Weiss Associates *Environmental and Geologic Services*

5500 Shellmound Street, Emeryville, CA 94608-2411 FAX: 510-547-5043 Phone: 510-450-6000

TRANSMITTAL

DATE:	July 10, 1996	**PROJECT #:**	4-0630-70
TO:	Juliet Shin Alameda County Department of Environmental Health Services 1131 Harbor Bay Parkway, #250 Alameda, CA 94502	**FAX #:**	(510) 337-9335
CC:	Phil Briggs, Chevron USA Products Company	**FAX #:**	Chevron
FROM:	Mike Cooke, (510) 450-6150		
SUBJECT:	**Preliminary Gardening Scenario RBCA results, Chevron Service Station 9-1153, 3126 Fernside Blvd, Alameda**		

VIA:	FAX:	AS:	FOR:
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Please call (510) 450-6000 if there are any problems with transmission.

COMMENTS:

Dear Juliet,

Summarized below are the results of the calculation of potential health risk posed by residual hydrocarbons for the residential gardening scenario at the subject site followed by the calculation.

The RBCA Tier 2 dissolved benzene SSTL concentration is 457 mg/L for residential receptors in the outdoor air gardening scenario. The SSTL is based on a conservative 10^{-5} risk level and the California dose response slope factor for benzene. The 95% UCL for dissolved benzene in well C-1 (27 mg/L) is more than an order of magnitude below the SSTL concentration. The risk level corresponding to the 95% UCL is 5.9 x 10-7 risk (less than one in one million). The SSTL concentration was calculated using the following site specific gardening scenario parameters:

- Lgw: *Depth to ground water*. The depth to ground water was calculated from the average depth to ground water in well C-1 minus 0.5 feet to account for gardening excavations. Gardening excavations were assumed to span the entire width of the impacted ground water area for the entire duration of exposure.
- δair: *Ambient air mixing height*. The ambient air mixing height was assumed to be approximately equal to 2 feet or about an arms length from the ground. This mixing height corresponds to the height of inhalation for a receptor whose hands touch the ground surface for the entire time working in the garden.
- EF: *Exposure frequency*. The exposure frequency of 3 hours gardening per week is based on regular activity and does not account for time off due to vacations or the winter season. In addition, the small area available for gardening at the subject site may require less than 3 hours per week to maintain.

Application of these conservative site specific parameters indicates that gardening activities do not present significant risk to human health at the above referenced site.

Please call us at (510) 450-6000 if you have any questions.

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Calculation of SSTL for Ground Water Volatilization to Outdoor Air

Residential Gardening Scenario

Former Chevron Service Station # 9-1153, 3126 Fernside Boulevard, Alameda, California

	Soil Specific Parameters		
ASTM 96	ρ_s	1.7	Bulk Density(g/cm^3)
ASTM 96	θ_{as}	0.26	Air Content (v/v)
ASTM 96	θ_{ws}	0.12	Water Content (v/v)
ASTM 96	θ_t	0.38	Porosity (v/v)
Calculated	h_v	98	Thickness of Vadose Zone (cm)
ASTM 96	θ_{acap}	0.038	Capillary Fringe Air Content (v/v)
ASTM 96	θ_{wcap}	0.342	Capillary Fringe Water Content (v/v)
ASTM 96	h_{cap}	5	Thickness of Capillary Fringe (cm)

	Diffusivity Parameters		
		benzene	Chemical Name
ASTM 96	H	0.22	Henry's Constant
ASTM 96	D^{air}	9.30E-02	Air Diffusion Coefficient (cm^2/s)
ASTM 96	D^{wat}	1.10E-05	Water Diffusion Coefficient (cm^2/s)
Calculated	D^{eff}_s	0.007258	Effective Diffusion Coefficient soil (cm^2/s)
Calculated	D^{eff}_{cap}	2.17E-05	Capillary Fringe Effective Diffusion Coefficient soil (cm^2/s)
Calculated	D^{eff}_{ws}	0.000423	Effective Diffusion Coefficient between ground water and soil surface (cm^2/s)

