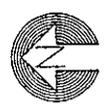


**LEGEND:**

MW1 EXISTING GROUNDWATER MONITORING WELL

LINE OF EQUAL GROUNDWATER ELEVATION  
CONTOUR INTERVAL = 0.40 FT



60' 60'  
1" = 60'-0"

SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

POTENTIOMETRIC SURFACE MAP  
 JANUARY 12, 2005  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA

FIGURE

7

GROUND ZERO ANALYSIS

FN: 0605/3655

**APPENDIX A**

**DATA SUMMARY TABLES FROM SITE  
CHARACTERIZATION**

### **Pure Etch Health Risk Assessment Tables**

Due to space limits on the DTSC website, the following list of tables have been omitted from the HRA web posting, volume 2 of 2 as they are listed at the following web address:

[http://www.dtsc.ca.gov/HazardousWaste/Projects/upload/PUreEtch\\_RFI\\_tables.pdf](http://www.dtsc.ca.gov/HazardousWaste/Projects/upload/PUreEtch_RFI_tables.pdf)

Table 1

Table 3

Table 6

Table 7

Table 12

Table 13

If you have any questions, please contact the DTSC project manager for this project.

**TABLE**  
**SOIL VAPOR ANALYTICAL RESULTS**  
**Former Pure-Etch Facility**  
**Concentrations in mg/m<sup>3</sup>**

CONSTITUENT	A-15-B1	A-15-B2	A-15-B3	BH6-7	BH6-16	MW6-5	MW6-25 (pv 1)	MW6-25 (pv 2)	MW6-25 (pv 3)	MW6-25 (pv 7)	MW9-5	MW9-25	MW11-5	MW11-25
Methylene Chloride	--	--	--	0.037	<4.7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	--	--	--	<0.0032	<5.4	<1.0	<1.0	<1.0	<1.0	<1.0	4.9	18	<1.0	2.9
1,1-Dichloroethane	--	--	--	<0.0032	<5.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.1	<1.0	2.5
cis-1,2-Dichloroethene	--	--	--	<0.0032	<5.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.1	<1.0	<1.0
1,1,1-Tetrachloroethane	--	--	--	<0.0044	<7.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.8	<1.0	<1.0
Benzene	ND	15	0.7	0.018	4.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	--	--	--	0.042	<7.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	860	750	9.2	0.063	1,100	<1.0	4.3	4.5	6.5	8.3	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	--	--	--	<0.0054	<9.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	1.3	3.5
Ethyl benzene	170	150	1,000	0.011	170	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m,p-Xylene	1,300	1,000	22	0.043	1,900	10	130	140	170	190	2.5	<1.0	<1.0	<1.0
o-Xylene	--	--	--	0.014	510	5.8	79	82	100	120	1.7	<1.0	<1.0	<1.0
1,3,5-Trimethylbenzene	--	--	--	0.01	70	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2,4-Trimethylbenzene	--	--	--	0.031	140	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene	--	--	--	0.0052	<8.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acetone	--	--	--	0.24	<13	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Propanol	--	--	--	0.0081	<13	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Butanone	--	--	--	0.023	<16	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hexane	--	--	--	0.047	<19	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cyclohexane	--	--	--	0.012	<19	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4-Ethyltoluene	--	--	--	0.025	260	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethanol	--	--	--	0.044	<10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl tert-Butyl Ether	--	--	--	0.038	<20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Heptane	--	--	--	<0.013	310	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

**NOTES**

A-15-B1, A-15-B2, A-15-B3 analyzed using Method 6010A, samples collected by CapRock March 1997

BH6-7 and BH6-16 analyzed using Method EPA TO-14 by Air Toxics LTD., samples collected July 2000

MW6-5, MW6-25, MW9-5, MW9-25, MW11-5, MW11-25 analyzed using Method EPA 8260B by Transglobal Environmental Geochemistry (TEG), samples collected March 2004

pv = purge volume relative to probe casing volume

**APPENDIX B**

**CONTAMINANT MASS CALCULATIONS AND  
ASSOCIATED FIGURES**

**CONTAMINANT MASS CALCULATIONS**

Former Pure-Etch facility, Salinas, CA

**Mass in soil.**

Based on Concentrations from drilling investigations 1997 to 2003

mass = (Volume of impacted zone)(soil density)(Average Concentration)(E-6);

Volume in cu. ft.; Three Zones are 12-42', 42-52', 52-65'

Soil density assumed 45.5 kg/cu. ft. (100lb/cu. ft.);

Contaminant	Area (sq.ft.) (pi x r <sub>1</sub> x r <sub>2</sub> )	Height (feet)	Volume (cu. ft.) (pi x r <sub>1</sub> x r <sub>2</sub> x h)	Average Concentration (mg/kg)	Mass of Contaminant (kg)	Mass of Contaminant (lbs)
<b>TPHG</b>						
<b>Zone 1 (12-42' bgs)</b>						
TPHG 5,000+ ppm	377	30	11310	6400	3293.4	7245.5
TPHG 500-5,000 ppm	1979	30	59376	2750	7429.4	16344.7
TPHG 50-500 ppm	942	30	28274	275	353.8	778.3
TPHG 5-50 ppm	1100	30	32987	27.5	41.3	90.8
Total estimated mass of TPHG in Zone 1 =			131947		11117.9	24459.3
<b>Zone 2 (42-52' bgs)</b>						
TPHG 50+ ppm	471	10	4712	183	39.2	86.3
TPHG 5-50 ppm	2278	10	22777	27.5	28.5	62.7
Total estimated mass of TPHG in Zone 2 =			27489		67.7	149.0
<b>Zone 3 (52-65' bgs)</b>						
TPHG 500+ ppm	578	13	7515	1800	615.5	1354.0
TPHG 50-500 ppm A	647	13	8413	275	105.3	231.6
TPHG 50-500 ppm B	3770	13	49009	125	278.7	613.2
TPHG 5-50 ppm	9692	13	125993	27.5	157.6	346.8
Total estimated mass of TPHG in Zone 3 =					1157.1	2545.6
Total estimated mass of TPHG in Soil =					12342.7	27154.0
<b>Benzene</b>						
<b>Zone 1 (12-42' bgs)</b>						
Benzene 0.5+ ppm	1571	30	47124	2.1	4.5	9.9
Benzene 0.05-0.5 ppm	1728	30	51836	0.275	0.6	1.4
Total estimated mass of Benzene in Zone 1 =					5.2	11.3
<b>Zone 2 (42-52' bgs)</b>						
Benzene 5+ ppm	481	10	4807	6.8	1.5	3.3
Benzene 0.5-5 ppm A	877	10	8765	2.75	1.1	2.4
Benzene 0.5-5 ppm B	368	10	3676	2.75	0.5	1.0
Benzene 0.05-0.5 ppm	1810	10	18096	0.275	0.2	0.5
Total estimated mass of Benzene in Zone 2 =					3.3	7.2
<b>Zone 3 (52-65' bgs)</b>						
Benzene 5+ ppm	898	13	11680	6.9	3.7	8.1
Benzene 0.5-5 ppm	6170	13	80211	2.75	10.0	22.1
Benzene 5-50 ppm	14923	13	193993	0.275	2.4	5.3
Total estimated mass of Benzene in Zone 3 =					16.1	35.5
Total estimated mass of Benzene in Soil =					24.6	54.0

