Chevron

Research and Technology

Facsimile Message

Date 9/27/96

TO:
Name Jennifer Eberle
Company ACHCS
City Alameda
Facsimile Number 510-337-9335

FROM:
Name Curt Peck
Company CRTC
Building/Room
Phone Number 510-242-7086

Number of Pages (including cover) 11

Special Instructions

Jennifer - I have re-run the calculations using agreed upon soil samples and made corrections to original calculations. Please review & comment.

Thanks

Curt Peck

If you do not receive all pages, please phone sender.

Our Facsimile information: **Ricoh 3100L** **Facsimile Number (510) 242-1380**

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1003 West Cutting Blvd.
P.O. Box 4054
Richmond, California 94804-0054

MEMORANDUM

"Jennifer's note"

September 27, 1996
Richmond, California

Amended Risk Evaluation
Former Gulf Service Station #G-0006
460 Grand Avenue, Oakland, CA

Mr. Phil Briggs:
San Ramon, California

Based on telephone discussions with Ms. Jennifer Eberle of Alameda County Health Care Services (ACHCS), the following amended RBCA Tier 2 Risk Evaluation for the inhalation of vapor in an enclosed -space from hydrocarbon impacted soil and groundwater is being re-submitted to the ACHCS to address concerns regarding soil sample selection and to also present the corrected solutions to the RBCA vapor volatilization equations (VFwesp and VFsesp attached). This amended report is a follow-up to the originally submitted May 20, 1996 Risk Evaluation for this site. Recommendations put forth in this report are based on the results of this amended risk evaluation.

Based on our discussions, it was decided that the modeled Conservative scenario for groundwater and soil vapor volatilization is represented by the maximum site benzene concentration in water (63 ppb in well C-2 on 12/16/92) and by the average of the six benzene impacted soil samples (avg. = 0.412 mg/Kg) in the 0-5.5' interval in the excavation sidewalls at the site. The modeled Plausible scenario is represented by the 12/12/95 benzene concentration in well C-2 of 0.93 ppb and the average benzene concentration of the 14 soil samples taken in the 0-5.5' interval at the site excavation (avg. = 0.178 mg/Kg - note that ND's were represented by 1/2 MDL of 0.005 mg/Kg or 0.0025 mg/Kg).

ASTM RBCA vapor Volatilization Factor equations for subsurface soil to enclosed-space (VFsesp) and groundwater to enclosed-space (VFwesp) were incorrectly solved for the site as presented in the May 20, 1996 Risk Evaluation. The attached equations are correctly solved and reflect current site conditions and estimated risk values due to these modeled exposure pathways.

Results

WO-9

The Conservative scenario calculated risks for the enclosed-space vapor inhalation pathways from site groundwater and soils, based upon the soil analytical data for the six benzene impacted soil samples from the 0' to 5.5' interval (samples WO-8, WO-8, IX-11, IX-13, IX-15 and IX-18) and the maximum site groundwater benzene concentration of 63 ppb, are 5×10^{-7} and 4×10^{-5} for a combined 4.05×10^{-5} risk value. This value is between the 1×10^{-4} and 1×10^{-6} risk range for commercial and residential occupancy.

The Plausible scenario calculated risks for the enclosed-space vapor inhalation pathways from site groundwater and soils, based upon the soil analytical data for the 14 soil samples from the excavation sidewalls in the 0-5.5' depth interval (6 detects and 8 non-detects) and the 12/12/95 site benzene concentration in well C-2 of 0.93 ppb, are 7×10^{-8} and 1.7×10^{-5} for a combined 1.7

x 10^{-5} risk value. This value is between the 1 x10^{-4} and 1 x 10^{-6} risk range for commercial and residential occupancy.

Recommendations

Based upon this amended risk evaluation, the groundwater at this site would not represent a risk to residential or commercial/industrial human health at the modeled 5 x 10^{-7} to 7 x 10^{-9} risk range. Soils over the vast majority (>90%) of this site pose no risk to human health because of the extensive excavation removal of contaminated soils. The soils located in a 15' zone from the Grand Ave. sidewalk northward at this site (Fig. 1) could represent a vapor inhalation health threat to future residential occupants (4 x 10^{-5} to 1.7 x 10^{-5} risk range) but not to future commercial or industrial occupants at a 10^{-4} target risk range based upon the model output.

