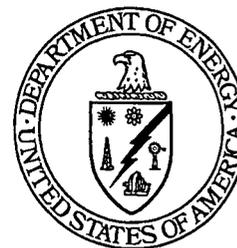




5076



Verification Report for the Removal of Trichloroethylene from Contaminated Soil Obtained from Remediation Area 3A

TABLE OF CONTENTS

1.0 Introduction 1

1.1 Background Information..... 1

2.0 Treatment Results..... 3

 2.1 Monitoring of Treatment Process... 5

 2.2 Statistical Analysis of
 TCLP Results 6

3.0 Conclusions 7

4.0 References 7

Attachment I.....Back Pg.

1.0 INTRODUCTION

This verification report summarizes analytical data to demonstrate that the enhanced soil venting carried out for the Fernald Closure Project (FCP) was successful in removing trichloroethylene (TCE) from contaminated soil originating from RCRA Soil Area 5 and staged at Quonset Hut No.1 (Figure 1). Successful treatment of the below-WAC, TCE-contaminated soil will now allow the treated soil to be placed in the On Site Disposal Facility (OSDF), per the direction provided in the Sitewide Excavation Plan (DOE 1998) and Implementation Plan for Area 3A/4A (DOE 2001).

1.1 Background Information

During the OU5 RI/FS process, six areas at the Fernald site were classified as Resource Conservation and Recovery Act (RCRA) soil areas that had the potential for successful treatment to remove the hazardous component. Soil staged at Quonset Hut No.1 is comprised of the brown and gray glacial deposits that were removed from RCRA Soil Area 5 (the excavation off the NW corner of the Maintenance Building; Figure 1).

20803-RP-0002
Final, Rev. 0

During the predesign investigation for Area 3A/4A, conducted in 2002, the toxicity characteristic was confirmed for the TCE-contaminated soil and the volume of RCRA soil was determined using the results of 20 TCE analyses that failed the toxicity characteristic leaching procedure (TCLP). Detailed information on the sampling and excavation history of the soil can be found in the Implementation Plan for Area 3A/4A (DOE 2001), the Project Specific Plan for Investigating Soil Staged in Quonset Hut #1 (DOE 2002) and the Treatment Plan for the Removal of Trichloroethylene from Contaminated Soil Obtained from Remediation Area 3A and Staged at Quonset Hut #1 (DOE 2003).