**CONTAMINANT MASS CALCULATIONS**

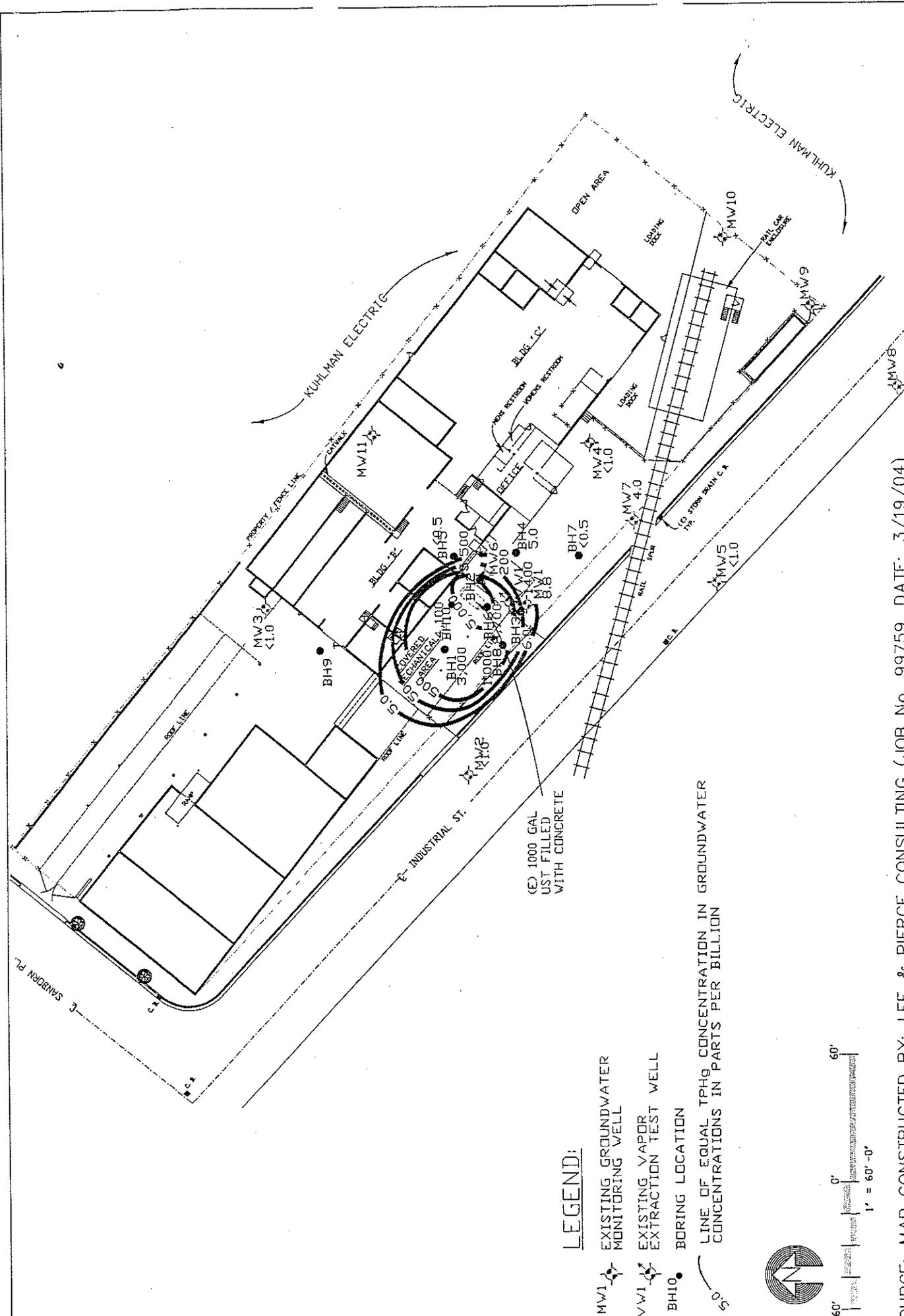
Former Pure-Etch facility, Salinas, CA

**Mass in Groundwater April 2005**

Based on isoconcentration contours April 2005

mass = (Volume in cu ft)(porosity)(Conc. in ppb)(E-9)(7.48 gal/cu ft)(8.34 lb/gal)(0.4536 kg/lb)  
 Thickness of aquifer is 15 feet; porosity is 0.30

Contaminant	Area (sq.ft.)	Volume (cu. ft.)	Average Concentration (ug/l)	Mass of Contaminant (kg)	Mass of Contaminant (lbs)
TPHG 50000+ ppb	471	7069	63500	3.81	8.38
TPHG 5,000-50,000 ppb	4697	70450	27500	16.45	36.18
TPHG 500-5,000 ppb	13682	205224	2750	4.79	10.54
TPHG 50-500 ppb	14530	217948	275	0.51	1.12
Total Mass of dissolved TPHG in groundwater				25.6	56.2
Benzene 5,000+ ppb	471	7069	6000	0.36	0.79
Benzene 500-5,000 ppb	4555	68330	2750	1.60	3.51
Benzene 50-500 ppb	7069	106029	275	0.25	0.54
Benzene 5-50 ppb	7697	115453	28	0.03	0.06
Benzene 0.5-5 ppb	11310	169646	2.8	0.00	0.01
Total Mass of dissolved Benzene in groundwater				2.2	4.9



**LEGEND:**

- MW1 EXISTING GROUNDWATER MONITORING WELL
- VW1 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION
- LINE OF EQUAL TPHG CONCENTRATION IN GROUNDWATER CONCENTRATIONS IN PARTS PER BILLION