	Site specific parameters		
Site Specific	L_{gw}	103	Depth to ground water (cm) ◄ Average depth to ground water in well C-1 minus 0.5 foot depth of garden excavation.
ASTM 96	U_{air}	225	Air velocity (cm/sec)
ASTM 96	W	1500	Width of plume parallel to velocity (cm)
Site Specific	δ_{air}	60	Ambient air mixing height (cm) ◄ Approximately 2 feet (arms length).
Calculated	VF_{wamb}	0.0001	Volatilization factors, ground water -> outdoor (mg/m^3-air)/(mg/L-H_2O)

	RBSL Calculation		
ASTM 96	IR_{air}-outdoor	20	Outdoor air inhalation rate - residential (m^3/day)
Site Specific	EF	6.5	Exposure frequency - residential (day/yr) ◄ One day per week for 3 hour duration.
ASTM 96	ED	30	Exposure duration - residential (yr)
CAL EPA	SFi	0.1	Benzene cancer slope factor (kg-day/mg)
ASTM 96	TR	1.00E-05	Cancer risk
ASTM 96	BW	70	Body weight (kg)
ASTM 96	ATc	70	Averaging time for carcinogens (yr)
Calculated	$RBSL_{air}$	45.9	SSTL - ambient air (ug/m^3 - air)

Notes:

ASTM 96 - Parameter from: American Society for Testing and Materials, Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, March 5 1996.

$h_v = L_{gw} - h_{cap}$.

D^{eff}_s, D^{eff}_{cap}, D^{eff}_{ws}, VF_{wamb} : Calculated from equations presented in ASTM 96 Table X2.5.

$RBSL_{air}$, $RBSL_w$: Calculated from equations presented in ASTM 96 Table X2.3.

Weiss Associates

Environmental and Geologic Services

5500 Shellmound Street, Emeryville, CA 94608-2411 *FAX: 510-547-5043 Phone: 510-450-6000*

TRANSMITTAL

what is EF? ED? not 3 MSL/acceptability?
it's not acceptable!
Ken will

DATE:	June 19, 1996	**PROJECT #:**	4-0630-70
TO:	Juliet Shin	**PHONE:**	567-6763
COMPANY:	Alameda County Health Care Services 1131 Harbor Bay Parkway	**FAX:**	337-9335
FROM:	Mike Cooke, (510) 450-6150		

ENCLOSED PLEASE FIND: **Preliminary RBCA results, Chevron Service Station 9-1153, 3126 Fernside Blvd, Alameda**

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☐ Courier			

Please call (510) 450-6000 if there are any problems with transmission.

COMMENTS:

Dear Juliet:

Summarized below is the calculation of the potential health risk for residential receptors for the ground water to outdoor air exposure pathway followed by the calculation sheets which present the calculation details.

The result of the 95 % upper confidence limit (95%UCL) calculation for dissolved benzene concentration in well C-1 was 27 mg/L. The 95% UCL is an estimator of the mean benzene concentration (with 95% certainty, the true mean of the dissolved benzene concentration is less than 27 mg/L).

The RBCA Tier 1 RBSL is 32 mg/L for residential receptors in the ground water-to-outdoor-air-pathway, 10^{-5} risk and California dose response for benzene. The site passes Tier 1 using the 95%UCL as a representative dissolved benzene concentration. However, the Tier 1 default value for depth to ground water is not conservative in this case (3 meters below ground surface). The average depth to water in well C-1 is 1.18 meters. Benzene flux (and ultimately dose) is inversely proportional to depth to ground water in the Tier 1 RBSL model for

volatilization from ground water-to-outdoor-air. The Tier 1 RBSL is 13 mg/L if the site specific depth to water is taken into account.

We performed a preliminary Tier 2 SSTL calculation using the site specific depth to ground water and a conservative 730 day 1/2 life for benzene in ground water (730 days is the longest benzene 1/2 life listed in the ASTM standard guidance). The SSTL was 330 mg/L for residential receptors and 10^{-5} risk. The site passes the ground water-to-outdoor-air pathway at Tier 2.

We will send you the results of our "residential gardening scenario" risk evaluation by the end of the week or early next week.

Please don't hesitate to call if you have questions or have additional requirements.