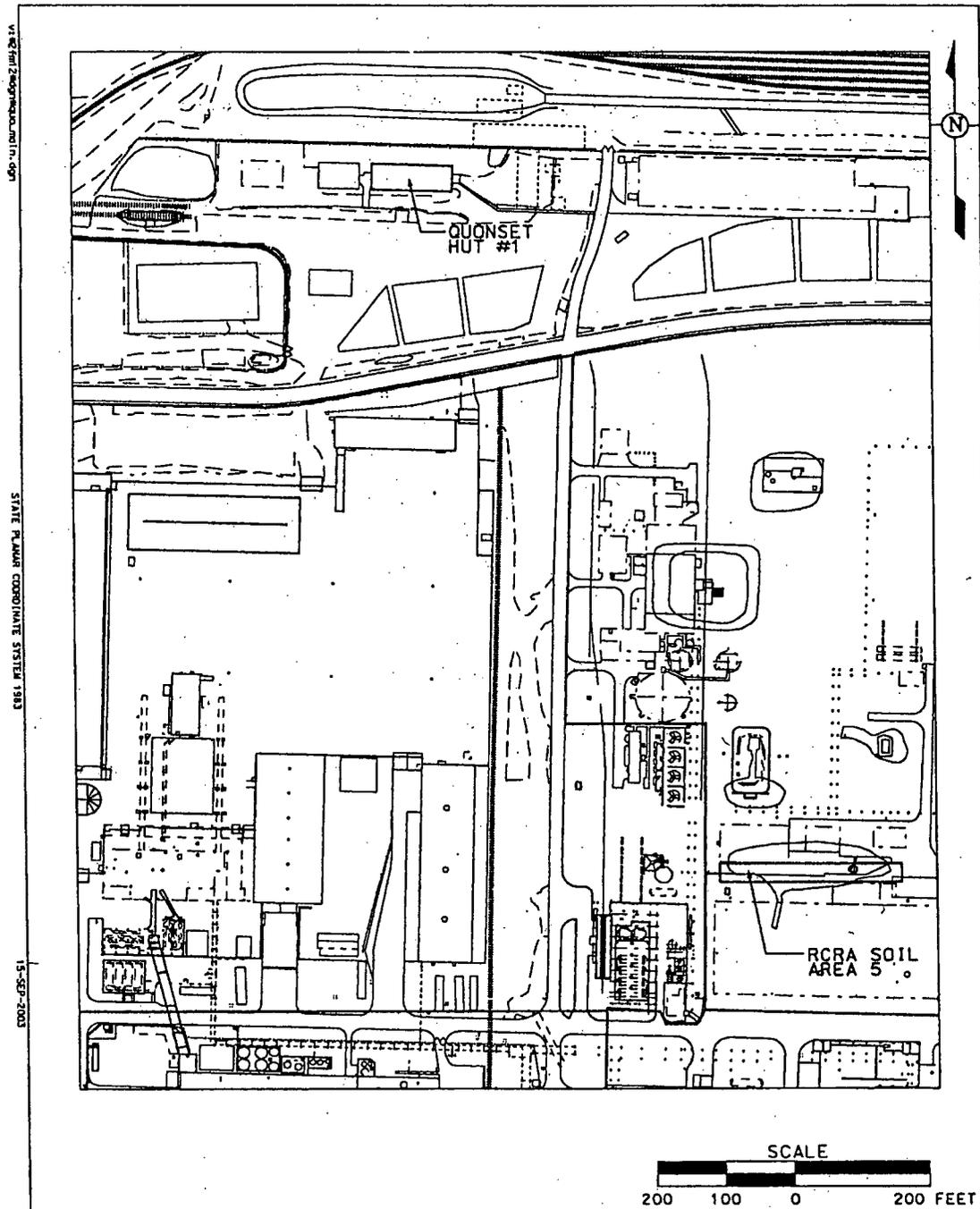


FIGURE 1. Location of RCRA Soil Area 5 and Quonset Hut No. 1

2.0 TREATMENT RESULTS

Treatment of approximately 400 cubic yards of soil began on August 5, 2003 and continued for approximately 23 days before samples were collected for TCLP analysis. Gas samples were collected when treatment was initiated and analytical results for the five most abundant volatile compounds (Table 1) indicate that off-gas emissions were well below the 15 pounds per day permit-exemption requirement [Ohio Administrative Code (OAC) 3745-31-03, Paragraph D]. Based on the initial gas-sampling results, TCE and PCE are the two most abundant volatiles in the gas samples and these compounds were monitored throughout the treatment process. (Note: the soil is not toxic with respect to PCE, as all past and present PCE TCLP results are below the regulatory limit.)

Table 1
Results for Initial Gas Sample¹ Collected on August 5, 2003

Sample ID	Analyte	ppmv ²	µg/L ³	pounds/day ⁴
QHUT-SP1-1	TCE	25	134	0.60
QHUT-SP1-1	PCE	5.2	35	0.16
QHUT-SP1-1	TCA	2.3	13	0.06
QHUT-SP1-1	1,1-DCA	1.3	5.3	0.02
QHUT-SP1-1	cis1,2-DCE	0.32	1.3	0.01

¹Only the initial analysis is reported, as it represents the maximum concentration and maximum estimate of pounds per day.

²Parts per million by volume = $(L_{TCE}/L_{gas}) * 10^6$.