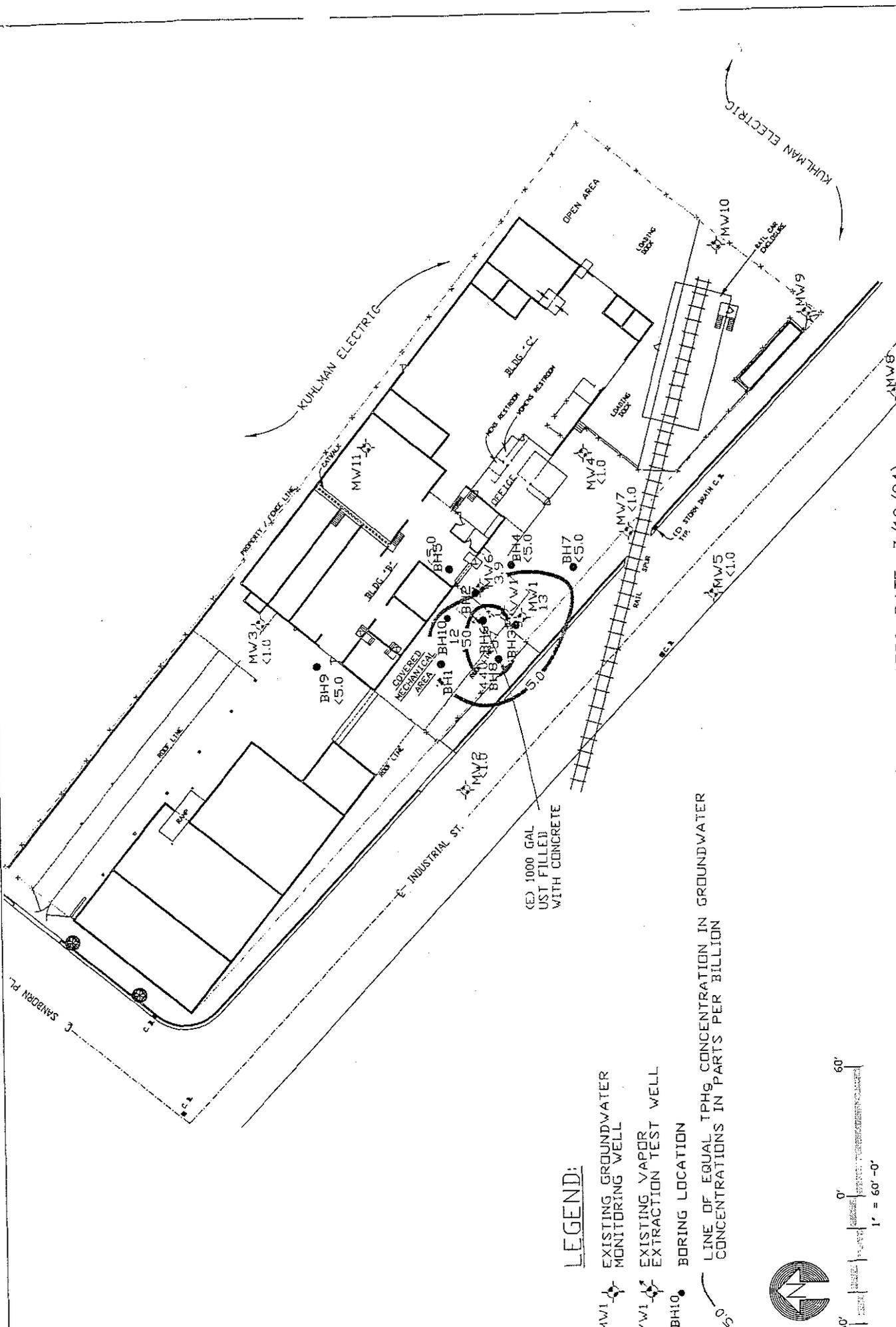


SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

FIGURE  
B1  
FN: 0605/365S

TPHG 12-42' (PRIMARYLY SAND)  
PURE ETCH COMPANY  
1031 INDUSTRIAL ST.,  
SALINAS, CALIFORNIA

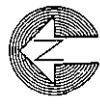
**GROUND ZERO ANALYSIS**



**LEGEND:**

- MW1 EXISTING GROUNDWATER MONITORING WELL
- VW1 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION

LINE OF EQUAL TPH9 CONCENTRATION IN GROUNDWATER CONCENTRATIONS IN PARTS PER BILLION



SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

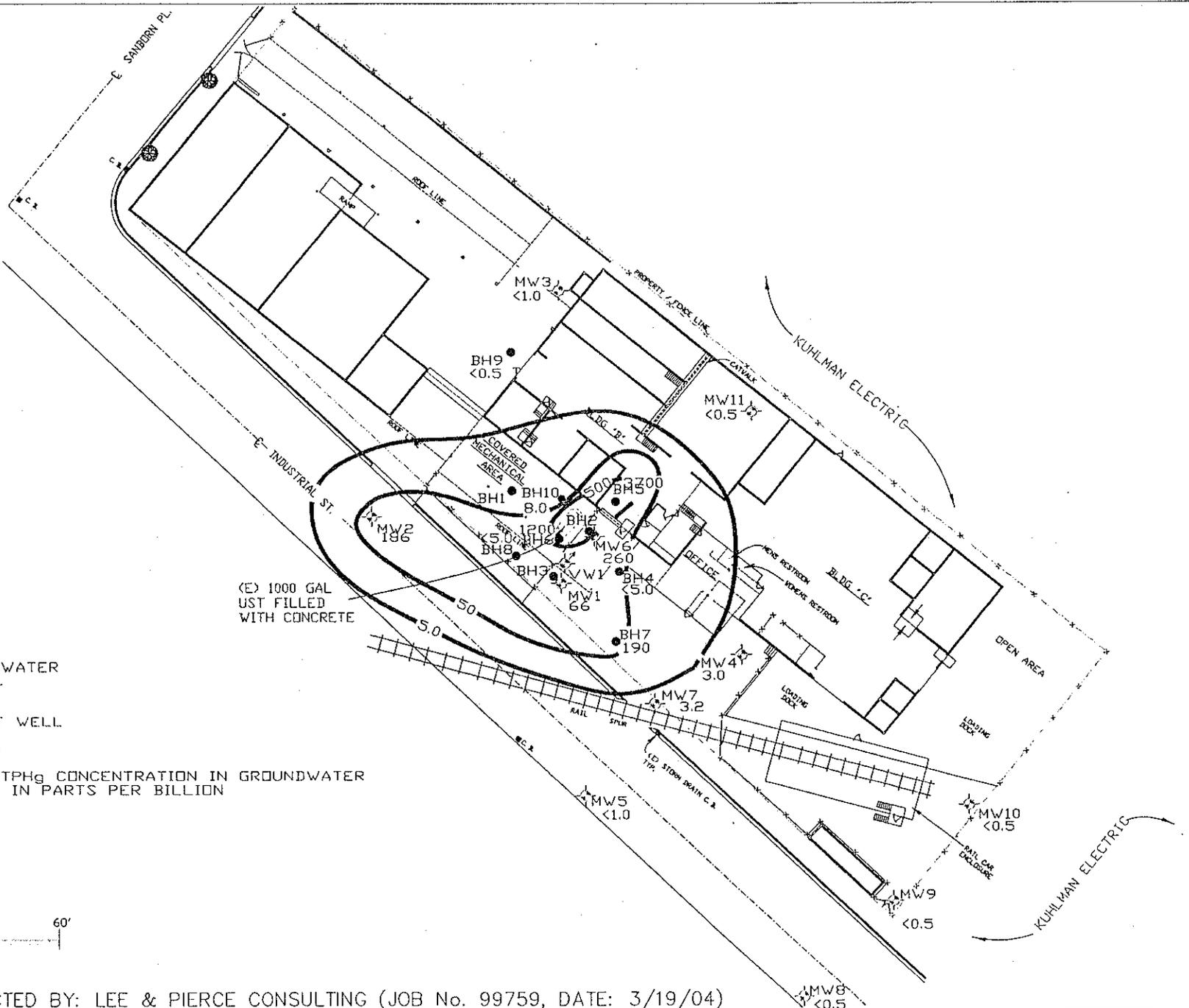
TPHIG 42-52' (PRIMARYLY SAND)  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA

FIGURE

B2

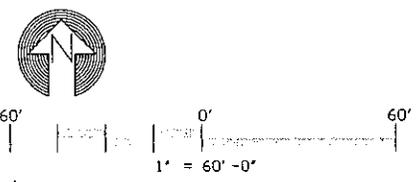
FN: 0605/3655

GROUND ZERO ANALYSIS



**LEGEND:**

- MW1 EXISTING GROUNDWATER MONITORING WELL
- VW1 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION
- 5.0 LINE OF EQUAL TPH<sub>g</sub> CONCENTRATION IN GROUNDWATER CONCENTRATIONS IN PARTS PER BILLION



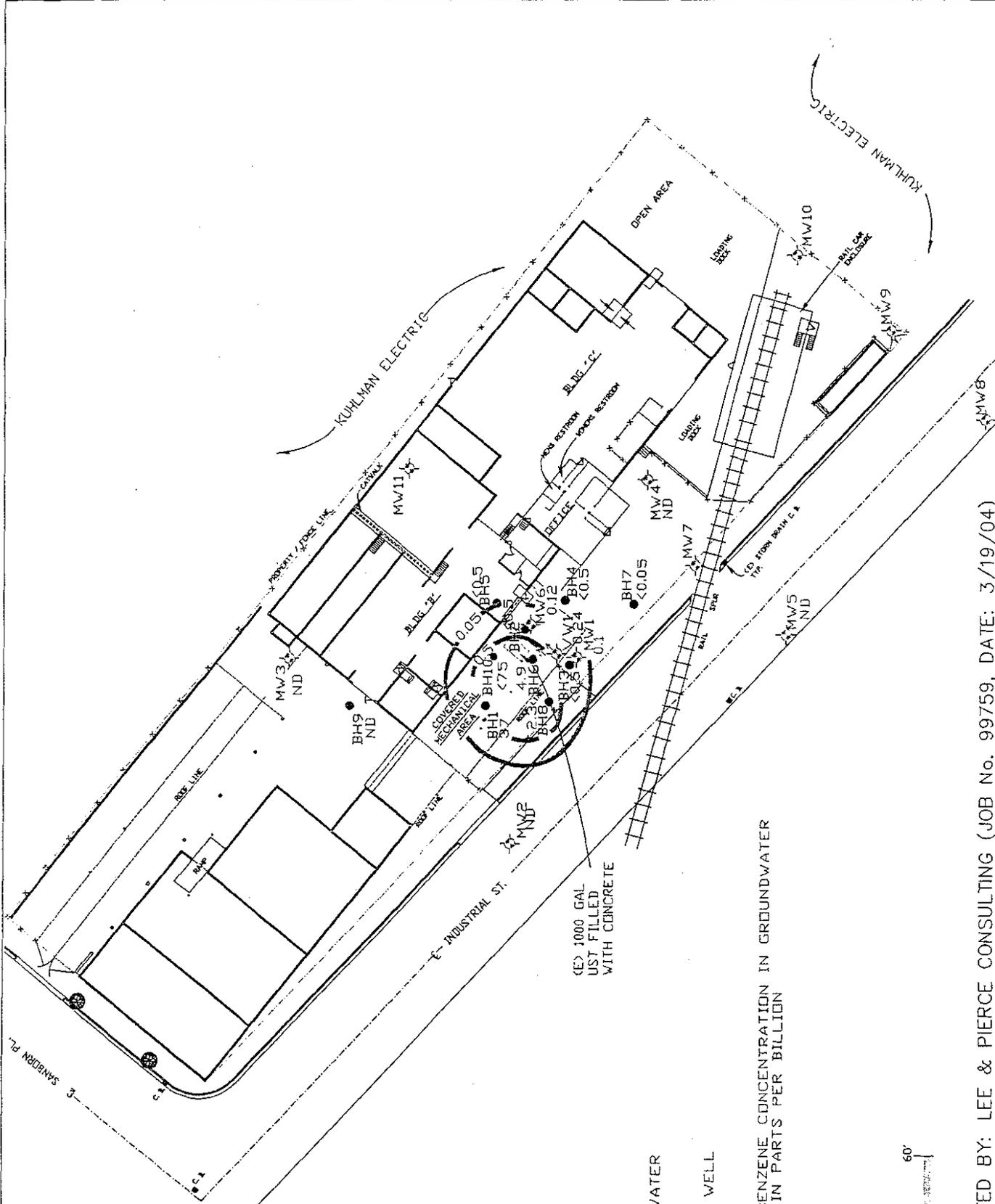
SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

GROUND ZERO ANALYSIS

TPHG 52-65' (PRIMARYLY SAND)  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA

FIGURE  
 B3

FN: 0605/3655



**LEGEND:**

- MW1 EXISTING GROUNDWATER MONITORING WELL
- VW1 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION

LINE OF EQUAL BENZENE CONCENTRATION IN GROUNDWATER  
 CONCENTRATIONS IN PARTS PER BILLION



60' 0' 60'  
 1" = 60'-0"

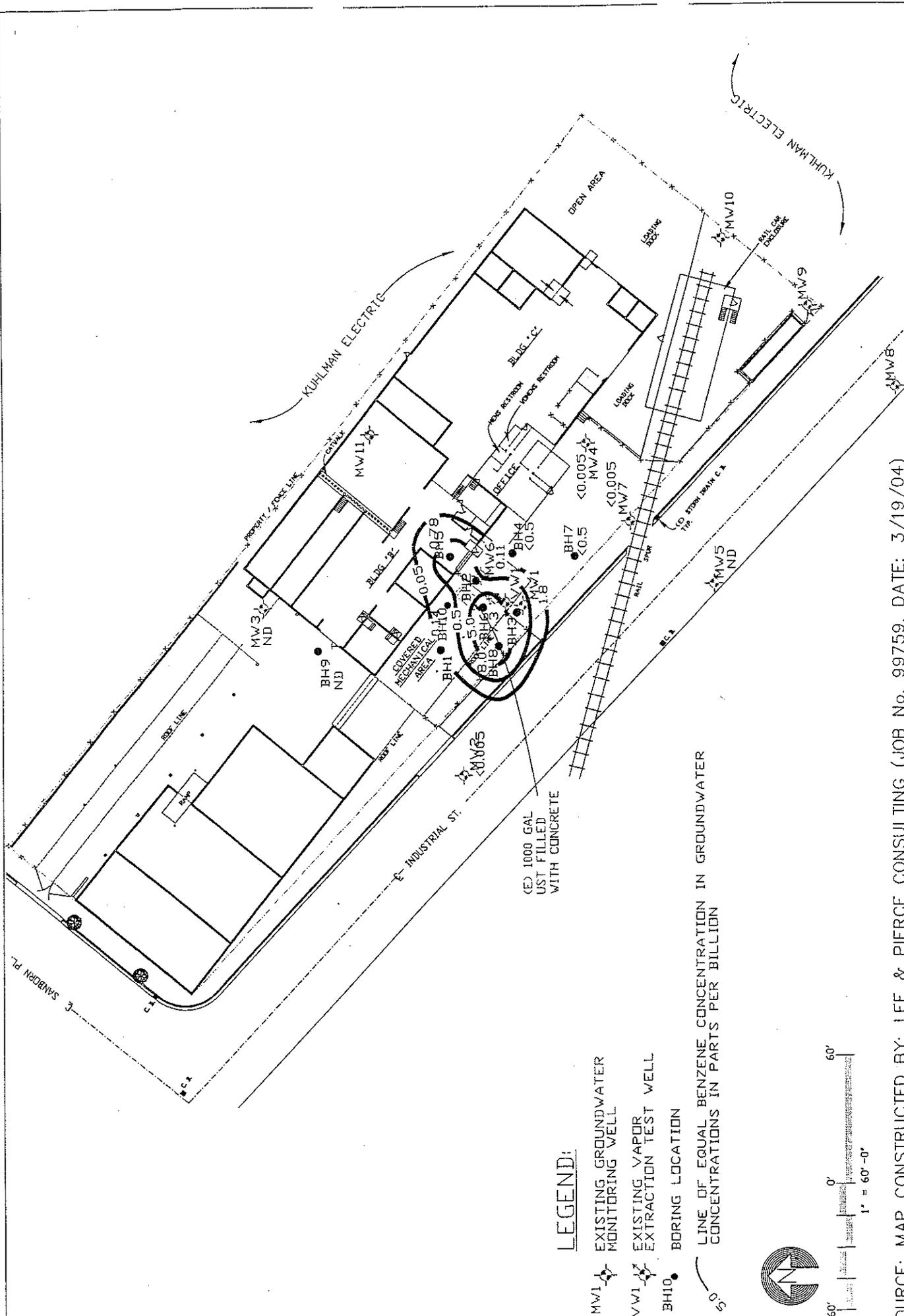
SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