To address this modeled soil vapor threat to future site occupants, Chevron should work with the land owner and Regulatory Agency to develop mitigation measures during and after site development. These measures may include: 1) Allow only commercial development and prohibit residential development at this site; 2) Restricting any site residential development directly over the impacted soil located in a setback zone 15' from the Grand Ave. sidewalk (Figure 1); and 3) Excavating out the impacted soil within the 15' setback zone during site development, if warranted.

It is recommended that Chevron pursue site soils and groundwater closure or request a letter of developability from the Alameda County Health Services and agree to work with the landowner and County to address site soil environmental concerns once a buyer for the property has been located. It is important to note that extensive excavation has removed the soil contamination sources (UST/piping etc.) and that the remaining residual soil contamination is confined to a 15' zone along Grand Ave. and that soil contaminant concentrations will continue to decay with time due to natural degradation processes.

Please contact me at CTN 242-7086 with questions or comments regarding this risk evaluation for this site.

Curt Peck

Curtis A. Peck
Lead Hydrogeologist

Attachment
1) Figure 1
2) Calculated Average soil benzene concentrations

#G-0006 ASTM RBCA - Volatilization Factor for Enclosed-Spaces

ADULT RESIDENT RECEPTOR - Benzene

EQUATIONS - Volatilization from Groundwater to Enclosed-Space (VFwesp) - Benzene

$$VFwesp = \frac{(0.22)\ \frac{[(6.5 \times 10^{-5}\ cm^2/s) / (150\ cm)]}{[(1.4 \times 10^{-4}\ s\text{-}1) * (200\ cm)]}}{1 + \frac{[(6.5 \times 10^{-5}\ cm^2/s) / (150\ cm)]}{[(1.4 \times 10^{-4}\ s\text{-}1) * (200\ cm)]} + \frac{[(6.5 \times 10^{-5}\ cm^2/s / (150\ cm)]}{[(6.5 \times 10^{-5}\ cm^2/s) / 15\ cm) \times 0.01]}} \times 1000\ L/m^3$$

Correction

$$VFwesp = \frac{(0.22)\ (1.55 \times 10^{-5})}{1 + [(1.55 \times 10^{-5}) + (0.1)]} \times 1000\ L/m^3$$

$$VFwesp = \frac{(3.4 \times 10^{-5})}{1.1000155} \times 1000\ L/m^3$$

$$VFwesp = (3.1 \times 10^{-8}) * 1000\ L/m^3$$

$$\mathbf{VFwesp = 3.1 \times 10^{-3}\ \frac{mg/m^3\text{-}air}{mg/L\text{-}water}}$$

2) C building = (VFwesp) x (C water)

2a) C building Plausible = for 0.93 ppb benzene (12/95)

$$\text{C building} = 3.1 \times 10^{-5}\ \frac{[mg/m^3\text{-}air]}{[mg/L\text{-}water]} \times (9.3 \times 10^{-4}\ mg/L)$$

= **2.90×10^{-6} mg/m³-air at 0.93 ppb groundwater benzene concentration**

2b) C building Conservative = for 63 ppb (12/92)

$$\text{C building} = 3.1 \times 10^{-5}\ \frac{[mg/m^3\text{-}air]}{[mg/L\text{-}water]} \times (0.063\ mg/L)$$

= **1.95×10^{-4} mg/mg³ air at 63 ppb benzene (12/92 C-2 value)**

3) Chemical Intake = (C building) x (Inhalation Rate) x (Days Exposed) x (Years Exposed) / (Receptor Weight) x (Days/year) x (Expected Lifetime)

3a) Plausible Chemical Intake

$$\text{Intake} = \frac{(2.90 \times 10^{-6}\ mg/m^3) \times (15\ m^3/day) \times (350\ days) \times (30\ years)}{(70\ Kg) \times (365\ days) \times (70\ years)}$$

= **2.55×10^{-2} mg/Kg-day at 0.93 ppb benzene groundwater concentration**

3b) Conservative Chemical Intake

$$\text{Intake} = \frac{(1.95 \times 10^{-4}\ mg/m^3) \times (15\ m^3/day) \times (350\ days) \times (30\ years)}{(70\ Kg) \times (365\ days) \times (70\ years)}$$

