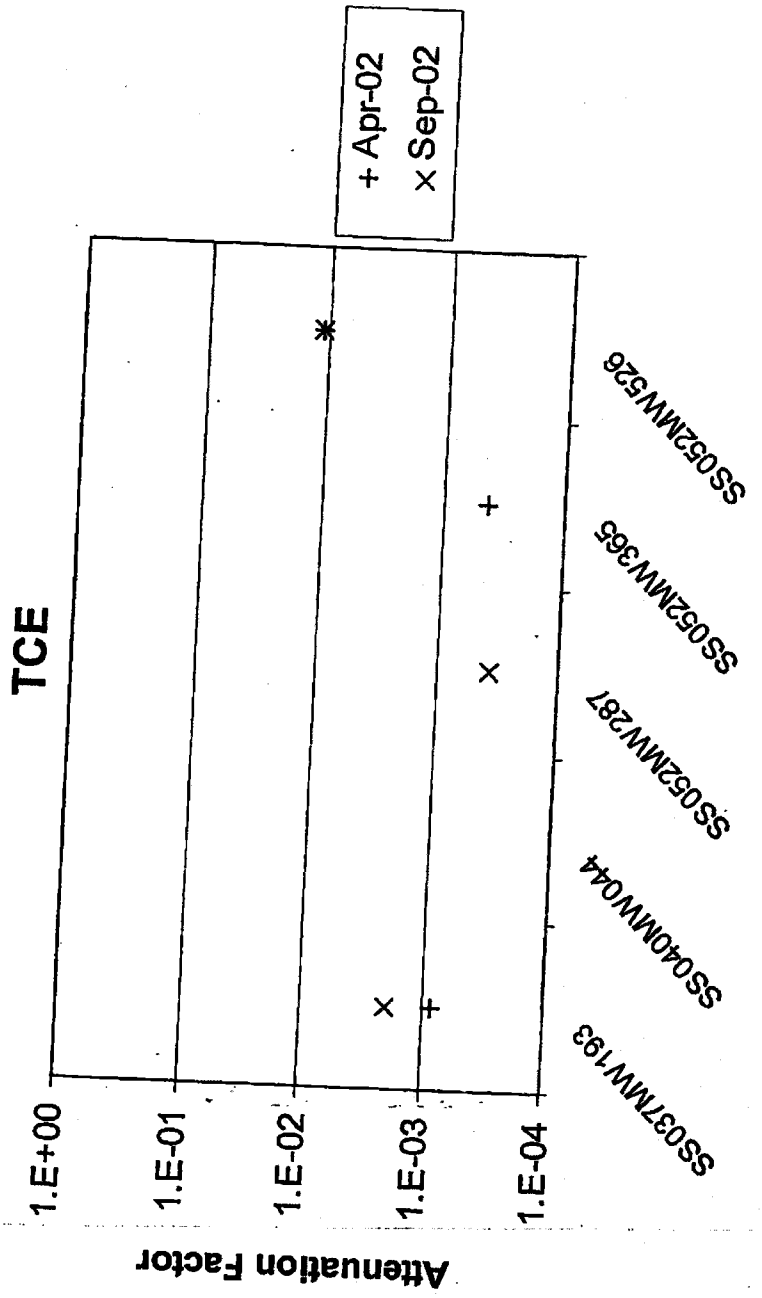


Figure 3. Soil Vapor Attenuation of TCE

EXECUTIVE SUMMARY
SEMIANNUAL COMPLIANCE PLAN REPORT
JULY THROUGH DECEMBER 2006
FORMER KELLY AIR FORCE BASE
SAN ANTONIO, TEXAS

This report meets the requirements of Compliance Plan Number CP-50310 and Permit Number HW-50310 (Texas Natural Resource Conservation Commission [TNRCC], 1998), which were finalized and issued by the Texas Commission on Environmental Quality (TCEQ) (formerly the TNRCC) on June 12, 1998 and subsequently modified. The Compliance Plan and Permit require the former Kelly AFB to conduct Corrective Action and Groundwater Monitoring programs to address basewide groundwater contamination in the uppermost (alluvial) aquifer. The Compliance Plan and Permit also require the former Kelly AFB to close four Resource Conservation and Recovery Act (RCRA)-regulated units (Sites E-3, SD-1, SA-2, and S-8) and investigate Solid Waste Management Units (SWMUs) under applicable regulatory programs.