**GROUND ZERO ANALYSIS**

BENZENE IN SOIL 12-42'  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA

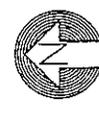
FIGURE  
 B4

FN: 0605/365S



**LEGEND:**

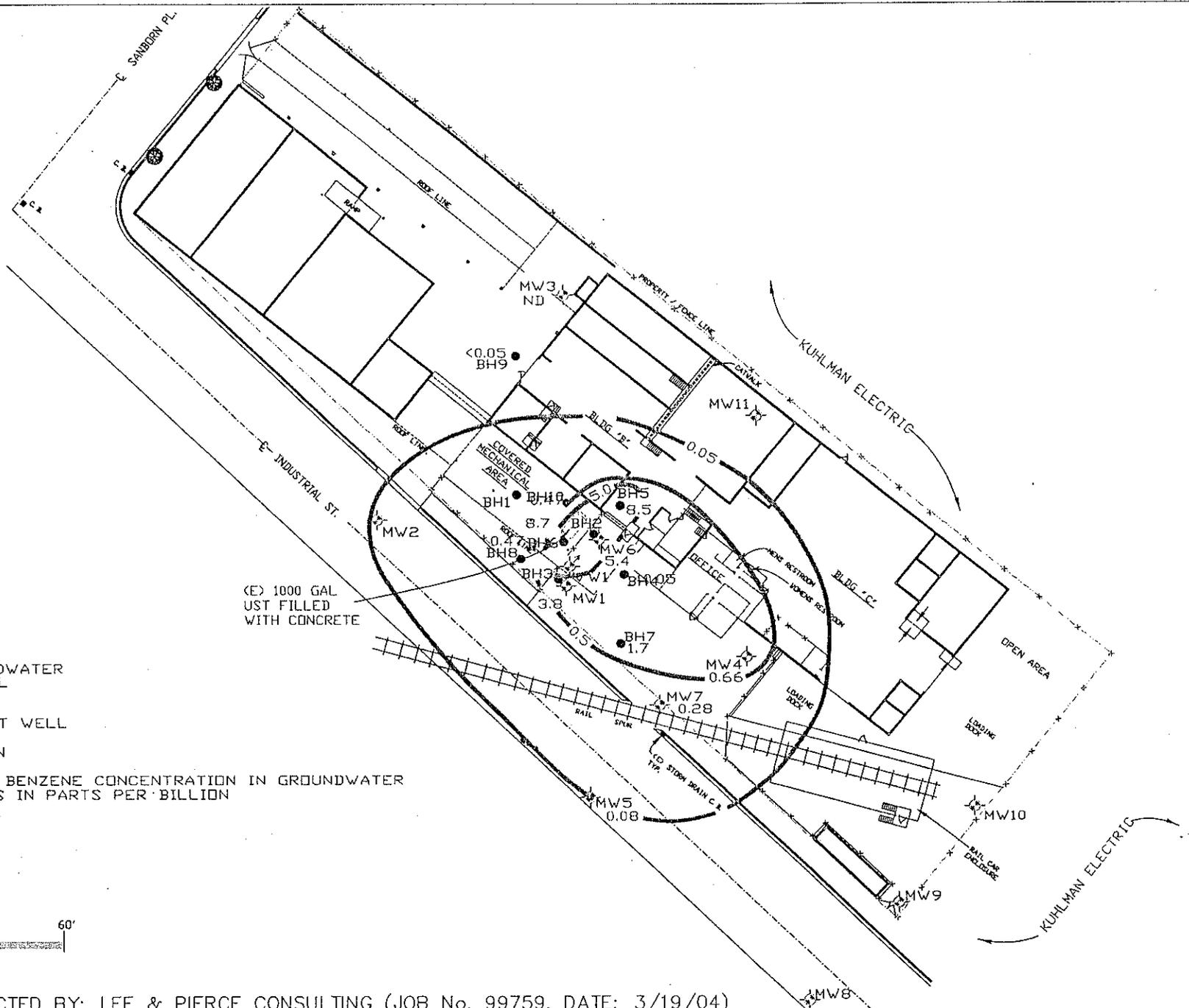
- MW1 EXISTING GROUNDWATER MONITORING WELL
- MW2 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION
- LINE OF EQUAL BENZENE CONCENTRATION IN GROUNDWATER CONCENTRATIONS IN PARTS PER BILLION



SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

**GROUND ZERO ANALYSIS**

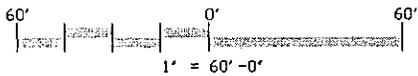
BENZENE IN SOIL 42-52'  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA



**LEGEND:**

- MW1 EXISTING GROUNDWATER MONITORING WELL
- VW1 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION
- 5.0 LINE OF EQUAL BENZENE CONCENTRATION IN GROUNDWATER CONCENTRATIONS IN PARTS PER BILLION

(E) 1000 GAL UST FILLED WITH CONCRETE



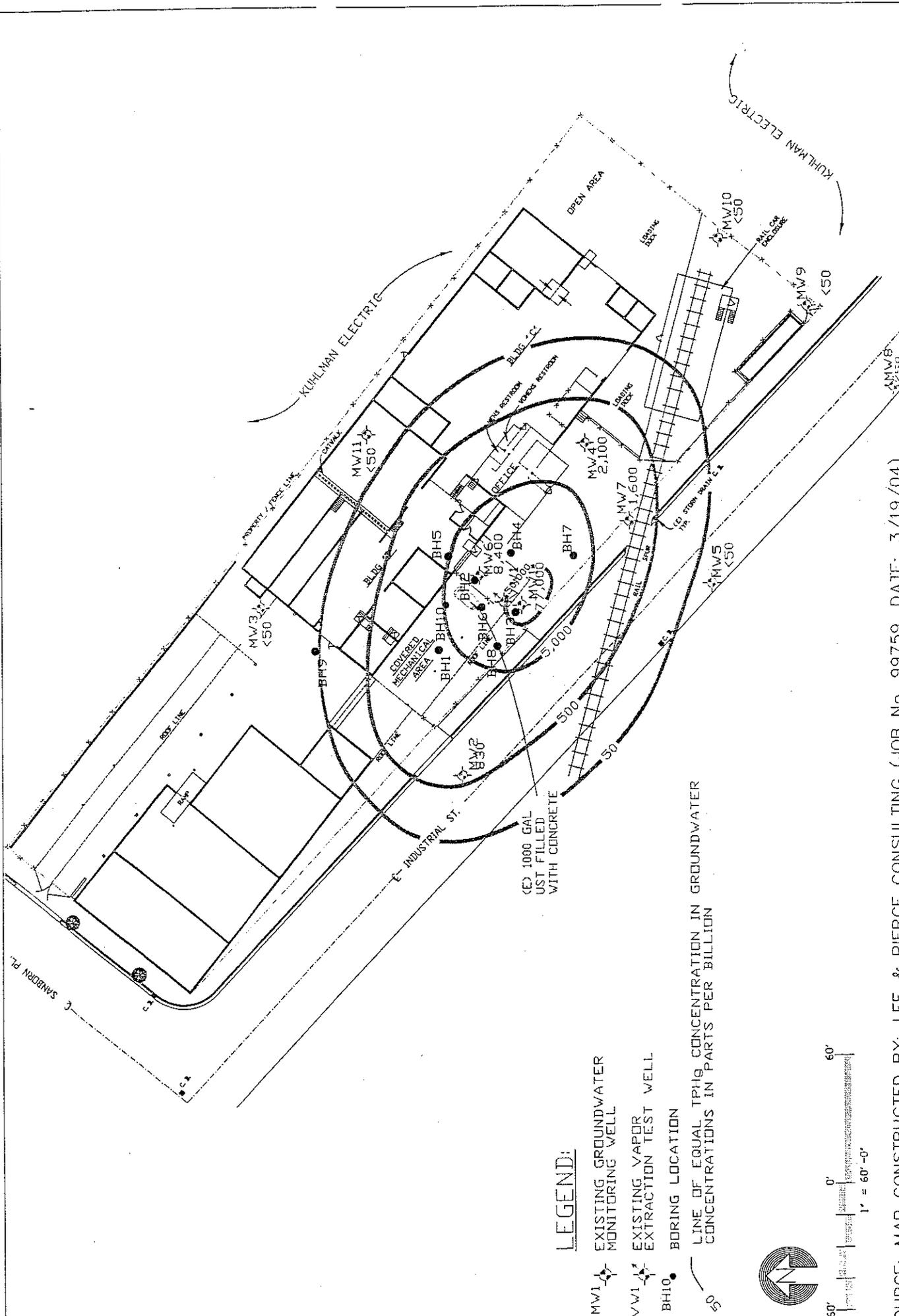
SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