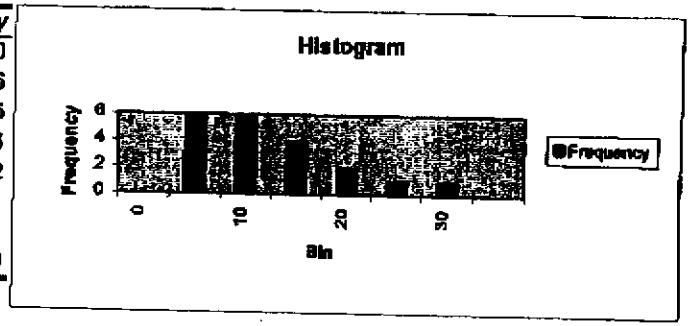
Calculation of 95% UCL - Dissolved benzene concentrations in Well C-1
Chevron Service Station 9-1153, 3126 Fernside Boulevard, Alameda, CA

benzene ground water (mg/L)	Arithmetic bin (mg/L)	Ln benzene ground water Ln(mg/L)	Lognormal bin Ln(mg/L)
0.76	0	-0.27	-1
0.25	5	-1.39	0
3.8	10	1.34	1
8	15	2.08	2
12	20	2.48	3
4.26	25	1.45	4
10	30	2.30	
4.9		1.59	
5.8		1.76	
9.4		2.24	
11		2.40	
1.5		0.41	
7.3		1.99	
27		3.30	
12		2.48	
8.6		2.15	
12		2.48	
19		2.94	
23		3.14	
18		2.89	
	mean=	1.89	
	s=	1.16	
	s^2=	1.35	
	n=	20	
	H(95)=	2.79	
	UCL-95(mg/L)=	27	

Residential GW to Outdoor Air Tier 1 RBSL (10^{-5} risk) = 32 mg/L

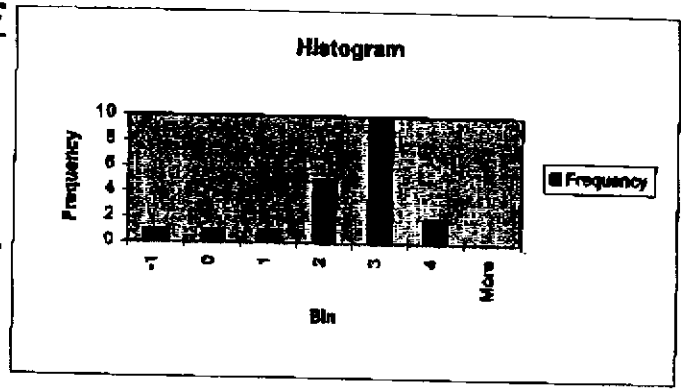
ARITHMETIC

Bin	Frequency
0	0
5	6
10	5
15	4
20	2
25	1
30	1
More	0



LOGNORMAL

Bin	Frequency
-1	1
0	1
1	1
2	5
3	10
4	2
More	0



Site Specific RBCA Tier 1 Analysis, Chevron Service Station 9-1153, 3126 Fernside Boulevard, Alameda, CA

WA implementation of Jury model, from Sanders and Stern 1994
adapted for GW as initial source

Appendix ___ - CALCULATIONS - Residential Receptor - Ground Water to Outdoor Air SSTL

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source			
		Soil Specific Parameters	
ASTM 96	ρ_s	1700	Bulk Density(kg/m^3)
ASTM 96	θ_{as}	0.26	Air Content (v/v)
ASTM 96	θ_{ws}	0.12	Water Content (v/v)
ASTM 96	θ_t	0.38	Porosity (v/v)
		Chemical Specific Parameters	
		benzene	Chemical Name
ASTM 96	H	0.222	Henry's Constant
Howard	Thalf	730	Contaminant Half Life (d) in GW, Howard 1991
ASTM 96	D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 96	D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
ASTM 96	f_{oc}	0.01	Organic Carbon Fraction
ASTM 96	K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg) (Log Koc = 1.58)
calc, Jury	D^{eff}	1.95E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stern)