= **1.72×10^{-6} mg/Kg-day at 63 ppb benzene groundwater concentration**

4) Risk Value = Chemical Intake x Cancer Potency Factor (benzene); where CPF = 0.029 mg/Kg-day

4a) Plausible Scenario Risk

= (2.55 x 10^{-7} mg/Kg/day) x (0.029 mg/Kg-day)

= **7 x10^{-9} at 0.93 ppb benzene, the current situation at the site.**

4b) Conservative Scenario Risk

= (1.72 x 10^{-5} mg/Kg/day) x (0.029 mg/Kg-day)

= **5.0 x10^{-7} at 63 ppb benzene, the site maximum.**

NOTE: The modeled results for the groundwater to enclosed-space vapor inhalation pathway are below the standard 1 x 10^{-6} risk value for residential exposure and as modeled would not represent a threat to residential or commercial occupants at this site.

#G-0006 ASTM RBCA - Volatilization Factor for Enclosed-Spaces

ADULT RESIDENT RECEPTOR - Benzene

EQUATIONS - Volatilization from Soil to Enclosed-Space (VFsesp) - Benzene

$$VFsesp = \frac{(0.22)(1.7)}{(0.12) + (0.83)(1.7) + (0.22)(0.26)} \; \frac{[(7.28 \times 10^{-3}\ cm^2/s) / (100\ cm)]}{[(1.4 \times 10^{-4}\ s\text{-}1) * (200\ cm)]}$$

$$\frac{[(7.28 \times 10^{-3}\ cm^2/s) / (100\ cm)]}{1 + [(1.4e\text{-}4\ s\text{-}1) * (200\ cm)]} + \frac{[(7.28 \times 10^{-3}\ cm^2/s) / (100\ cm)]}{[(7.28 \times 10^{-3}\ cm^2/s)/15\ cm) \times 0.01]} \times 1000\ [cm^3\text{-}kg/m^3\text{-}g]$$

Correction

$$VFsesp = \frac{(0.2355)(2.6 \times 10^{-3})}{1 + [(2.6 \times 10^{-3}) + (15)]} \times 1000\ cm^3\text{-}kg/m^3\text{-}g$$

$$VFsesp = \frac{(6.1 \times 10^{-3})}{16.0026} \times 1000\ cm^3\text{-}kg/m^3\text{-}g$$

$$VFsesp = (3.82 \times 10^{-5}) \times 1000\ cm^3/m^3\text{-}g$$

$$\mathbf{VFsesp = 0.038\ \frac{mg/m^3\text{-}air}{mg/Kg\text{-}soil}}$$

2) C building = (VFsesp) x (C soil)

2a) Plausible Scenario; benzene = 0.178 mg/Kg soil in average of 14 soil samples (detects and non-detects)

$$\text{C building} = 0.038\ \frac{[mg/m^3\ air]}{[mg/Kg\text{-}soil]} \times (0.178\ mg/Kg)$$

C building = 0.00676 mg/m³-air at 0.178 mg/Kg soil concentration

2b) Conservative Scenario: benzene = 0.412 mg/Kg soil; average of 6 of 14 detects in former tank pit excavation sidewalls

C building = 0.0157 mg/m³-air at 0.412 mg/Kg soil concentration

3) Chemical Intake = (C building) x (Inhalation Rate) x (Days Exposed) x (Years Exposed) / (Receptor Weight) x (Days/year) x (Expected Lifetime)

3a) Plausible Scenario

$$\text{Intake} = \frac{(0.00676\ mg/m^3) \times (15\ m^3/day) \times (350\ days) \times (30\ years)}{(70\ Kg) \times (365\ days) \times (70\ years)}$$

Intake = 5.95 x 10⁻⁴ mg/Kg-day at 0.178 mg/Kg benzene in soil

3b) Conservative Scenario

$$\text{Intake} = \frac{(0.0157\ mg/m^3) \times (15\ m^3/day) \times (350\ days) \times (30\ years)}{(70\ Kg) \times (365\ days) \times (70\ years)}$$

Intake = 1.38 x 10⁻³ mg/Kg-day at 0.412 mg/Kg benzene in soil

4) Risk Value = Chemical Intake x Cancer Potency Factor (benzene); where CPF = 0.029 mg/Kg-day