³Micrograms per liter = $ppmv * P * MW / RT$

P = 1 atm, MW = molecular weight, T = 298 K, R = 0.082 L atm/mol K

⁴Pounds per day = $\mu g/L * 1416 L/min * 60 min * 24 hrs * (1 lb/454000000 \mu g)$
1416 L/min corresponds to the gas flow rate of 50 ft³/min

On August 20, 2003, 12 soil samples were collected from 8 boring locations (Figure 2) under Variance 8 (PSP for Investigating Soil Staged in Quonset Hut No. 1) to assess the progress of the treatment process, and analytical results indicate total TCE and PCE concentrations were below the 20-times threshold (Table 2). Based on monitoring data for gas samples (Section 2.1), the favorable results from the August 20 soil-sampling event, and consistent with the approved treatment plan, 12 soil samples were collected for TCLP analysis on August 27, 2003 (Figure 3) under Variance 9 (PSP for Investigating Soil Staged in Quonset Hut No. 1). All results from the TCLP test (Table 3) are below the limit, which indicates that the toxicity characteristic for TCE has been removed from the soil.

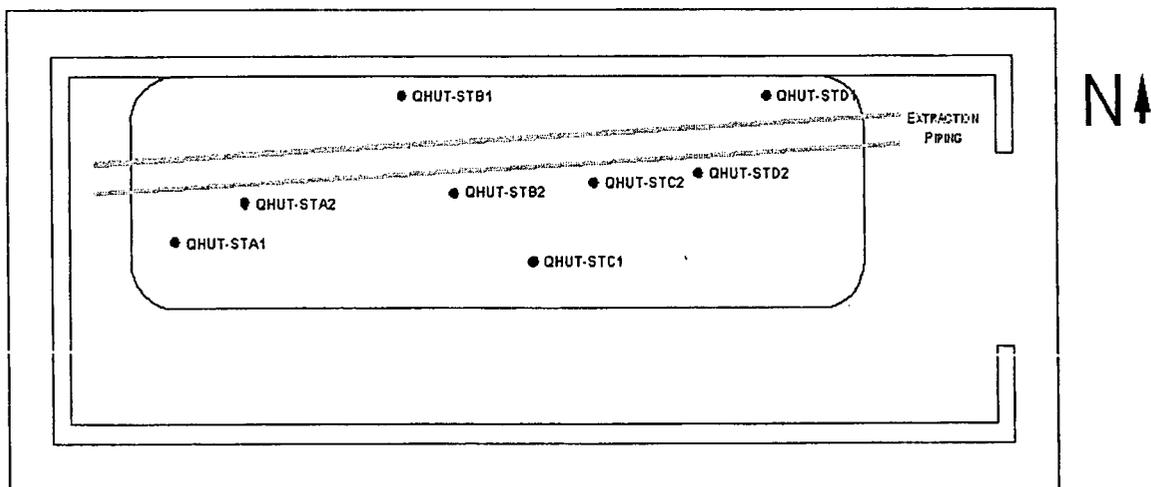


FIGURE 2. Boring locations for the August 20th sampling event.

Table 2
Results for Soil Samples Collected on August 20, 2003

Sample ID ¹	Depth (fbps) ²	TCE (mg/kg) ³	PCE (mg/kg)
QHUT-STA1-B-L	3.75	0.549	<0.250
QHUT-STA2-M-L	3.25	2.00	1.63
QHUT-STA2-B-L	6.25	6.25	0.727
QHUT-STB1-B-L	3.75	2.16	0.415
QHUT-STB2-M-L	3.25	2.26	1.15
QHUT-STB2-B-L	6.75	0.488	0.256
QHUT-STC1-B-L	3.75	6.06	<0.250
QHUT-STC2-M-L	3.25	1.98	0.469
QHUT-STC2-B-L	5.75	2.43	0.642
QHUT-STD1-B-L	3.75	0.496	0.359
QHUT-STD2-M-L	2.25	1.52	0.810
QHUT-STD2-B-L	4.25	3.60	1.78
20-times limit	NA	10	14

¹Locations shown on Figure 1-2. Last two letters are for sample depth (B=bottom or M=middle) and analytical method (L=volatiles)

²Feet below pile surface

³Milligrams per kilogram.