C_{water}	27	Ground Water Concentration (mg/L)
Co	5.994	(g/m^3)
L	1.18	Depth to Contamination (m) ≅ 4'
W	6,378,000	Thickness of Contamination Zone (m)
A	225	Zone of Influence (m^2)
Qb	243,000	Outdoor air Ventilation Rate (m^3/Hr)
I	20	Inhalation volume (m^3/day)

95% UCL of benzene concentrations in well C-1
Conc * Kh
Average depth to ground water in C-1
Radius of earth (eq. to infinite thickness, non-receding source)
ASTM plume width^2 = (15m)^2 = 225m^2
Int= 200 cm(ASTM), air velocity = 225cm/sec (ASTM)
20 m^3/day (ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	0.59	x=(ln(2)/Thalf)^.5 (yr^-.5)
y	0.2360892	y=L/(2*D^{eff}a^.5) (yr^.5)
z	1288892.8	z=(L+W)/(2*D^{eff}a^.5) (yr^.5)

Integration Constants

ICs	0.0097341	ICs=(Co*A*I*D^{eff}a^.5)/(2*a^*Qb) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right)\theta_t^{\,2}}{\left(\rho_s f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoAI}{2xQb}\sqrt{Dx}\left[\exp(2yx)erf\left(x\sqrt{t} + \frac{y}{\sqrt{t}}\right) + \exp(-2yx)erf\left(x\sqrt{t} - \frac{y}{\sqrt{t}}\right)\right]_{\sqrt{ti}}^{\sqrt{tf}}$$

Integration

0.0001	Lower Time Limit (yr)	30	Upper Time Limit (yr)
0.01	Sq root LTL (yr^.5)	5.48	Sq root UTL (yr^.5)
1.323565	Term 1	1.32356	Term 1
-0.75554	Term2	0.75553	Term2

Site dose (mg)=	14.7	=	2.4E-07 risk
Acceptable Dose (mg) =	620	=	1.0E-05 risk

Site Specific RBCA Tier 2 Analysis, Chevron Service Station 9-1153, 3126 Fernside Boulevard, Alameda, CA
Backcalculate to acceptable concentration= SSTL

Appendix ___ - CALCULATIONS - Residential Receptor - Ground Water to Outdoor Air SSTL

Default Chemical and Soil Values (symbol notation from ASTM for consistency)

Source			
	Soil Specific Parameters		
ASTM 96	ρ_b	1700	Bulk Density(kg/m^3)
ASTM 96	θ_{as}	0.26	Air Content (v/v)
ASTM 96	θ_{ws}	0.12	Water Content (v/v)
ASTM 96	θ_T	0.38	Porosity (v/v)
	Chemical Specific Parameters	benzene	Chemical Name
ASTM 96	H	0.222	Henry's Constant
Howard	Thalf	730	Contaminant Half Life (d) in GW (Howard, 1991)
ASTM 96	D^{air}	9.30E-06	Air Diffusion Coefficient (m^2/s)
ASTM 96	D^{wat}	1.10E-09	Water Diffusion Coefficient (m^2/s)
ASTM 96	f_{oc}	0.01	Organic Carbon Fraction
ASTM 96	K_{oc}	0.038	Organic Carbon Partition Coefficient (m^3/Kg)
			(Log Koc = 1.58)
calc, Jury	D^{eff}	1.95E-07	Effective Diffusion Coefficient (m^2/s)

Site Specific Parameters (symbol notation consistent with Sanders and Stern)

	330	SSTL mg/L (California Dose Response)	
C_{water}	1,136	Ground Water Concentration (mg/L)	
Co	252.66841	(g/m^3)	Conc * Kh
L	1.18	Depth to Contamination (m)	Average depth to ground water in C-1
W	8,378,000	Thickness of Contamination Zone (m)	Radius of earth (eq. to infinite thickness, non-receeding source)
A	225	Zone of Influence (m^2)	ASTM plume width^2 = (15m)^2 = 225m^2
Qb	243,000	Outdoor air Ventilation Rate (m^3/Hr)	ht= 200 cm(ASTM), air velocity = 225cm/sec (ASTM)
I	20	Inhalation volume (m^3/day)	20 m^3/day (ASTM)