4a) Plausible Scenario - Risk

Risk = (5.95 x 10^{-4} mg/Kg-day) x (0.029 mg/Kg-day)

Risk = 1.73 x 10^{-5} at 0.178 mg/Kg benzene in site soil

4b) Conservative Scenario - Risk

Risk = (1.38 x 10^{-3} mg/Kg-day) x (0.029 mg/Kg-day)

Risk = 4 x 10^{-5} at 0.412 mg/Kg benzene in site soil

NOTE: The modeled results for the soil to enclosed-space vapor inhalation pathway are below the standard 1 x 10^{-4} risk value for commercial/industrial exposure and as modeled would not represent a threat to commercial occupants at this site. The modeled results for the soil to enclosed-space vapor inhalation pathway are above the standard 1 x 10^{-6} risk value for residential exposure and as modeled would represent a threat to residential occupants at this site. Therefore, restricting the site development to commercial would alleviate the concerns regarding the residential exposure pathway.

Benzene Impacted soils in the 0 - 5.5' interval

1) Conservative scenario: Only those samples that had benzene detected and that were not over-excavated Note: the sample IX-3 was not included as it was removed during over-excavation.

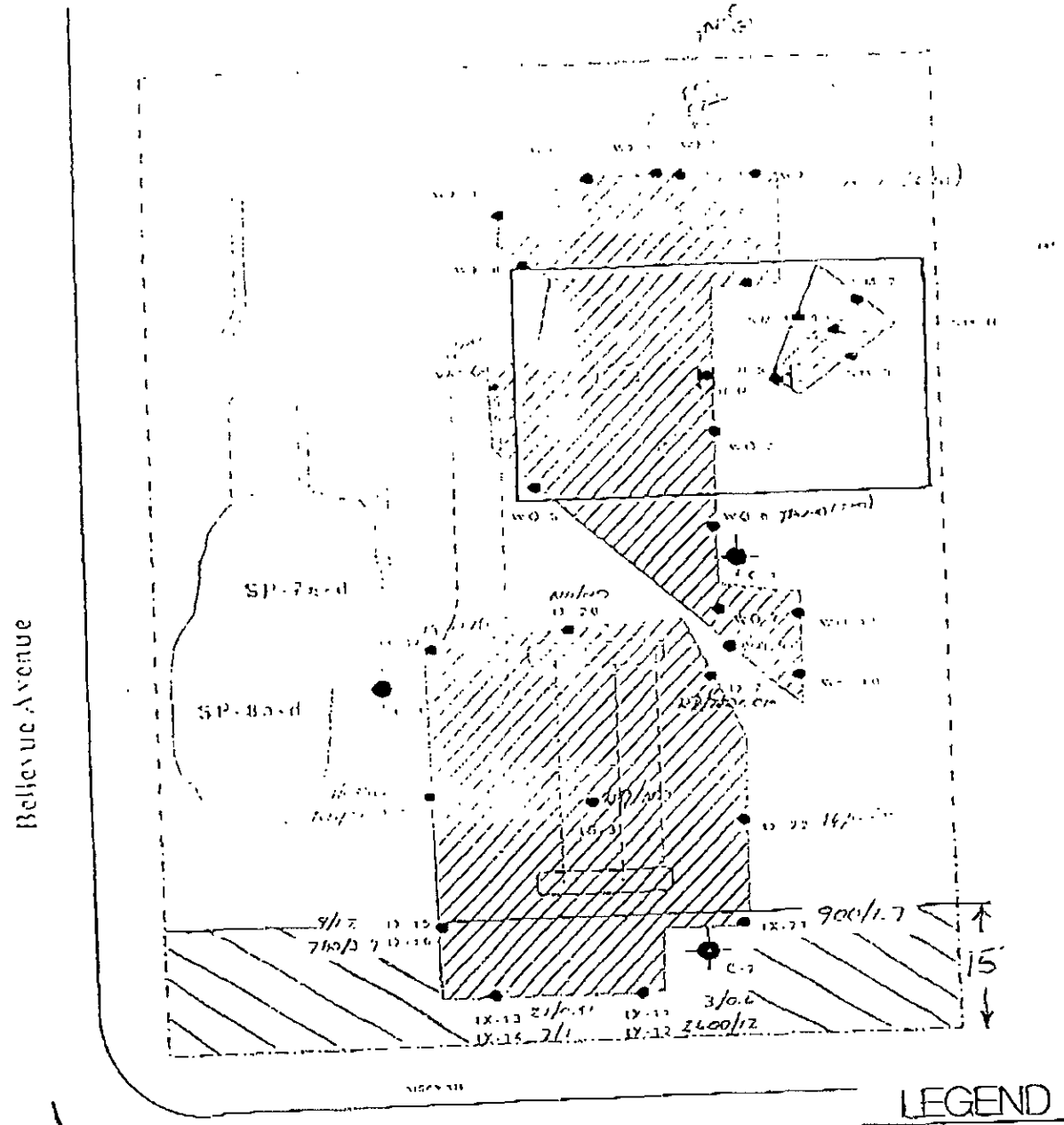
Sample	Depth	Benzene (mg/Kg)
WO-8	4.5'	0.005
WO-9	5.5'	0.077
IX-11	5'	0.6
IX-13	5.5'	0.41
IX-15	5'	1.2
IX-18	4'	0.18
		2.472 mg/Kg