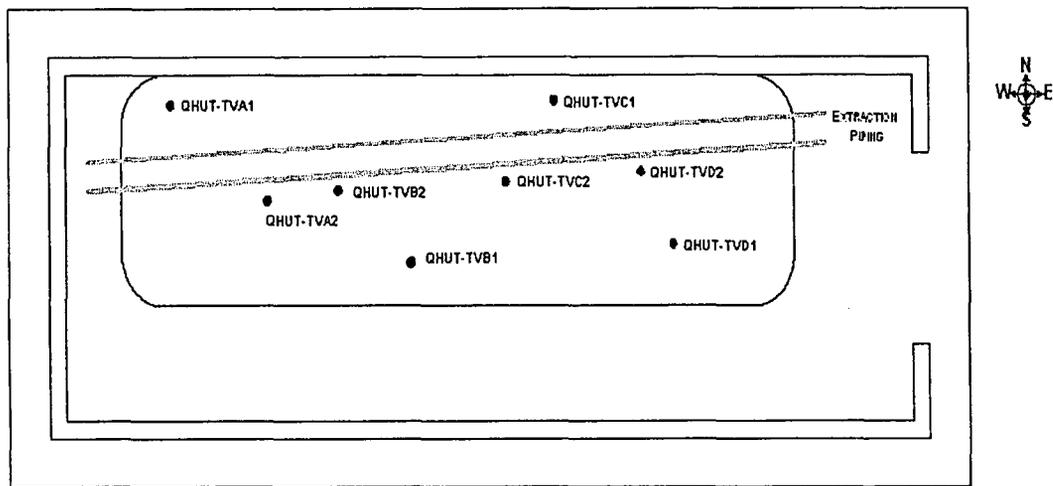


FIGURE 3. Boring locations for the August 27th sampling event.

Table 3
TCLP Results for Soil Samples Collected on August 27, 2003

Sample ID ¹	Depth (fbps) ²	TCE (mg/L) ³	PCE (mg/L)
QHUT-TVA1-B-TL	3.25	<0.020	0.232
QHUT-TVA2-M-TL	3.75	0.022	0.0092
QHUT-TVA2-B-TL	7.25	0.156	<0.020
QHUT-TVB1-B-TL	3.25	0.436	0.0916
QHUT-TVB2-M-TL	3.25	0.0505	0.0071
QHUT-TVB2-B-TL	7.25	0.0410	0.0085
QHUT-TVC1-B-TL	3.75	0.0146	<0.020
QHUT-TVC2-M-TL	3.25	0.111	0.0484
QHUT-TVC2-B-TL	7.25	0.0554	0.0137
QHUT-TVD1-B-TL	2.75	0.0387	0.0076
QHUT-TVD2-M-TL	2.25	0.0725	0.0079
QHUT-TVD2-B-TL	4.25	0.0329	<0.020
TCLP limit	NA	0.5	0.7

¹Locations shown on Figure 1-3. Last two letters are for sample depth (B=bottom or M=middle) and analytical method (TL=volatiles by TCLP)

²Feet below pile surface

³Milligrams per kilogram.

5076

2.1 Monitoring of Treatment Process

As noted in the treatment plan (DOE 2003), gas concentrations were monitored several times a week to track the progress of the treatment process. Static and pumping conditions were evaluated to estimate the air concentration during the pumping cycle that would correspond to a high probability of passing the TCLP test ($^{HS}C_{g,p}$ in Attachment I). This evaluation also estimated a maximum air concentration for the rebound test ($^{HS}C_{g,s}$ in Attachment I), which was performed by shutting down the pump for approximately five days (August 28 to September 2) and then restarting the pump on September 2 (about 670 hours after the initial sample was collected on August 5).