Equation Parts a, b and c : a=x, b=y,c=z

x	0.59	x=(ln(2)/Thalf)^.5 (yr^-.5)
y	0.2360892	y=L/(2*D^{wat}^.5) (yr^.5)
z	1288892.8	z=(L+W)/(2*D^{eff}^.5) (yr^.5)

Integration Constants

ICs	0.4103078	ICs=(Co*A*I*D^{eff}^.5)/(2*a**Qb) (grams)

Formulas

$$D^{eff} = \frac{\left(\theta_{as}^{10/3} D^{air} H + \theta_{ws}^{10/3} D_{wat}\right)\theta_T^{\,2}}{\left(\rho_b f_{oc} K_{oc} + \theta_{ws} + \theta_{as} H\right)}$$

$$dose = \frac{CoAI}{2xQb}\sqrt{De}\left[\exp(2yx)erf\left(x\sqrt{t} + \frac{y}{\sqrt{t}}\right) + \exp(-2yx)erf\left(x\sqrt{t} - \frac{y}{\sqrt{t}}\right)\right]_{\sqrt{ti}}^{\sqrt{tf}}$$

Integration

0.0001	Lower Time Limit (yr)	30	Upper Time Limit (yr)
0.01	Sq root LTL (yr^.5)	5.48	Sq root UTL (yr^.5)
1.323585	Term 1	1.32358	Term 1
-0.75554	Term2	0.75553	Term2

Site dose (mg)=	620	=	1.0E-05 risk
Acceptable Dose (mg) =	620	=	1.0E-05 risk

$$RBSL_{ani} = \frac{10^{-6} \times 70\,kg \times (70 \times 365) \times 10^{3}}{\cdot 029 \times 20 \times 350 \times 30\,yrs}$$

$$\frac{17885}{6090} \qquad \frac{17885}{6090}$$

$$= 0.293.$$

$$RBSL_{w} = \frac{0.293}{1.1 \times 10^{-5}} \times 10^{-3}$$

~~266.98~~ 26.63 for 10^{-6}

22852 → 50 689-1405

$$V_{F amb} = \frac{H}{1 + \left[\frac{V_{air} + S_{air} L_{GW}}{WD^{eff}_{ws}}\right]} \times 10^3$$

$$= \frac{0.22}{1 + \left[\frac{225 \times 200 \times 118}{1500 \times 1.83 \times 10^{-4}}\right]} \times 10^3$$

$$= \frac{0.22}{1 + \frac{5310000}{0.2745}} \times 10^3$$

$$= \frac{0.22}{19344263.3} \times 10^3 = 1.1 \times 10^{-5}$$

$$Deff_{ws} = \left[15 + 113\right]\left[\frac{15}{2.2 \times 10^{-5}} + \frac{113}{7.4 \times 10^{-8}}\right]^{-1} = (128)\left(\frac{1}{681818.1 + 152710}\right)^{-1}$$

$$= \frac{1.83 \times 10^{-4}}{(128 \times 1.4 \times 10^{-6})}$$

$$Deff_{cap} = .093 \times \frac{.038^{3.33}}{.38^2} + 1.1 \times 10^{-5} \times \frac{0.342}{0.38^2} \times \frac{3.33}{0.22} \times 1$$

$$.093 \times \frac{1.8 \times 10^{-5}}{0.14} + 1.1 \times 10^{-5} \times \frac{.0280}{0.14} \times \frac{1}{0.22}$$

$$\frac{1.8 \times 10^{-6}}{3.33} + 1 \times 10^{-5} = 2.2 \times 10^{-5}$$

$$Ds_{eff} = .093 \times \frac{0.26}{0.38^2} + 1.1 \times 10^{-5} \frac{\times 0.12}{0.38^2} \times \frac{3.33}{1/0.22}$$

$$\left(.093 \times \frac{1.1 \times 10^{-2}}{0.14}\right) + \left(1.1 \times 10^{-5} \times \frac{8.5 \times 10^{-4}}{0.14} \times \frac{1}{0.22}\right)$$

$$7.4 \times 10^{-3} + 3.06 \times 10^{-7}$$

$$= 7.4 \times 10^{-3}$$