Average Benzene Conc. = 0.412 mg/Kg for these six samples

2) Plausible scenario: Includes the six samples with benzene detects and the 8 samples that were non-detect. The non-detect samples were assumed to contain benzene at 1/2 the method detection limit of 0.005 mg/Kg, i.e., each non-detect sample was assumed to contain 0.0025 mg/Kg benzene.

Sample	Depth	Benzene (mg/Kg)
WX-2	5 5'	0.0025 (ND)
WX-3	3'	0.0025 (ND)
WO-5	5'	0.0025 (ND)
WO-6	5'	0.0025 (ND)
WO-7	5'	0.0025 (ND)
WO-8	4.5'	0.005
WO-9	5.5'	0.077
WO-10	5'	0.0025 (ND)
WO-11	4.5'	0.0025 (ND)
IX-11	5'	0.6
IX-13	5.5'	0.41
IX-15	5'	1.2
IX-18	4'	0.18
IX-20	5'	0.0025 (ND)
		2.492 mg/Kg

Average Benzene Conc. = 0.178 mg/Kg for the 14 samples



Touchstone Developments
Environmental Management

Final Excavation & Sample Locations
460 Grand Avenue
Oakland, California

Figure 3

3-13-94 mjt

Project Number 0006-2

Table A: Analytical Summary for Over-excavation Samples (in ppm)

Waste Oil Tank Excavation Sampling Results

Sample ID	Depth (FT)	TPH-gas	Benzene	Toluene	Ethyl Benzene	Xylenes	TPH-D	TOG	8010	8270	Metals
WX-1	6	ND	ND	ND	ND	ND	2	ND	ND	ND	*
WX-2	5.5	ND	— ND	ND	ND	ND	ND	ND	ND	ND	*
WX-3	3	30	— ND	ND	ND	0.85	8300	970	*	*	*
WX-4	6	ND	ND	ND	ND	ND	470	ND	ND	ND	*
WX-5	6	ND	ND	ND	ND	ND	24	ND	ND	ND	*
WX-6	6	ND	ND	ND	ND	ND	3	ND	ND	ND	*
WX-7	6	ND	ND	ND	ND	ND	14	ND	ND	ND	*
WX-8	6	ND	ND	ND	ND	ND	2	ND	ND	ND	*
WO-1	6	ND	ND	ND	ND	0.008	ND	ND	ND	ND	*
WO-2	6	ND	ND	ND	ND	0.011	ND	ND	ND	ND	*
WO-3	6.5	170	ND	ND	0.36	0.34	1400	120	ND	ND	*
WO-4	6.5	27	ND	0.007	0.054	0.18	130	210	ND	ND	*
WO-5	5	ND	— ND	ND	ND	0.005	ND	ND	NA	NA	NA
WO-6	5	5*	— ND	ND	ND	0.011	17*	ND	NA	NA	NA
WO-7	5	16*	— ND	0.006	ND	0.056	51*	ND	NA	NA	NA
WO-8	4.5	10*	— 0.005 ✓	0.007	0.007	0.021	200*	ND	NA	NA	NA
WO-9	5.5	49	— 0.077 ✓	0.71	0.99	6.43	10	ND	ND	ND	NA
WO-10	5	16	— ND	ND	0.034	0.26	30	ND	ND	ND	NA
WO-11	4.5	ND	— ND	ND	ND	0.006	2	ND	ND	ND	NA