Figure 4 summarizes the air monitoring data and the small spike in TCE concentration (at about $5.7E+07$ liters) that corresponds to the rebound in gas concentrations after the system was shut down for five days. The maximum rebound concentration recorded is 4.36 mg/L, which is below the predicted maximum concentration of 9 mg/L ($^{HS}C_{g,s}$ in Attachment I). Therefore, the rebound test results indicate that significant hot spots are not likely to be found in the soil pile.

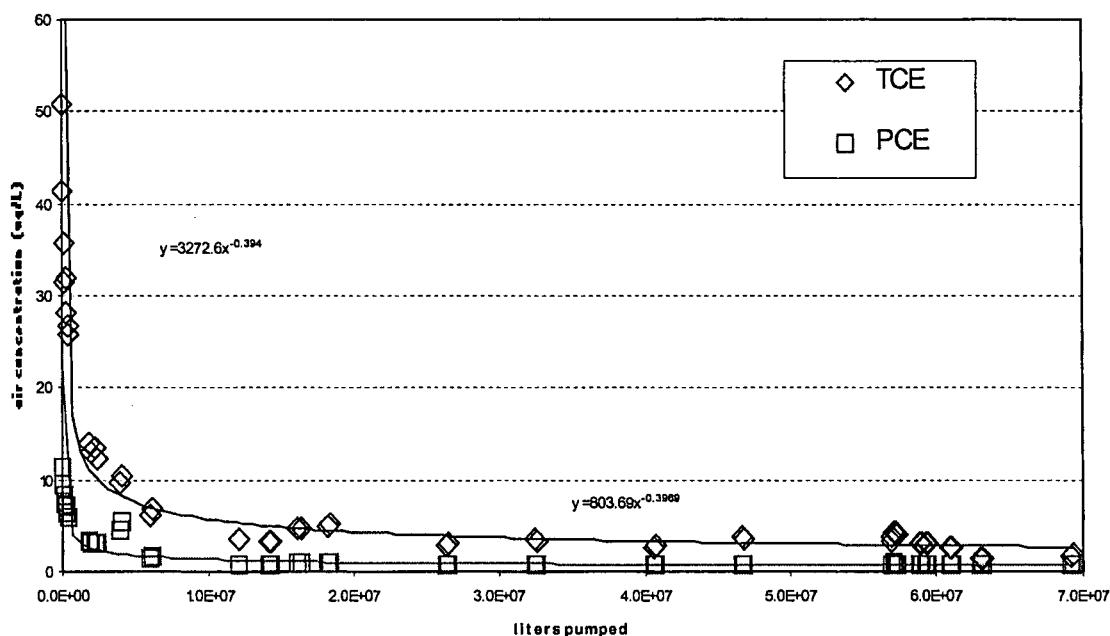


FIGURE 4. Air monitoring results for August 5 through September 8.
Power curves are used to estimate mass of released TCE and PCE (Figure 5)

5

Power curves for the TCE and PCE concentrations (Figure 4) were used to estimate the mass of TCE and PCE removed by the treatment process (Figure 5). The mass of TCE and PCE removed by the vacuum pump represents one fraction of the mass of TCE and PCE removed from the soil since the soil was excavated and placed in Quonset Hut No.1. Other passive venting activities that have aided in the reduction of TCE and PCE soil concentrations include the initial excavation event, residence time in the quonset hut and movement of the soil pile to place the horizontal pipe used in the treatment process.