GROUND ZERO ANALYSIS

BENZENE IN SOIL 52-65'  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA

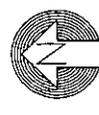
FIGURE  
 B6

FN: 0605/365S



**LEGEND:**

- MW1 EXISTING GROUNDWATER MONITORING WELL
- VW1 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION
- LINE OF EQUAL TPHg CONCENTRATION IN GROUNDWATER CONCENTRATIONS IN PARTS PER BILLION



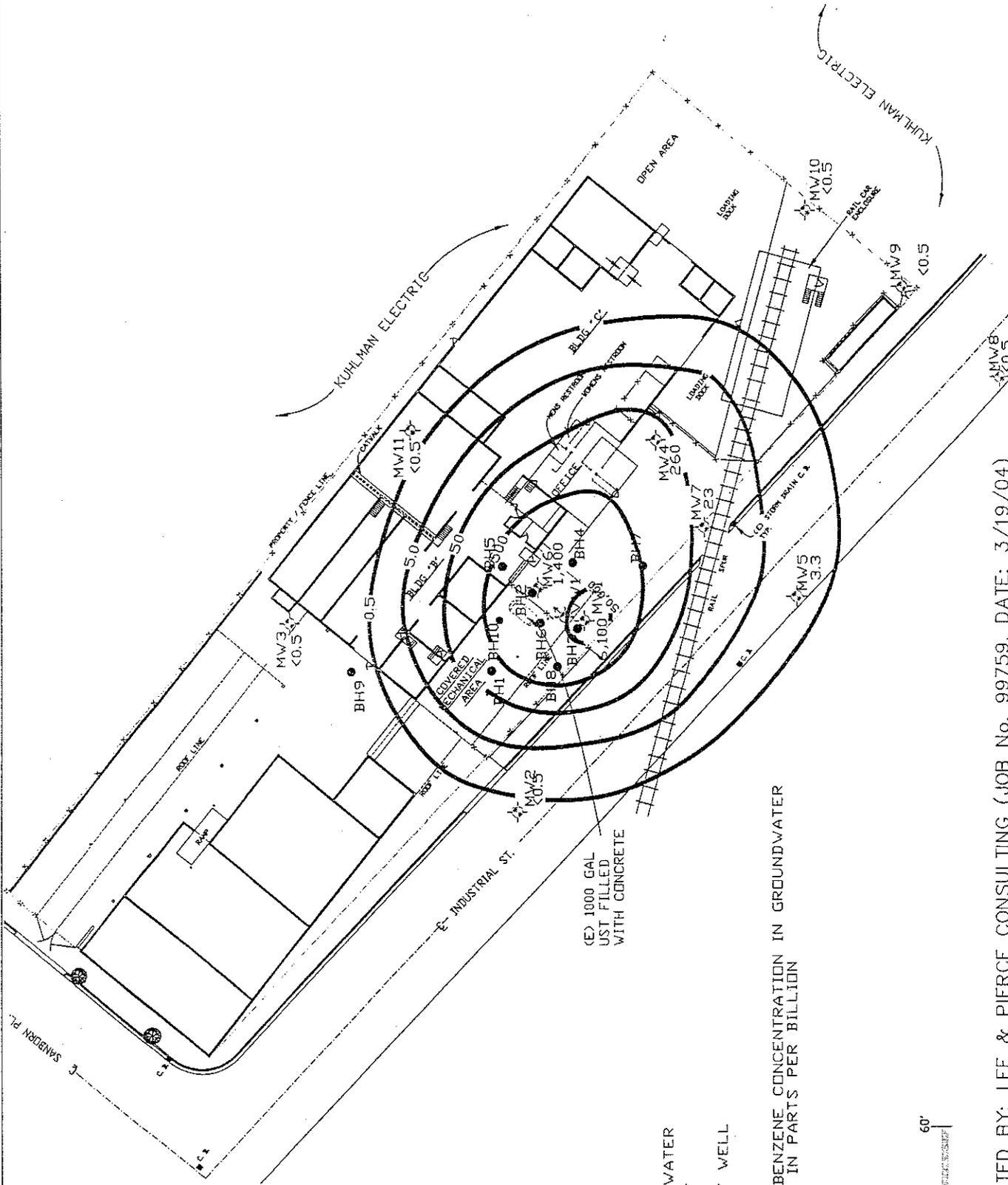
SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

DISSOLVED TPHg ISOPLETH MAP  
 JANUARY 13-14, 2005  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA

**GROUND ZERO ANALYSIS**

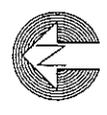
FIGURE  
 B7

FN: 0605/3655



**LEGEND:**

- MW1 EXISTING GROUNDWATER MONITORING WELL
- VW1 EXISTING VAPOR EXTRACTION TEST WELL
- BH10 BORING LOCATION
- LINE OF EQUAL BENZENE CONCENTRATION IN GROUNDWATER CONCENTRATIONS IN PARTS PER BILLION



SOURCE: MAP CONSTRUCTED BY: LEE & PIERCE CONSULTING (JOB No. 99759, DATE: 3/19/04)

DISSOLVED BENZENE ISOPLETH MAP  
 JANUARY 13-14, 2005  
 PURE ETCH COMPANY  
 1031 INDUSTRIAL ST.,  
 SALINAS, CALIFORNIA

**GROUND ZERO ANALYSIS**

## **APPENDIX C**

# **RISK SCREENING EVALUATION MODEL EQUATIONS (FROM PEA GUIDANCE MANUAL)**

FIGURE 2.2: CALCULATION OF RISK/HAZARD FOR WATER

1. Risk for Non-VOCs

$$\text{Risk}_{\text{water}} = (\text{SF}_o \times C_w \times 0.0149) + (\text{SF}_o \times C_w \times 0.0325 \times K_p)$$

2. Risk for VOCs

$$\begin{aligned} \text{Risk}_{\text{water}} = & (\text{SF}_o \times C_w \times 0.0149) + (\text{SF}_i \times C_w \times 0.0149) \\ & + (\text{SF}_o \times C_w \times 0.0325 \times K_p) \end{aligned}$$

3. Hazard for Non-VOCs

$$\text{Hazard}_{\text{water}} = ((C_w/\text{RfD}_o) \times 0.0639) + ((C_w/\text{RfD}_o) \times 0.0644 \times K_p)$$

4. Hazard for VOCs

$$\begin{aligned} \text{Hazard}_{\text{water}} = & (C_w/\text{RfD}_o) \times 0.0639 + (C_w/\text{RfD}_i) \times 0.0639 \\ & + ((C_w/\text{RfD}_o) \times 0.0644 \times K_p) \end{aligned}$$

Where:

$\text{SF}_o$  = oral cancer potency slope,  $(\text{mg}/\text{kg}\text{-day})^{-1}$

$\text{SF}_i$  = inhalation cancer potency slope,  $(\text{mg}/\text{kg}\text{-day})^{-1}$

$C_w$  = concentration in surface or ground water,  $\text{mg}/\text{L}$

$\text{RfD}_o$  = oral reference dose,  $\text{mg}/\text{kg}\text{-day}$

$\text{RfD}_i$  = inhalation reference dose,  $\text{mg}/\text{kg}\text{-day}$ .

$K_p$  = the chemical-specific dermal permeability coefficient from water.<sup>a</sup>

a. Refer to Table 1 in Appendix A (USEPA, 1992, Table 5-7) for the chemical-specific value for organic compounds. If the chemical of concern is not in Table 1, then use a value for a chemical in the Table with similar molecular weight and  $K_{ow}$  values.

FIGURE 2.3: CALCULATION OF RISK/HAZARD FOR SOIL

$$\text{Risk}_{\text{soil}} = (\text{SF}_o \times C_s \times (1.57 \times 10^{-6})) \\ + (\text{SF}_o \times C_s \times (1.87 \times 10^{-5}) \times \text{ABS})$$

$$\text{Hazard}_{\text{soil}} = ((C_s/\text{RfD}_o) \times (1.28 \times 10^{-5})) \\ + ((C_s/\text{RfD}_o) \times (1.28 \times 10^{-4}) \times \text{ABS})$$

Where:

$\text{SF}_o$  = oral cancer slope factor,  $(\text{mg}/\text{kg}\text{-day})^{-1}$   
 $C_s$  = concentration in soil,  $\text{mg}/\text{kg}$   
 $\text{RfD}_o$  = oral reference dose, in units of  $\text{mg}/\text{kg}\text{-day}$ .  
 $\text{ABS}$  = absorption fraction, dimensionless<sup>a</sup>.

a. Refer to Table 2 in Appendix A for the absorption fraction value based on class of compound. For purposes of this document, the term "metals" is taken to include true metals such as cadmium and zinc, as well as metalloid elements, such as arsenic and selenium.