Pump Island Excavation Sampling Results

Sample ID	Depth (FT)	TPH-gas	Benzene	Toluene	Ethyl Benzene	Xylenes
IB-1	9	ND	ND	ND	ND	ND
IB-2	7	ND	ND	ND	ND	ND
IB-3	9	ND	ND	ND	ND	ND
IX-1	3.5	16	0.07	2.2	0.4	2.5
IX-2	8.5	1900	2	11	15	66
IX-3	3	290	1.3	5.8	1.5	6.7
IX-4	7	84	0.89	3.2	2.6	16
IX-5	8	4	0.73	0.62	0.12	0.62
IX-6	7	ND	ND	ND	ND	0.008
IX-7	7	ND	0.016	0.012	0.017	0.058
IX-8	8	1	0.023	0.21	0.056	0.38
IX-9	7	1	0.005	0.064	0.032	0.21
IX-10	7.5	ND	NO	ND	ND	ND
IX-11	5	3	— 0.8 ✓	0.24	0.097	0.5
IX-12	9	2600	12	120	46	740
IX-13	5.5	21	— 0.41 ✓	0.077	0.19	0.13
IX-14	10	7	1	0.62	0.2	0.78
IX-15	5	9	— 1.2 ✓	1.2	0.13	0.66
IX-16	4.5	780	3.7	31	20	100
IX-17	8	7	0.25	1.2	0.22	5.8
IX-18	4	15	— 0.18 ✓	0.49	0.52	3.1
IX-19	8.5	ND	0.11	0.01	0.055	0.029
IX-20	5	ND	— ND	0.006	ND	0.006
IX-21	8	900	1.7	35	18	110
IX-22	8	14	0.26	0.84	0.17	1.5

* = see certified analytical reports
NA = analysis not requested
ND = not detected
TPH-gas = Total petroleum hydrocarbons calculated as gasoline
TPH-D = Total petroleum hydrocarbons calculated as diesel
TOG = Total oil and grease

✓ = Conservative
— = Plausible

1) NO 8270's ON WX-3
2) WO-6 NOT ON FIGURES
3) a) LABEL O/W SEP ON FIGS.
   b) CHANGE TITLE OF TABLE B
   c) O/W SEP IN TEXT

Table B: Analytical Summary for Hoist & Sump Excavation Samples (in ppm)

Hoist Sampling Results

Sample ID	Depth (FT)	TPH-gas	Benzene	Toluene	Ethyl Benzene	Xylenes	TPH-D	TOG	8010	8270	Metals
H-N	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
H-S	8	ND	ND	ND	ND	ND	ND	ND	ND	ND	*

Oil-Water Separator Sampling Results

Sample ID	Depth (FT)	TPH-gas	Benzene	Toluene	Ethyl Benzene	Xylenes	TPH-D	TOG	8010	8270	Metals
SM-B	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	*
SM-1	5	1	ND	ND	ND	0.012	16	ND	*	ND	*
SM-2	5	ND	ND	ND	ND	ND	3	ND	ND	ND	*
SM-3	5	ND	ND	ND	ND	ND	5	ND	ND	ND	*

Table C: Analytical Summary for Stockpile Samples (in ppm)

Stockpile Sampling Results

Sample ID	TPH-gas	Benzene	Toluene	Ethyl Benzene	Xylenes	TPH-D	TOG	8010	8270	Metals
SP-2a-d	47*	ND	0.093	0.25	1.9	1200	2500	*	ND	*
SP-3a-d	33*	ND	0.066	0.54	0.17	230	160	*	ND	*
SP-4a-d	150	ND	2	3	20	NA	NA	NA	NA	ND
SP-5a-d	1300	0.8	30	21	120	NA	NA	NA	NA	NA
SP-6a-d	2600	1.6	86	49	230	NA	NA	NA	NA	NA
SP-7a-d	130*	ND	2.2	2.9	20	NA	NA	NA	NA	NA
SP-8a-d	190*	ND	1.4	3.5	27	NA	NA	NA	NA	NA