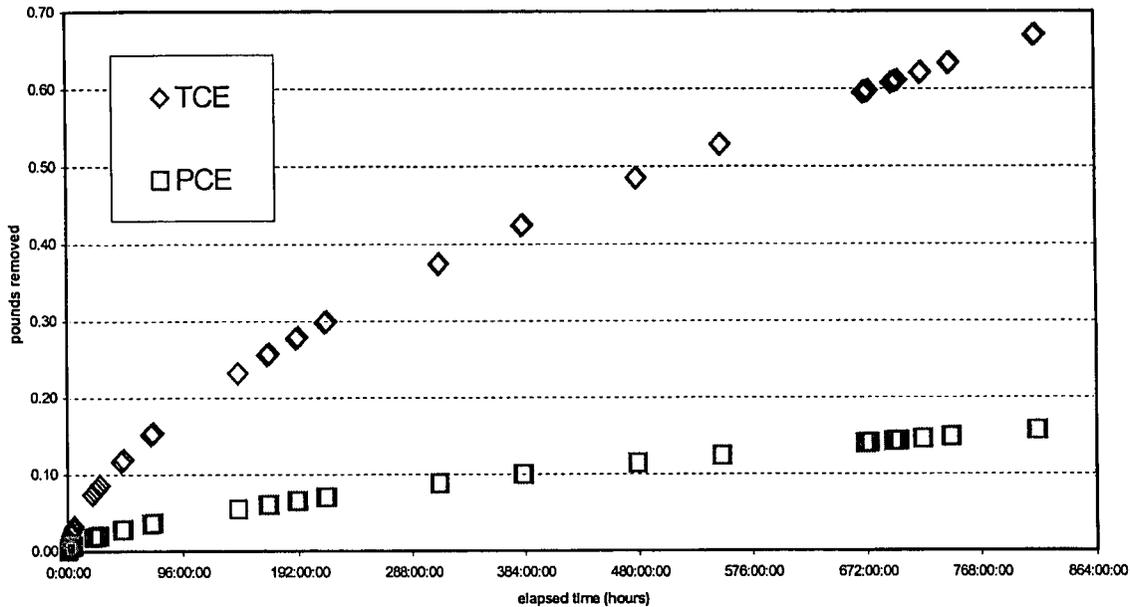


FIGURE 5. Estimated mass of TCE and PCE removed during the treatment process.

2.2 Statistical Analysis of TCLP Results

Analytical results in Table 3 were used to evaluate the appropriate number of samples for demonstrating that the upper confidence level is less than the TCE regulatory threshold (RT) of 0.5 mg/L. Table 4 summarizes the calculations for Equations 2 through 8 in Table 9.1 of SW-846 and the upper 95 percentile of the population. The calculations show that a sufficient number of samples were collected to statistically conclude that the toxicity characteristic has been removed for the soil pile. Though not required by SW-846 to demonstrate successful treatment, the 95th percentile indicates that the soil is unlikely to contain TCE contamination zones that exceed the TCLP limit of 0.5 mg/L.

Table 4
Statistical Calculations for TCLP Results

Parameter	Result
\bar{x}	0.0867 mg/L
s^2	0.0139 mg/L
s	0.118 mg/L
$s_{\bar{x}}$	0.0340 mg/L
upper CI	0.133 mg/L
RT	0.5 mg/L
n	2
P_{95}	0.280 mg/L

\bar{x} = mean of measurements
 s^2 = variance of measurements
 s = standard deviation of measurements
 $s_{\bar{x}}$ = standard error of the mean
 CI = confidence interval
 RT = regulatory threshold
 n = appropriate number of samples to collect
 P_{95} = 95th percentile of the population



3.0 CONCLUSIONS

The passive treatment process implemented for the soil staged in Quonset Hut #1 removed sufficient TCE from the soil matrix to achieve passing results for the TCLP test (i.e., all results are below the TCLP limit). Statistical calculations demonstrate that a sufficient number of samples were collected and that the 95 percentile of the sample population is well below the TCE toxicity threshold of 0.5 mg/L. As the toxicity characteristic for TCE has been removed from the soil, the soil can be placed in the OSDF upon concurrence from EPA and OEPA that the treatment is successful.