FIGURE 2.4: CALCULATION OF RISK/HAZARD FOR AIR

$$\text{Risk}_a = \text{SF}_i \times C_a \times 0.149$$

$$\text{Hazard}_a = (C_a/\text{RfD}_i) \times 0.639$$

Where:

$\text{SF}_i$  = inhalation cancer slope factor,  $(\text{mg}/\text{kg}\text{-day})^{-1}$

$\text{RfD}_i$  = the inhalation reference dose,  $\text{mg}/\text{kg}\text{-day}$ .

$C_a$  = concentration in air,  $\text{mg}/\text{m}^3$

The value for  $C_a$  is estimated using Figures 2.5, 2.6 & 2.7 for VOCs and Figure 2.8 for non-VOCs.

#### 2.5.2.2 WATER PATHWAY

If water is a pathway for the site, use the equations in Figure 2.2 to calculate the risk and hazard from this pathway. The risk calculated is a summation of ingestion exposure, inhalation of VOCs released from water used indoors, and dermal exposure for child and adult. However, hazard is calculated only for the first 6 years of childhood. If the hazard index is not exceeded for the child, it will not be exceeded for any other age. These equations do not include exposure from ingestion of aquatic organisms in surface water.

#### 2.5.2.3 SOIL PATHWAY

Use the equations in Figure 2.3 to calculate the risk and hazard for the soil pathway. The risk calculated is a summation of the incidental soil ingestion exposure for a child and an adult and the dermal exposure for a child and an adult. However, hazard is calculated only for the first 6 years of

childhood. If the hazard index is not exceeded for the child, it will not be exceeded for any other age. The equations do not include exposure from ingestion of homegrown fruits and vegetables, or products from animal (e.g., meat, milk, eggs) that feed on vegetation grown on contaminated soil.

#### 2.5.2.4 AIR PATHWAY

The risk and hazard for the air pathway are based on either the exposure to volatile emissions for VOCs or the exposure to fugitive dust emissions for non-VOCs. OSA has performed extensive modeling assuming contaminants are present in respirable dust at the respective weight fractions as in site soils, assuming the default value of  $50 \mu\text{g}/\text{m}^3$  for respirable dust in air, and defining a VOC as a chemical with a vapor pressure of 0.001 mm Hg or higher and a Henry's Law constant of  $1 \times 10^{-5}$  or higher. Results showed that using either volatilization or fugitive dust

FIGURE 2.5: CALCULATION OF SATURATION CONCENTRATION FOR VOCs

$$C_{\text{sat}} = \frac{S \times (0.15K_d + 0.015 + 1.16 H_c)}{1.5}$$

If the concentration of the contaminant in the soil is greater than  $C_{\text{sat}}$ , then the equation given in Figure 2.6 is not valid, and the calculation of volatile emissions is beyond the scope of this screening evaluation

Where:

$C_{\text{sat}}$  = Saturation concentration, mg/kg

$K_d$  = soil/water partition coefficient,  $\text{cm}^3/\text{g}$   
(=L-water/kg-soil)  
=  $K_{\text{oc}} \times f_{\text{oc}}$

Where:

$K_{\text{oc}}$  = organic carbon partition  
(refer to Table 3, Appendix A<sup>a</sup>)

$f_{\text{oc}}$  = fraction of organic carbon (default = 0.02)

$S$  = solubility of contaminant in water, mg/L-water  
(refer to Table 3, Appendix A)

$H_c$  = Henry's Law Constant,  $\text{atm}\cdot\text{m}^3/\text{mole}$   
(refer to Table 3, Appendix A)

a. If the  $K_{\text{oc}}$  is not available in Table 3 of Appendix A, refer to Appendix B, Step 1 for the appropriate equation.

Note: The above equation incorporates the default parameters and unit conversion factors. Refer to Appendix B for the complete equation and derivation of this simplified equation.

(NOTE for figure 2.5: see Errata Sheet at end of Chapter 2.)

FIGURE 2.6: CALCULATION OF EMISSION RATE FOR VOCs

$$E_i = \frac{1.6 \times 10^5 \times D_i \times \frac{H_c}{K_d} \times C_i}{\sqrt{D_i \times \frac{0.023}{0.284 + 0.046 \times \frac{K_d}{H_c}}}}$$

Where:

- $E_i$  = average emission rate of contaminant i over the residential lot during the exposure interval, mg/sec
- $D_i$  = diffusivity in air for compound i,  $\text{cm}^2/\text{sec}$   
(refer to Table 3, Appendix A)
- $H_c$  = Henry's Law constant,  $\text{atm}\cdot\text{m}^3/\text{mole}$  (refer to Table 3, Appendix A)
- $K_d$  = soil-water partition coefficient,  $\text{cm}^3/\text{g}$ ; calculated in Figure 2.5
- $C_i$  = bulk soil concentration of contaminant i;  
(chemical concentration in soil,  $\text{mg}/\text{kg}$ ,  $\times (10^{-6} \text{ kg}/\text{mg})$ )

---

Note: The above equation includes unit conversion factors for the various parameters. Refer to Appendix B, Step 2 of the Volatile Emission Model for the complete equation and derivation of the condensed equation.

FIGURE 2.7: ESTIMATION OF AIR CONCENTRATION FOR VOCs

Equation:

$$C_a = E_i / 99$$

---

Where:

$C_a$  = ambient air concentration, mg/m<sup>3</sup>

$E_i$  = total emission rate for compound i (mg/second);

---

Derivation:

$$C_a = \frac{E}{LS \times V \times MH}$$

$E$  = emission rate over residential lot (mg/sec)

$LS$  = length dimension perpendicular to the wind (m)  
(default value = 22 m, one side of a square lot 484 m<sup>2</sup> in area)

$V$  = average wind speed within the mixing zone (m/sec)  
(default value = 2.25 m/sec)

$MH$  = mixing height (m) (default value = 2 m)

Therefore:

$$C_a = E / 99$$

FIGURE 2.8: ESTIMATION OF AIR CONCENTRATION FOR non-VOCs

Equation:

$$C_a = C_s \times (5 \times 10^{-8} \text{ kg/m}^3)$$

---

Where:

$C_a$  = concentration in air,  $\text{mg/m}^3$

$C_s$  = concentration in soil,  $\text{mg/kg}$ .

---

Derivation:

$$C_a = C_s \times 0.05 \text{ mg/m}^3 \times (1 \times 10^{-6} \text{ kg / mg})$$

For screening purposes, it is assumed that ambient air particulates are equal to the National Ambient Air Quality Standard for the annual average respirable portion ( $\text{PM}_{10}$ ) of suspended particulate matter of  $50 \mu\text{g/m}^3$  ( $0.05 \text{ mg/m}^3$ ) (USEPA, 1993), and the screening-level assumption is made that 100% of the particulates have the same contaminant concentration (non-VOCs only) as the maximum soil value. It should be noted that this estimation procedure is not applicable to a site which is particularly dusty, i.e. the air quality standard for suspended particulate matter is routinely exceeded. This approach is also not applicable to contaminant fibers, such as asbestos.

Therefore:

$$C_a = C_s \times (5 \times 10^{-8} \text{ kg/m}^3)$$

(Note: See Errata Sheet, Item 3, at end of Chapter 2.)

Volatile Emission Model (EPA, 1991; 1992b; 1992c)

Step 1: Calculate the Saturation Concentration

Use soil bulk concentrations to calculate emission rates, first estimate the saturation concentration ( $C_{sat}$ ) for each contaminant in the vadose zone.  $C_{sat}$  for each contaminant is the concentration at which the adsorptive limit of the soil plus the theoretical dissolution limit of the contaminant in the available soil moisture has been reached. Concentrations greater than  $C_{sat}$  indicate "free-phase" contaminants within the soil matrix. In such an instance, the VOC emission model contained in Step 2 is not valid, and this screening procedure cannot be used.

$$C_{sat} = \frac{(K_d \times C_w \times \beta) + (C_w \times P_w) + (C_w \times H' \times P_a)}{\beta}$$

Where:

$C_{sat}$  = soil saturation concentration, mg/kg

$C_w$  = Upper limit of free moisture in soil (mg/L-water),  
=  $s \times \Theta_m$

Where:

$S$  = solubility of contaminant in water, mg/L-water  
(values can be found in Table 4 of Appendix C)

$\Theta_m$  = soil moisture content, kg-water/kg-soil  
(default = 0.1)

$\beta$  = soil bulk density (kg/L) (default = 1.5)

$P_w$  = water filled soil porosity (unitless)  
=  $P_t - P_a$  (default =  $0.434 - 0.284 = 0.15$ )

Where:

$P_t$  = total soil porosity (unitless)  
=  $1 - \beta/\sigma$   
= 0.434

Where:

$\beta$  = soil bulk density,  
(default =  $1.5 \text{ g/cm}^3$ )  
 $\sigma$  = particle density,  
(default =  $2.65 \text{ g/cm}^3$ )

$$\begin{aligned}
 P_a &= \text{air-filled porosity (unitless)} \\
 &= P_t - \beta \Theta_m \\
 &= 0.284
 \end{aligned}$$

Where:

$$\begin{aligned}
 \beta &= \text{soil bulk density, g/cm}^3, \text{ (default = 1.5)} \\
 \Theta_m &= \text{soil moisture content,} \\
 &\quad \text{cm}^3/\text{g (= g-water/g-soil), (default = 0.1)}
 \end{aligned}$$

$$\begin{aligned}
 H' &= \text{Henry's Law constant (unitless)} \\
 &= H_c \times 41
 \end{aligned}$$

Where:

$$\begin{aligned}
 41 &= \text{a conversion factor to change } H_c \text{ to dimensionless form} \\
 H_c &= \text{the Henry's Law constant, atm-m}^3/\text{mole}
 \end{aligned}$$

$$K_d = \text{soil/water partition coefficient, cm}^3\text{-water/g-soil} \quad (= \text{L/kg})$$

$$K_d = K_{oc} \times f_{oc}$$

Where:

$$K_{oc} = \text{organic carbon partition coefficient, cm}^3\text{-water/g-soil} \quad (= \text{L/kg})$$

(Values can be found in Table 4 of Appendix C.)

$$f_{oc} = \text{fraction of organic carbon in soil, g/g}$$

(default = 0.02)

If  $K_d$  and/or  $K_{oc}$  are not available in Table 4 or in the scientific literature, then estimate them as follows. Use one of the following equations based on the chemical class closest to the subject contaminant.