Aerated Stockpile Sampling Results

Sample ID	TPH-gas	Benzene	Toluene	Ethyl Benzene	Xylenes
SP-4a-d	33	ND	0.096	0.086	1
SP-5a-d	88	0.005	0.19	0.19	2.4
ASP-6a-d	36	ND	0.11	0.067	0.72
ASP-7a-d	50	ND	0.059	0.23	1.8
ASP-8a-d	4	0.29	0.39	0.27	1.3

* = see certified analytical reports
NA = analysis not requested
ND = not detected
TPH-gas = Total petroleum hydrocarbons calculated as gasoline
TPH-D = Total petroleum hydrocarbons calculated as diesel
TOG = Total oil and grease

Chevron

Health, Environment and Safety

Richmond, CA

TO: NAME Jennifer Eberle

COMPANY ACHCS

CITY ALAMEDA

FACSIMILE NUMBER 337-9335 PHONE NUMBER 567-6761

FROM: Curt Peck (510) 242-7086

COMPANY: CRTC - Groundwater Team

CITY: Richmond CA

FACSIMILE NUMBER: 510-242-1380 PHONE NUMBER: 242-7086

NUMBER OF PAGES (INCLUDING COVER): 4

SPECIAL INSTRUCTIONS:
Jennifer - I have included the soil boring results for the wells C-1, C-2 & C3 in the Conservative & Plausible Scenario. Calculations for average B concentrations are attached. Recalculated Soil Vapor Inhalation risk based on these values and the Conservative Scenario is now at 1.88×10^{-4} for soil vapor. Plausible is at 8.85×10^{-5}.

Call with questions/comments

Thanks

Curt

IF YOU DO NOT RECEIVE ALL PAGES, PLEASE PHONE SENDER.

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1003 WEST CUTTING BOULEVARD
P.O. BOX 4054
RICHMOND CA 94804-0054

Curt did

1-23 ML says use arithmetric avg (like I done here)

2nd revised RA

#G-0006 ASTM RBCA - Volatilization Factor for Enclosed-Spaces

ADULT RESIDENT RECEPTOR - Benzene

EQUATIONS - Volatilization from Soil to Enclosed-Space (VFsesp) - Benzene

$$VFsesp = \frac{(0.22)(1.7)}{(0.12) + (0.83)(1.7) + (0.22)(0.26)} \frac{[(7.28 \times 10^{-3}\ cm^2/s) / (100\ cm)]}{[(1.4 \times 10^{-4}\ s\text{-}1) * (200\ cm)]} \times 1000\ [cm^3\text{-}kg]$$

$$\frac{[(7.28 \times 10^{-3}\ cm^2/s) / (100\ cm)]}{1 + [(1.4e\text{-}4\ s\text{-}1) * (200\ cm)]} + \frac{[(7.28 \times 10^{-3}\ cm^2/s)/15\ cm) X\ 0.01]}{[m^3\text{-}g]}$$

$$VFsesp = \frac{(0.2355)(2.6 \times 10^{-3})}{1 + [(2.6 \times 10^{-3}) + (15)]} \times 1000\ cm^3\text{-}kg/m^3\text{-}g$$

$$VFsesp = \frac{(6.1 \times 10^{-4})}{16.0026} \times 1000\ cm^3\text{-}kg/m^3\text{-}g$$

$$VFsesp = (3.82 \times 10^{-5}) \times 1000\ cm^3/m^3\text{-}g$$

VFsesp = 0.038 mg/m³-air / mg/Kg-soil

0.178 mg/kg avg of 14 samples
+ ND - C1
+ 13 mg/kg - C2
+ 0.008 mg/kg - C3 = 13.186
÷ 17 = 0.7756
+ 0.912

2) C building = (VFsesp) x (C soil) ok

2a) Plausible Scenario; benzene = 0.912 mg/Kg soil in average of 17 soil samples (detects and non-detects) ok

$$C\ building = 0.038\ [mg/m^3\ air] / [mg/Kg\text{-}soil] \times (0.912\ mg/Kg)$$

C building = 0.03466 mg/m³-air at 0.912 mg/Kg soil concentration

0.477 = 6 samples
+13
+0.008
= 13.485 ÷ 8 = 1.6855
+ 1.935

2b) Conservative Scenario: benzene = 1.935 mg/Kg soil; average of 8 detects in and around former tank pit excavation sidewalls and monitoring wells ok