This report summarizes: (1) the July 2006 field and laboratory data associated with sampling at the two RCRA-regulated sites; (2) the July and August 2006 field and laboratory data associated with sampling along Leon Creek; (3) the April through July 2006 basewide groundwater sampling data; and (4) an evaluation of ongoing groundwater Corrective Action Programs (CAPs) at the two RCRA-regulated units and SWMUs with environmental concerns to determine if the CAPs have attained specified groundwater protection standards (GWPS) listed in the Compliance Plan.

The former Kelly AFB has historically been subdivided into five groundwater zones (Zones 1 through 5), with report organization by zone. Submittal of Compliance Plan Modifications for Zones 2, 3, 4 and 5 redefined discrete contamination areas and associated remediation activities resulting in the reorganization of the former base into 11 Waste Management Areas (WMAs). SWMUs within Zone 1 have not been reorganized into WMAs at this time, and will continue to be associated with Zone 1.

GROUNDWATER GAUGING

Groundwater sampling and gauging are associated with a relatively shallow groundwater aquifer located within native alluvial sediments and man-made fill materials beneath the site. The April through July 2006 groundwater gauging and sampling activities included: (1) measurement of the depth to groundwater in monitoring wells and actively pumping groundwater recovery wells located across the base and in immediately adjacent off-base areas; (2) visual inspection of the condition of gauged groundwater wells; and (3) where sufficient data were available, development of RCRA or SWMU site-specific groundwater potentiometric maps showing the general direction of groundwater flow.

Groundwater in the main portion of the former base generally flows towards Leon Creek, located along the west side of the former base and crossing through the southwest corner of the former base. Groundwater along the eastern side of the former base and in the vicinity of Zone 4

generally flows toward Six Mile Creek, located southeast of Zone 4. These observed flow directions are similar to previous years.

Groundwater gradients are used to estimate the rate at which groundwater moves through the subsurface. Based on the March through April 2006 groundwater gauging activity (discussed in further detail in the July 2006 Semiannual Compliance Plan Report), groundwater gradients on former Kelly AFB varied from 0.001 feet per foot (ft/ft) to 0.227 ft/ft. The steepest groundwater gradient was located in the southwest portion of the former base, south of Leon Creek.

In general, depths to groundwater in March and April 2006 ranged from less than one foot to 34.85 feet below the ground surface. The average depth to groundwater was 19.9 feet. In comparison, the average depth to groundwater in March 2005 was 15.5 feet below the ground surface. This 4.5-foot decrease in the average depth to groundwater reflects drought conditions experienced in the San Antonio area prior to and during the sampling period.

BASEWIDE WELL SAMPLING

Groundwater sampling was performed in accordance with the Compliance Plan to evaluate groundwater conditions in the shallow alluvial aquifer beneath the former Kelly AFB and off site areas adjacent to the former base. The following types of wells were sampled:

- Basewide groundwater monitoring wells (basewide list);
- Monitoring wells associated with the seven Permeable Reactive Barriers (PRB) (PRB well list);
- Recovery wells associated with active groundwater pump and treat systems (recovery well list); and
- Monitoring wells associated with the two RCRA sites (RCRA well list).

Evaluation of each site included: a comparison of the analytical data to determine, on a well-by-well basis, those chemicals that exceeded the GWPS; an evaluation of the groundwater gradient, velocity, and flow direction; how the hydrology at each site may affect contaminant migration; and a general evaluation of the effectiveness of any groundwater treatment or containment systems that may be present at each site. Key areas of concern were identified based on the data analysis, and are summarized below.

Zone 1: Zone 1 includes SWMUs D-1, D-2, D-3, D-4, D-5, D-6, D-7, D-9, CS-3 and SA-1. Interim groundwater recovery systems are present at Sites D-2, D-4, and D-5. A Corrective Measures Study for the Zone 1 sites is currently under development. Key areas of concern are identified below by site.

- **IRP Site D-1:** No issues were identified.
- **IRP Site D-2**: A groundwater plume consisting of trichloroethylene (TCE) and its associated degradation products total 1,2-dichloroethene (total 1,2-DCE) and vinyl chloride, appears to be migrating into the western portion of the site from the adjacent Lackland AFB.
- **IRP Site D-3:** No key areas of concern were identified.