For aromatic or polynuclear aromatic contaminants:

$$K_{oc} = 10^{((1.00 \log K_{ow}) - 0.21)}$$

For herbicides, fungicides, and non-chlorinated insecticides:

$$K_{oc} = 10^{((1.029 \log_{ow}) - 0.18)}$$

For contaminants which do not fit into either of the classes listed above, use this third equation, which is based primarily on pesticides:

$$K_{oc} = 10^{((0.544 \log K_{ow}) + 1.377)}$$

Where:

$K_{oc}$  = organic carbon partition coefficient, L/kg (mL/g)

$K_{ow}$  = octanol/water partition coefficient, L/kg (ML/g)

### Step 2: Calculate the Total Emission Rate

If bulk soil concentrations do not exceed  $C_{sat}$ , then calculate an emission rate for each contaminant using the equation below. This equation assumes the bulk soil concentration of the contaminant is less than the saturation concentration,  $C_{sat}$ . The default values are the same as those stated in EPA (1991b), except for the area of contamination, (A), the fraction of organic carbon in the soil ( $f_{oc}$ ), and the exposure interval (T). The default value for the exposed surface area is equal to 5,000 square feet ( $4.84 \times 10^6 \text{ cm}^2$  or  $484 \text{ m}^2$ ), the minimum dimensions of a residential lot in California (Hadley and Sedman, 1990). The default value for soil organic carbon is 0.02 (1992b). The default values for exposure interval are 30 yr for carcinogenic risk and 6 yr for non-carcinogenic hazard.

$$E = \frac{2 A D_{ei} P_a K_{as} C_i \times 10^3 \text{ mg/g}}{\sqrt{\pi a T}}$$

Where:

$E_i$  = average emission rate of contaminant i over the residential lot during the exposure interval, mg/sec

A = area of contamination,  $\text{cm}^2$ ; default =  $4.84 \times 10^6 \text{ cm}^2$ ,

$D_{ei}$  = effective diffusivity of compound,  $\text{cm}^2/\text{sec}$   
 =  $D_i (P_a^{3.33}/P_t^2)$

Where:

$D_i$  = diffusivity in air,  $\text{cm}^2/\text{s}$ .  
 (Values are shown in Appendix C, Table 4. If the desired value is not found in Table 4, refer to USEPA (1992b), equation (9), page 13.)

$P_t$  = total soil porosity, unitless  
 =  $1 - (\beta/\rho)$

Where:

$\beta$  = soil bulk density, g/cm<sup>3</sup> (default = 1.5 g/cm<sup>3</sup>)

$\rho$  = particle density, g/cm<sup>3</sup> (default = 2.65 g/cm<sup>3</sup>)

$$P_t = 0.434$$

$P_a$  = air filled soil porosity, unitless

$$= P_t - \Theta_m \beta$$

Where:

$\Theta_m$  = soil moisture content, cm<sup>3</sup>/g (default = 0.1 cm<sup>3</sup>/g)

$$P_a = 0.284$$

$K_{as}$  = soil/air partition coefficient, g/cm<sup>3</sup>

$$= (H_c/K_d) \times 41$$

Where:

$H_c$  = Henry's Law constant, atm-m<sup>3</sup>/mole

41 = conversion factor to change  $H_c$  to dimensionless form

$K_d$  = soil-water partition coefficient (cm<sup>3</sup>-water/g-soil)  
(= L/kg)

$C_i$  = bulk soil concentration of contaminant i, g/g-soil

$T$  = exposure interval, sec (default = 30 yr =  $9.5 \times 10^8$  seconds)

$\alpha$  = conversion factor composed of quantities defined above

$$\alpha = \frac{D_{ef} \times P_a}{P_a + [(\rho)(1 - P_a) / K_{as}]}$$

## DERIVATIONS FOR SCREENING EVALUATION EQUATIONS

Original Equations:

$$\begin{aligned} \text{Risk}_{\text{water}} = & \text{SF}_o \times C_w \times \frac{\text{IR}_{w,\text{adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ day/yr}} \\ & + \text{SF}_o \times C_w \times \frac{\text{IR}_{w,\text{child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ day/yr}} \\ & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{adult}} \times K_p \times \text{EF} \times \text{ED}_{\text{adult}} \times \text{ET}_{\text{adult}} \times 1 \text{ L/1000 cm}^3}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\ & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{child}} \times K_p \times \text{EF} \times \text{ED}_{\text{child}} \times \text{ET}_{\text{child}} \times 1 \text{ L/1000 cm}^3}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}} \end{aligned}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR <sub>w</sub>	=	intake rate (adult = 2 L/day; child = 1L/day)
ET	=	exposure time during showering/bathing (adult, 15 min/shower = 0.25 hr/day; child, four 15 min baths/week = 0.14 hr/day [USEPA, 1992a])
SA	=	skin surface area available for contact (cm <sup>2</sup> ) (adults, 23,000 cm <sup>2</sup> [USEPA, 1992a]; child, 7,200 cm <sup>2</sup> [USEPA, 1989b])
K <sub>p</sub>	=	chemical-specific dermal permeability coefficient from water, cm <sup>2</sup> /hr.

Reduced Equations:

$$\text{Risk}_{\text{water}} = (\text{SF}_o \times C_w \times 0.0149) + (\text{SF}_o \times C_w \times 0.0325 \times K_p)$$

FIGURE 1: DERIVATION OF RISK EQUATION FOR non-VOCs IN WATER

Original Equations:

$$\begin{aligned} \text{Risk}_{\text{water}} = & \text{SF}_o \times C_w \times \frac{\text{IR}_{\text{w,adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ day/yr}} \\ & + \text{SF}_o \times C_w \times \frac{\text{IR}_{\text{w,child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ day/yr}} \\ & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{adult}} \times K_p \times \text{EF} \times \text{ED}_{\text{adult}} \times \text{ET}_{\text{adult}} \times 1 \text{ L}/1000 \text{ cm}^3}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\ & + \text{SF}_o \times C_s \times \frac{\text{SA}_{\text{child}} \times K_p \times \text{EF} \times \text{ED}_{\text{child}} \times \text{ET}_{\text{child}} \times 1 \text{ L}/1000 \text{ cm}^3}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}} \end{aligned}$$

Default exposure factors:

BW	=	body weight, (70 kg adult; 15 kg child)
AT	=	averaging time, 70 yr
EF	=	exposure frequency, 350 day/yr (EPA, 1991)
ED	=	exposure duration (24 yr adult; 6 yr child)
IR <sub>w</sub>	=	intake rate (adult = 2 L/day; child = 1L/day)
ET	=	exposure time during showering/bathing (adult, 15 min/shower = 0.25 hr/day; child, four 15 min baths/week = 0.14 hr/day [USEPA, 1992a])
SA	=	skin surface area available for contact (cm <sup>2</sup> ) (adults, 23,000 cm <sup>2</sup> [USEPA, 1992a]; child, 7,200 cm <sup>2</sup> [USEPA, 1989b])
K <sub>p</sub>	=	chemical-specific dermal permeability coefficient from water, cm <sup>2</sup> /hr.

Reduced Equations:

$$\text{Risk}_{\text{water}} = (\text{SF}_o \times C_w \times 0.0149) + (\text{SF}_o \times C_w \times 0.0325 \times K_p)$$

FIGURE 2: DERIVATION OF RISK EQUATION FOR VOCs IN WATER

Original Equations:

$$\text{Risk}_{\text{voc,water}} = \text{Risk}_{\text{water}} + \frac{\text{SF}_i \times C_w \times \text{IR}_{\text{voc,adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}}$$
$$+ \frac{\text{SF}_i \times C_w \times \text{IR}_{\text{voc,child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}}$$

Default exposure factors:

- BW = body weight, (70 kg adult; 15 kg child)
- AT = averaging time, 70 yr
- EF = exposure frequency, 350 day/yr (EPA, 1991)
- ED = exposure duration (24 yr adult; 6 yr child)
- IR<sub>voc</sub> = intake from inhalation of VOCs from domestic use of water is equivalent to the amount of ingested water (USEPA, 1989c).