C building = 0.07353 mg/m³-air at 1.935 mg/Kg soil concentration

3) Chemical Intake = (C building) x (Inhalation Rate) x (Days Exposed) x (Years Exposed) / (Receptor Weight) x (Days/year) x (Expected Lifetime)

3a) Plausible Scenario

$$Intake = \frac{(0.03466\ mg/m^3) \times (15\ m^3/day) \times (350\ days) \times (30\ years)}{(70\ Kg) \times (365\ days) \times (70\ years)}$$

Intake = 3.05 x 10⁻³ mg/Kg-day at 0.912 mg/Kg benzene in soil

3b) Conservative Scenario

$$Intake = \frac{(0.07353\ mg/m^3) \times (15\ m^3/day) \times (350\ days) \times (30\ years)}{(70\ Kg) \times (365\ days) \times (70\ years)}$$

Intake = 6.48 x 10⁻³ mg/Kg-day at 1.935 mg/Kg benzene in soil

4) Risk Value = Chemical Intake x Cancer Potency Factor (benzene); where CPF = 0.029 mg/Kg-day

use plausible

4a) Plausible Scenario - Risk

Risk = (3.05×10^{-3} mg/Kg-day) x (0.029 mg/Kg-day)

8.85 x 10^{-5} → 10^{-4}

→ **Risk = <u>8.85×10^{-5} at 0.912 mg/Kg benzene in site soil</u>**

4b) Conservative Scenario - Risk

Risk = (6.48×10^{-3} mg/Kg-day) x (0.029 mg/Kg-day)

1.88×10^{-4} → 10^{-3}

→ **Risk = <u>1.88×10^{-4} at 1.935 mg/Kg benzene in site soil</u>**

NOTE: The modeled results for the soil to enclosed-space vapor inhalation pathway are slightly above (Conservative scenario) to below the standard 1×10^{-4} risk value for commercial/industrial exposure. As Conservatively modeled, the remaining benzene soil concentrations would have the potential to pose a threat to long-term commercial occupants at this site. The modeled results for the soil to enclosed-space vapor inhalation pathway are above the standard 1×10^{-5} risk value for residential exposure and as modeled would represent a threat to long-term residential occupants at this site. Therefore, restricting the site development to commercial would alleviate the concerns regarding the residential exposure pathway.

Benzene Impacted soils in the 0 - 5.5' interval

1) Conservative scenario: Only those samples that had benzene detected and that were not over-excavated. Note: the sample IX-3 was not included as it was removed during over-excavation. Includes the benzene concentrations in site monitoring wells.

Sample	Depth	Benzene (mg/Kg)
WO-8	4.5'	0.005
WO-9	5.5'	0.077
IX-11	5'	0.6
IX-13	5.5'	0.41
IX-15	5'	1.2
IX-18	4'	0.18
C-2	5.5'	13.0
C-3	5.5'	0.008
		15.480 mg/Kg

→ Average Benzene Conc. = 1.935 mg/Kg for these eight samples

2) Plausible scenario: Includes the eight samples with benzene detects and the 9 samples that were non-detect. The non-detect samples were assumed to contain benzene at 1/2 the method detection limit of 0.005 mg/Kg, i.e., each non-detect sample was assumed to contain 0.0025 mg/Kg benzene.

Sample	Depth	Benzene (mg/Kg)
WX-2	5.5'	0.0025 (ND)
WX-3	3'	0.0025 (ND)
WO-5	5'	0.0025 (ND)
WO-6	5'	0.0025 (ND)
WO-7	5'	0.0025 (ND)
WO-8	4.5'	0.005
WO-9	5.5'	0.077
WO-10	5'	0.0025 (ND)
WO-11	4.5'	0.0025 (ND)
IX-11	5'	0.6
IX-13	5.5'	0.41
IX-15	5'	1.2
IX-18	4'	0.18
IX-20	5'	0.0025 (ND)
C-1	5.5'	0.0025 (ND)
C-2	5.5'	13.000
C-3	5.5'	0.008
		15.5025 mg/Kg

→ Average Benzene Conc. = 0.912 mg/Kg for the 17 samples

6.4×10^{-2} — based on Geometric mean - lognormal distribution