- **IRP Site D-4:** The 2006 data suggest that some groundwater in the region between the remediation system and Leon Creek may escape capture and discharge into Leon Creek.
- **IRP Site D-5:** No key areas of concern were identified in the 2006 data.
- **IRP Site D-6:** No site-specific data were collected during the period covered by this report.
- **IRP Site D-7:** The northern edge of this site may be impacted by contaminants from Site D-9 or D-6 or from a source(s) within D-7 itself.
- **IRP Site D-9**: The sample from well KY032MW006 contained GWPS exceedances for a large number of chemicals, including 1,1,1-trichloroethane, 1,1,2-trichloroethene, 1,1-dichloroethene, 1,1-dichloroethane, 2,4-dichloropropane, acetone, arsenic, benzene, lead, nickel, p,p'-DDE, toluene, total 1,2-DCE, TCE, and vinyl chloride. Measured concentrations of four of these chemicals (1,1-DCA, 1,1-DCE, total 1,2-DCE and vinyl chloride) exceeded the corresponding GWPS by two to four orders of magnitude.
- **IRP Site CS-1:** No key areas of concern were identified.
- **IRP Site SA-1:** No site-specific data were collected during the period covered by this report.

Site E-3 WMA: The Site E-3 WMA is located in the northern portion of Zone 2 and includes RCRA Site E-3. Site E-3 contains a groundwater recovery system and a soil vapor extraction (SVE) system. One key area of concern was identified:

- Approximately two feet of dense non-aqueous phase liquid (DNAPL) was identified in Point of Compliance (POC) well WP022MW100. The trend graph for this well shows a relatively steady increase in benzene concentrations between July 2001 and July 2004, then stabilization in the benzene concentration between July 2004 and July 2005. The chlorobenzene concentration in this well has fluctuated since 2000. Based on the relatively low concentrations of other VOCs at this site, it is believed that the DNAPL may be associated with the chlorobenzene. Based on the current and historical non-detect results for benzene and chlorobenzene in the wells downgradient from well WP022MW100, recovery well WP022RW096 appears to be operating effectively as a boundary control recovery well.

600 Area WMA: The 600 Area WMA is located in the north-central portion of Zone 2 and includes Site IWTP. The IWTP Site contains three groundwater recovery wells located in the southern portion of the WMA. The Zone 2 groundwater treatment plant is located in the northern end of this WMA. Additional corrective actions within the 600 Area WMA consisted of vegetable oil injection near Building 621 for VOC degradation performed in 2006 and Hydrogen Releasing Compound (HRC) injection for chromium reduction in the southern portion of the WMA in 2004. Two key areas of concern were identified:

- **Building 621:** Vegetable oil was injected in the vicinity of Building 621 in 2006. This area is located near the current groundwater treatment plant in the northern portion of the 600 Area WMA. The purpose of the vegetable oil injection is to enhance the natural degradation of VOCs in groundwater. There has not been sufficient time between the 2006 injection and the 2006 annual groundwater sampling event to discern potential effects of the vegetable oil on the contaminant plumes in this area.

- **HRC Injection in the Southern 600 Area WMA:** In Fall 2004, HRC was injected at 42 locations in the vicinity of the northwestern end of the Zone 2 PRB and extending north and west into the southern portion of the 600 Area WMA. The purpose of the HRC injection was to reduce hexavalent chromium to its trivalent form. Two areas of total chromium were identified based on groundwater sampling. Wells SS002MW001 and SS002MW005, located in the southern portion of the 600 Area WMA and within the area of the HRC injection, reported total chromium concentrations of 2,680 µg/L and 113 µg/L, respectively. However, the turbidity at monitoring well SS002MW001 was recorded at 290 NTU; therefore, the sample collected from this well may not represent groundwater concentrations. The GWPS for total chromium is 100 µg/L. It is recommended that these wells continue to be sampled in the future to evaluate the effectiveness of the HRC injection.

Site E-1 WMA: The Site E-1 WMA is located in the southern portion of Zone 2 and includes Site E-1. Site E-1 contains a groundwater recovery system consisting of vertical groundwater recovery wells and a groundwater recovery trench with four standpipes. Historic soil excavation has been performed to remove source material from the site. One key area of concern was identified:

- Monitoring wells WP021MW011 and WP021MW038, which represent isolated TCE detections, are located downgradient of the groundwater recovery system. Based on their location, these wells should continue to be sampled in the future to evaluate the effectiveness of the recovery system.