Reduced Equations:

$$\text{Risk}_{\text{water}} = [0.0149 \times ((\text{SF}_o \times C_w) + (\text{SF}_i \times C_w))] + (\text{SF}_o \times C_w \times 0.0325 \times K_p)$$

FIGURE 3: DERIVATION OF HAZARD EQUATION FOR non-VOCs IN WATER

Original Equation:

$$\text{Hazard}_w = (1/\text{RfD}_o) \times \frac{C_w \times \text{IR}_w \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}} +$$

$$(1/\text{RfD}_o) \times \frac{C_w \times \text{SA} \times K_p \times \text{ET} \times \text{EF} \times \text{ED} \times (1 \text{ L}/1000 \text{ cm}^3)}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}}$$

Default exposure factors (for childhood exposure from birth to six years of age):

- BW = body weight = 15 kg  
 AT = averaging time = 6 yr  
 EF = exposure frequency = 350 day/year (EPA, 1991)  
 ED = exposure duration = 6 yr  
 IR<sub>w</sub> = daily intake of water = 1 L/day  
 ET = exposure time = 0.14 hours/day; based on the assumption of four 15 minute baths taken weekly.  
 SA = skin surface area (cm<sup>2</sup>) exposed during bathing = 7,200 cm<sup>2</sup>  
 K<sub>p</sub> = chemical-specific dermal permeability coefficient from water

Reduced Equations:

$$\text{Hazard}_{\text{water}} = ((C_w/\text{RfD}_o) \times 0.0639) + ((C_w/\text{RfD}_o) \times 0.0644 \times K_p)$$

FIGURE 4: DERIVATION OF HAZARD EQUATION FOR VOCs IN WATER

Original Equation:

$$\text{Hazard}_w = (1/\text{RfD}_o) \times \frac{C_w \times \text{IR}_w \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}} +$$

$$(1/\text{RfD}_i) \times \frac{C_w \times \text{IR}_{w,\text{voc}} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}} +$$

$$(1/\text{RfD}_o) \times \frac{C_w \times \text{SA} \times K_p \times \text{ET} \times \text{EF} \times \text{ED} \times (1 \text{ L}/1000 \text{ cm}^3)}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Default exposure factors (for childhood exposure from birth to six years of age):

BW = body weight = 15 kg

AT = averaging time = 6 yr

EF = exposure frequency = 350 day/year (EPA, 1991)

ED = exposure duration = 6 yr

$\text{IR}_{w,\text{voc}}$  = intake from inhalation of VOCs + ingestion rate = 1L/day  
 (A chemical is a VOC if it has a vapor pressure greater than  $1 \times 10^{-3}$  mm Hg or a Henry's Law constant greater than  $1 \times 10^{-5}$  atm-m<sup>3</sup>/mole). The increased intake for VOCs is to account for the additional exposure via inhalation of volatilized compounds from domestic use of water (USEPA, 1989c).

ET = exposure time = 0.14 hours/day; based on the assumption of four 15 minute baths taken weekly.

SA = skin surface area (cm<sup>2</sup>) exposed during bathing = 7,200 cm<sup>2</sup>

$K_p$  = chemical-specific dermal permeability coefficient from water

Reduced Equations:

$$\text{Hazard}_{\text{water}} = [0.0639 \times ((C_w/\text{RfD}_o) + (C_w/\text{RfD}_i))] + [(C_w/\text{RfD}_o) \times 0.0644 \times K_p]$$

FIGURE 5: DERIVATION OF RISK EQUATION FOR SOIL

Original Equation:

$$\begin{aligned} \text{Risk}_{\text{soil}} = & \frac{\text{SF}_o \times C_s \times \text{IR}_{\text{s,adult}} \times \text{EF} \times \text{ED}_{\text{adult}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\ & + \frac{\text{SF}_o \times C_s \times \text{IR}_{\text{s,child}} \times \text{EF} \times \text{ED}_{\text{child}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}} \\ & + \frac{\text{SF}_o \times C_s \times \text{SA}_{\text{adult}} \times \text{AF} \times \text{ABS} \times \text{EF}_{\text{adult}} \times \text{ED}_{\text{adult}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\ & + \frac{\text{SF}_o \times C_s \times \text{SA}_{\text{child}} \times \text{AF} \times \text{ABS} \times \text{EF}_{\text{child}} \times \text{ED}_{\text{child}} \times 10^{-6} \text{ kg/mg}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ days/yr}} \end{aligned}$$

Default exposure factors:

- AT = averaging time = 70 years
- EF = exposure frequency for soil ingestion = 350 day/yr (EPA, 1991a)  
= exposure frequency for dermal contact = 2 events/week or 100 day/yr for adults, and 7 events/week or 350 days/year for children (USEPA, 1991a)
- ED = exposure duration; 24 yr for adults and 6 yr for children
- IR<sub>s</sub> = incidental soil ingestion rate, mg/day; 100 mg/day for adults and 200 mg/day for children (USEPA, 1991a)
- BW = body weight; adults = 70 kg, children = 15 kg (USEPA, 1991a)
- SA = skin surface area exposed (cm<sup>2</sup>); adult = 5,800 cm<sup>2</sup>/day, child = 2,000 cm<sup>2</sup>/day (DTSC, 1992, Chapter 1)
- AF = soil to skin adherence factor, mg/cm<sup>2</sup>; default value is 1.00 mg/cm<sup>2</sup> (EPA, 1992)
- ABS = absorption fraction of chemical from soil

Reduced Equation:

$$\begin{aligned} \text{Risk}_{\text{soil}} = & (\text{SF}_o \times C_s \times 4.7 \times 10^{-7}) + (\text{SF}_o \times C_s \times 1.1 \times 10^{-6}) + \\ & (\text{SF}_o \times C_s \times 7.8 \times 10^{-6} \times \text{ABS}) + (\text{SF}_o \times C_s \times 1.1 \times 10^{-5} \times \text{ABS}) \end{aligned}$$

FIGURE 6: DERIVATION OF HAZARD EQUATION FOR SOIL

Original Equation:

$$\text{Hazard}_{\text{soil}} = \frac{(1/\text{RfD}_o) \times C_s \times \text{IR}_s \times \text{EF} \times \text{ED} \times 10^{-6} \text{ kg/mg}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}}$$
$$+ \frac{(1/\text{RfD}_o) \times C_s \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED} \times 10^{-6} \text{ kg/mg}}{\text{BW} \times \text{AT} \times 365 \text{ days/yr}}$$

Default exposure factors (based on childhood exposure from birth to six years of age):

- $\text{IR}_s$  = incidental soil ingestion rate = 200 mg/day
- $\text{EF}$  = exposure frequency, 350 days/year for soil ingestion and dermal contact (EPA, 1991).
- $\text{ED}$  = exposure duration = 6 years
- $\text{BW}$  = body weight = 15 kg (USEPA, 1991a)
- $\text{AT}$  = averaging time = 6 years
- $\text{SA}$  = skin surface area exposed = 2,000  $\text{cm}^2$
- $\text{AF}$  = soil to skin adherence factor = 1  $\text{mg}/\text{cm}^2$  (USEPA, 1992a)
- $\text{ABS}$  = absorption fraction of chemical from soil (See Table 3)

Reduced Equation:

$$\text{Hazard}_{\text{soil}} = [(C_s/\text{RfD}_o) \times 1.28 \times 10^{-5}] + [(C_s/\text{RfD}_o) \times 1.28 \times 10^{-4} \times \text{ABS}]$$

FIGURE 7: DERIVATION OF RISK EQUATION FOR AIR

Original Equation:

$$\text{Risk}_{\text{air}} = \text{SF}_i \times \text{C}_a \times \frac{\text{IR}_{\text{adult}} \times \text{EF} \times \text{ED}_{\text{adult}}}{\text{BW}_{\text{adult}} \times \text{AT} \times 365 \text{ days/yr}} \\ + \text{SF}_i \times \text{C}_a \times \frac{\text{IR}_{\text{child}} \times \text{EF} \times \text{ED}_{\text{child}}}{\text{BW}_{\text{child}} \times \text{AT} \times 365 \text{ day/yr}}$$

Default exposure factors for risk:

- BW = body weight = 70 kg for adults, 15 kg for children
- AT = averaging time, 70 yr
- EF = exposure frequency, 350 day/yr (EPA, 1991)
- ED = exposure duration = 24 yr for adults, 6 yr for children
- IR<sub>a</sub> = inhalation rate = 20 m<sup>3</sup>/day for adults, 10 m<sup>3</sup>/day for children (EPA, 1989a; Schum, et al., 1993).

Reduced Equation:

$$\text{Risk}_{\text{air}} = (\text{SF}_i \times \text{C}_a \times 0.0939) + (\text{SF}_i \times \text{C}_a \times 0.0548) \\ = \text{SF}_i \times \text{C}_a \times 0.149$$

FIGURE 8: DERIVATION OF HAZARD EQUATION FOR AIR

Original Equation:

$$\text{Hazard}_{\text{air}} = (1/\text{RfD}_i) \times C_a \times \frac{\text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT} \times 365 \text{ day/yr}}$$

Default exposure factors (based on childhood exposure from birth to six years):

BW = body weight, 15 kg

AT = averaging time, 6 years

EF = exposure frequency, 350 day/yr

ED = exposure duration, 6 yr

IR<sub>a</sub> = inhalation rate, 10 m<sup>3</sup>/day (Schum, et al., 1993)

Reduced Equation:

$$\text{Hazard}_{\text{air}} = (1/\text{RfD}_i) \times C_a \times 0.639$$