4.0 REFERENCES

- U.S. Department of Energy, 1998, "Sitewide Excavation Plan," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.
- U.S. Department of Energy, 2001, "Implementation Plan for Area 3A/4A," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.
- U.S. Department of Energy, 2002, "Project Specific Plan for Investigating of Soil Staged in Quonset Hut No. 1," Revision 0, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.
- U.S. Department of Energy, 2003, "Treatment Plan for the Removal of Trichloroethylene from Contaminated Soil Obtained from Remediation Area 3A and Staged in Quonset Hut No. 1," Revision 0, Fernald Closure Project, DOE, Fernald Area Office, Cincinnati, Ohio.
- U.S. Environmental Protection Agency, SW-846, "Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods."

ATTACHMENT I

**TCE Gas Concentrations for
Meeting the TCL Clean-up Goal**

Attachment I
TCE Gas Concentrations for Meeting the TCLP Clean-up Goal

<p>Flux = 40780*Q*C_{g,p}</p> <p>Flux 40780 Q = flow rate C_{g,p} = conc of gas phase when pumping</p>	<p>Flux ~ 1000*k*A*(C_{g,s} - C_{g,p})</p> <p>Flux 1000 k = soil to gas coefficient A = surface area C_{g,s} = conc of gas phase when static</p>	<p>µg/day L/m³ m/day m² µg/L</p>																										
<p>Assume fluxes reach steady state soon after pumping begins</p> <p>40780*Q*C_{g,p} = 1000*k*A*(C_{g,s} - C_{g,p})</p> <p>C_{g,p} = (1000*k*A)/(40780*Q)*(C_{g,s} - C_{g,p}) - B(C_{g,s} - C_{g,p})</p> <p>B = site specific conditional concentration factor = 1/((C_{g,s}/C_{g,p})-1)</p>																												
<p>Relate gas concentration to TCLP clean-up goal via Henry's Law</p> <p>C_{g,s} = 1000*H_T*C_w ~ 1000*H_T*a*C_{TCLP}</p> <p>1000 H_T = Henry's law coefficient C_w = aqueous TCE concentration in soil moisture a = site specific factor relating CTCLP to C_w CTCLP = TCE concentration in TCLP test</p>																												
<p>Calculations for TCE at 25C</p> <table border="1"> <thead> <tr> <th>C_{g,s} µg/L</th> <th>C_{g,p} µg/L</th> <th>avg C_{TCLP} mg/L</th> <th>H_T</th> <th>a</th> <th>B</th> <th>goal C_{TCLP} mg/L</th> <th>goal C_{g,s} µg/L</th> <th>goal C_{g,p} µg/L</th> <th>max C_{TCLP} mg/L</th> <th>HS_{DF}</th> <th>HS C_{g,s} µg/L</th> <th>HS C_{g,p} µg/L</th> </tr> </thead> <tbody> <tr> <td>51</td> <td>10</td> <td>0.46</td> <td>0.4</td> <td>0.27</td> <td>0.24</td> <td>0.5</td> <td>55</td> <td>11</td> <td>3.0</td> <td>0.83</td> <td>9</td> <td>1.7</td> </tr> </tbody> </table>			C _{g,s} µg/L	C _{g,p} µg/L	avg C _{TCLP} mg/L	H _T	a	B	goal C _{TCLP} mg/L	goal C _{g,s} µg/L	goal C _{g,p} µg/L	max C _{TCLP} mg/L	HS _{DF}	HS C _{g,s} µg/L	HS C _{g,p} µg/L	51	10	0.46	0.4	0.27	0.24	0.5	55	11	3.0	0.83	9	1.7
C _{g,s} µg/L	C _{g,p} µg/L	avg C _{TCLP} mg/L	H _T	a	B	goal C _{TCLP} mg/L	goal C _{g,s} µg/L	goal C _{g,p} µg/L	max C _{TCLP} mg/L	HS _{DF}	HS C _{g,s} µg/L	HS C _{g,p} µg/L																
51	10	0.46	0.4	0.27	0.24	0.5	55	11	3.0	0.83	9	1.7																

NOTE: Parameters are defined and discussed in detail in the treatment plan (DOE 2003).