300 Area WMA: The 300 Area WMA encompasses the majority of Zone 3 and crosses the southern portion of Zone 5 into the central portion of Zone 2. This WMA includes Site MP, which includes a slurry wall that surrounds the site and an associated groundwater recovery well system. Two PRBs are located in the WMA in the vicinity of Buildings 301 and 360; a slurry wall is associated with the Building 360 PRB. A third PRB and slurry wall system is located in Zone 2. Corrective action performed within the 300 Area WMA included vegetable oil injections at Buildings 522 and Building 331 in 2006 and the Building 360 basement area in 2005. Five key areas of concern were identified:

- **Well SS042MW123**, located north of the Zone 2 PRB, reported a total chromium concentration of 1,210 µg/L. Previous sampling at this location has not detected chromium in the groundwater and the current detection may be the result of the stainless steel casing within the monitoring well. It is recommended that this well continue to be sampled in the future.
- **Zone 2 PRB:** The PCE concentration in downgradient well SS042MW019 and both PCE and TCE concentrations in downgradient well SS042MW032 exceeded the corresponding GWPS values. The plume located on the downgradient side of the Zone 2 PRB appears to have been cut off from the upgradient portion of the plume when the PRB was installed and should continue to decrease in concentration. These wells should continue to be sampled in the future to evaluate the effectiveness of the PRB.
- **Seep KY030SP003:** A water sample from Seep KY030SP003, associated with the Leon Creek sampling activities, contained a PCE concentration of 6.9 µg/L, which exceeds the Texas Surface Water Quality Standard (TWQS) criteria of 5 µg/L for human health. Seep KY030SP003 is located south of the Zone 2 PRB in the southern portion of the 300

Area WMA. The PCE plume located on the downgradient side of the Zone 2 PRB appears to have been cut off from the upgradient portion of the plume when the PRB was installed and should continue to decrease in concentration. The reported concentration suggests contaminated groundwater associated with the PCE plume is discharging into Leon Creek at this location.

- **Seep KY030SP011:** A PCE concentration of 12.3 µg/L and a TCE concentration of 10.8 µg/L were reported in the water sample collected from Seep KY030SP011. These concentrations exceed the TWQS of 5 µg/L for human health for both PCE and TCE. Seep KY030SP011 is located downgradient from well WP021MW145, which is located south of the Zone 2 PRB. The groundwater sample from well WP021MW145 reported an exceedance of the PCE GWPS. It appears that PCE present in groundwater within the vicinity of this well is discharging to Leon Creek as indicated by analytical results of the seep sample.
- **Area between Sites MP and S-8:** Each of these sites, which are both located along the southeastern boundary of the 300 Area WMA, contain groundwater recovery systems to protect from off-site migration of groundwater plumes. Well SS037MW113 is located in the area between these two sites and their respective recovery systems. The 2006 analytical data did not identify any constituent concentrations in groundwater within this area. This well should continue to be sampled in the future to evaluate the continued effectiveness of the groundwater recovery systems at these two sites.

Site S-4 WMA: The Site S-4 WMA is located in the southeastern portion of Zone 3 and includes Site S-4. Site S-4 contains multiple on-site and off-site groundwater recovery trenches and an off-site impermeable barrier associated with a City of San Antonio culvert. No key areas of concern were identified.

Site S-8 WMA: The Site S-8 WMA is also located in the southeastern portion of Zone 3 and includes RCRA Site S-8. No key areas of concern were identified.

East Kelly WMA: The East Kelly WMA includes East Kelly (Zone 4) and groundwater plumes off base to the east. East Kelly WMA includes Site OT-051 and Site SS052 (zone-wide contaminated groundwater). The East Kelly WMA also includes the East and South bank groundwater recovery well systems, located along the east and south property boundaries of Zone 4, respectively, and the Zone 4 groundwater treatment plant. Off-site PRBs are located along Commercial Street to the east and near a Union Pacific rail yard to the northeast. Corrective actions consisting of vegetable oil injections were performed at Rainmaker Park in 2006 and at Site OT-051 in 2002. Five key areas of concern were identified:

- **South Bank Recovery System:** Both the 2005 and 2006 analytical data indicate there are no groundwater plumes in the vicinity of the South Bank recovery system; therefore, continued operation of the recovery wells associated with this system is no longer needed.
- **East Bank Recovery System:** East Bank contains five overlapping horizontal groundwater recovery wells spaced along the eastern boundary of Zone 4. TCE was detected in wells SS052MW594, SS052MW183 and SS052MW180, located immediately downgradient from the East Bank recovery system. These wells should continue to be

sampled in the future to evaluate the effectiveness of the groundwater recovery systems along the East Bank.

- **UPRY PRB:** This PRB was newly constructed in 2005, so there are limited historical data to evaluate the effectiveness of this PRB. Although 2006 data show PCE and/or TCE concentrations above the GWPS in downgradient wells at four of the transects, these concentrations could still reflect pre-PRB construction conditions. These wells should continue to be sampled in the future to evaluate the effectiveness of the PRB.
- **Rainmaker Park:** Vegetable oil was injected in the vicinity of Rainmaker Park in 2006. Rainmaker Park is located in the southern portion of Zone 4. There has not been sufficient time between the 2006 injection and the 2006 annual groundwater sampling event to discern potential effects of the vegetable oil on the contaminant plumes in this area.
- **Site OT-051:** Vegetable oil was injected in this area in 2002 Site OT-051 is located in the northwest corner of Zone 4 on the edge of the Zone 4 TCE plume. Analytical data indicate that a residual vinyl chloride plume is present in this area from the microbial degradation of the TCE caused by the vegetable oil injection.

OT-50 North WMA: The OT-50 North WMA includes the northeastern portion of Zone 5 except for Site S-1 and the groundwater plumes off base to the north and northeast of Zone 5. The OT-50 North WMA includes on-site Building 1533 PRB located in the northeast corner of the WMA and off-site 34th Street PRB located northeast of Site S-1. Corrective action within the OT-50 North WMA has included vegetable oil injection performed at Building 1414 in 2006. Three key areas of concern were identified:

- **Building 1533 PRB**: Samples from wells along transects 3 and 4, located along the southern end of the Building 1533 PRB, reported TCE concentrations above the GWPS on both sides of the PRB. The wells associated with these transects should continue to be sampled in the future to evaluate the effectiveness of the PRB.
- **34th Street PRB:** No key areas of concern were identified.
- **Building 1414:** Vegetable oil was injected in the vicinity of Building 1414 in 2006. There has not been sufficient time between the 2006 injection and the 2006 annual groundwater sampling event to discern potential effects of the vegetable oil on the contaminant plumes in this area.

Site S-1 WMA: The Site S-1 WMA is located in the north-central portion of Zone 5 and includes Site S-1. Site S-1 contains a groundwater recovery system consisting of vertical recovery wells and a SVE system. Historic soil excavation was performed at Site S-1 to remove source material. The Zone 5 groundwater treatment plant is located within the Site S-1 WMA. No key areas of concern were identified.

Plume K WMA: The Plume K WMA is located in the northwestern portion of Zone 5. No key areas of concern were identified.

Plume D WMA: The Plume D WMA is located in the central portion of Zone 5. HRC injection was historically performed at Building 1600 to treat for PCE and at Building 1650 to treat for TCE. One key area of concern was identified:

- Wells SS050MW113, SS050MW513, SS050MW514, and SS050MW515, located within Plume D WMA near building 1650, continue to show TCE concentrations above the GWPS. These wells should continue to be sampled in the future to evaluate the effectiveness of the HRC injections in this area.

LEON CREEK SAMPLING

The Leon Creek monitoring program was initiated to document the physical, chemical, and biological conditions of the creek upstream, adjacent to, and downstream of the former Kelly AFB. This assessment summarizes results of the Leon Creek data collection activities performed in July and August 2006. The activities included surface water and sediment sampling; toxicological and biological monitoring; and surface water elevation and flow measurements.

The hydrologic characterization of Leon Creek consisted of analyses of surface water elevations, stream segment flows, and groundwater seep and point-source discharge inflows. Stream elevations ranged from 664.81 feet above mean sea level (amsl) to 603.11 feet amsl, a drop in elevation of 61.70 feet along a downstream distance of approximately 37,000 feet. Monthly average stream flow rates ranged from 2.49 cubic feet per second (cfs) in August to 10.5 cfs in September. The hydrologic budget for July 15, 2006 showed water losses in the first two stream segments and water gains in the two downstream stream segments with an overall net gain of water. The water gain is assumed to be primarily from groundwater flow.

Surface water samples were collected for chemical analysis from 38 stations: 32 in-stream stations, four seeps, and two outfalls. Some contaminants were detected but were below the TWQS standard. No polychlorinated biphenyls (PCBs) were detected. Cyanide was detected at one sample station, but there is not an applicable TWQS freshwater criteria published for cyanide. Chemical analyses that showed results in excess of TWQS standards are discussed in the following paragraph.

One general chemistry parameter, dissolved oxygen, was below its respective TWQS freshwater criteria for three sampled in-stream locations. One pesticide, heptachlor, was detected upstream from the former Kelly AFB slightly above the TWQS (0.0042J µg/L versus 0.004 µg/L) for human health and chronic aquatic life protection. Chromium was detected above TWQS criteria at one outfall. PCE was detected above TWQS freshwater criteria at two seeps. TCE was detected above TWQS freshwater criteria at one seep. No other contaminants exceeded the TWQS freshwater criteria.

Based on analytical data results and collected field data, it appears that PCE and TCE associated with the former Kelly AFB groundwater is migrating into the lower reaches of Leon Creek. The PCE detected in Leon Creek appears to be associated with a PCE plume located in the vicinity of well WP021MW145. The TCE detected in Leon Creek appears to be associated with the TCE plume located on the downgradient side of the Zone 2 PRB.

Additionally, surface water samples were collected at three reference stations: one in-stream station in Salado Creek, one in-stream station in Medio Creek, and one in-stream station in the Medina River. Heptachlor was detected at Salado Creek above the TWQS human health and

chronic aquatic life protection values. No other contaminants exceeded the TWQS freshwater criteria.

Sediment samples were collected for chemical analysis from 27 stations: 26 in-stream stations and one outfall. The following results were reported.

- Three VOCs were detected, but no concentrations exceeded the applicable TWQS sediment screening values.
- 18 SVOCs were detected. However, only eight of the SVOCs (benzo(a)anthracene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene) exceeded TWQS sediment screening values.
- Three pesticides were detected, but only two of the pesticides (4,4'-DDD and 4,4'-DDT) exceeded TWQS sediment screening values.
- PCBs 1254 and 1260 were detected at concentrations exceeding the applicable TWQS sediment screening values in samples collected within the former Kelly AFB.
- 16 metals were detected; however, only eight of the metals (chromium, copper, lead, mercury, nickel, selenium, silver, and zinc) exceeded the applicable TWQS sediment screening values. Except for beryllium, there are no established TWQS standards for the other metals detected.
- Cyanide was also detected at six sample stations, but there is no applicable TWQS sediment screening value for cyanide.

Sediment samples were also collected at three reference stations: one in-stream station in Salado Creek, one in-stream station in Medio Creek, and one in-stream station in the Medina River. Each of the three locations contained detectable concentrations of organic and inorganic compounds, but only the concentrations of three metals (cadmium, lead, and selenium) exceeded the applicable TWQS sediment screening values.

A rapid bioassessment was conducted as part of the Leon Creek assessment at eight Leon Creek stations and the three reference stations located at Salado Creek, Medio Creek, and the Medina River. Impairment, as represented by habitat quality and quality of community integrity of benthic organisms and fish, was indicated in seven of the eight Leon Creek stations and at the Salado Creek reference station. The primary influence on impairment at the majority of the stations appeared to be low flow conditions due to the current drought.

Surface water chronic toxicity tests were conducted at eight Leon Creek stations and the three reference stations located at Salado Creek, Medio Creek, and the Medina River. The surface water test organisms included the water flea (*Ceriodaphnia dubia*) and fathead minnow (*Pimephales promelas*). The IC25 results for chronic reference toxicant tests were within the allowable control chart limits range for *Pimephales promelas* and *Ceriodaphnia dubia* for the test endpoints of survival, growth, and reproduction. Regarding chronic toxicity, this appears to indicate that portions of Leon Creek associated with the former Kelly AFB are not impacted by upstream conditions or contaminants associated with the former Kelly AFB.

Fish tissue samples were collected for the purpose of ecosystem monitoring at eight Leon Creek stations and the three reference stations at Salado Creek, Medio Creek, and the Medina River. A total of 10 species were collected. In the whole body fish tissue samples collected during the current assessment, six pesticides and one PCB were detected. None of the detected parameters exhibited concentrations that exceeded the applicable TCEQ screening levels for organics in fish tissue. Similarly, none of the detected parameters exhibited concentrations that exceeded the whole body tissue residue effects levels for freshwater fish species. This appears to indicate that the fish sampled are not impacted by either Leon Creek upstream conditions or contaminants associated with the former Kelly AFB.

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE