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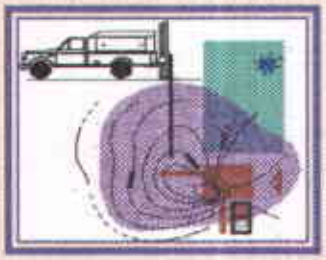


November 12, 2000

Barney M. Chan
Hazardous Materials Specialist
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-9335

Telephone: (510) 567-6765
FAX: (510) 337-9335

Subject: Risk-Based Corrective Action of Hydrocarbons related to the Former Underground Storage Tanks at the FORMER BILL CHUN SERVICE STATION @ 2301 SANTA CLARA AVENUE, ALAMEDA, CA 94501

Dear Barney:

This Risk-Based Corrective Action (RBCA) report has been submitted in response to a requirement by Alameda County Environmental Health to determine if active remediation is necessary to prevent any adverse impact to sensitive receptors. Although there are many potential scenarios which would demonstrate that the subsurface contamination is a potential health threat and possibly a threat to drinking water supplies, only a few scenarios were necessary to demonstrate this assertion as well as provide some estimates of acceptable exposure levels necessary to obtain soil and groundwater cleanup.

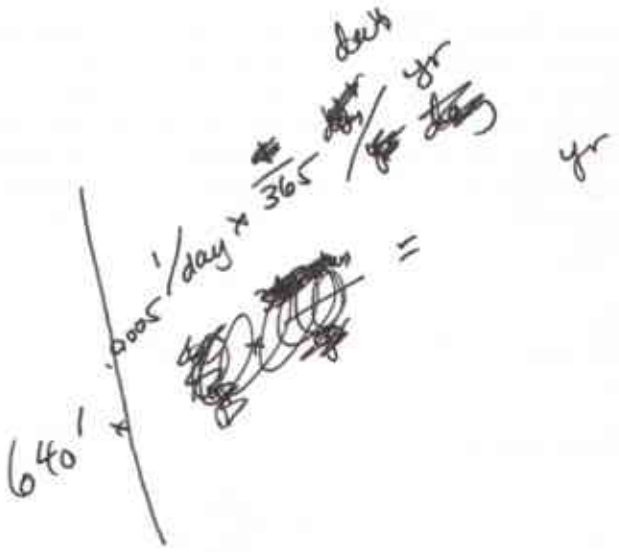
Environmental risks were evaluated in general accordance with the "Site Conceptual Model" (Figure 1). Benzene has been evaluated as the main indicator chemical of concern.

Please call me if you have any questions.

Sincerely,

Franklin J. Goldman

Franklin J. Goldman
Registered Geologist No. 5557
Certified Hydrogeologist No. 466



1) Distribution of benzene in soil and groundwater

Benzene has been identified in soil during past subsurface investigations and has identified the highest concentrations within the smear zone between 9 and 11 feet bgs (See ENSR Corrective Action Evaluation and Feasibility Study, benzene in soil map, Figure 9). An area weighted average of benzene in soil has revealed 68.5 ppm benzene (Figure 2). Since the dissolved benzene plume in groundwater has migrated to the east, an area weighted average concentration of benzene could not be determined, however, a representative dissolved benzene concentration was identified in groundwater monitoring well MW-11at 32 ppm (Figure 3).

2) General site hydrogeologic conditions relative to water supply wells

The smear zone between 9 and 11 feet bgs is predominantly clayey sand and silty sand and the soils beneath the smear zone are predominantly silty sands with some interbeds of clayey sand (See ENSR Corrective Action Evaluation and Feasibility Study, lithologic cross sections, Figures 7 & 8). It is these silty sands that the dissolved benzene would migrate laterally in groundwater towards the water supply well reported (personnel communique by Barney Chan of Alameda County Health) to be located at Alameda High School. Although the exact location of the water supply well at the high school has not been identified, it is located at least 640 feet, or more, away. A water supply well search performed at the State DWR revealed two irrigation and two industrial supply wells in within ½ mile of the site (Appendix A).

Since the supply well is located approximately 640 feet laterally from the point source, the resulting fate and transport scenario for benzene in shallow groundwater can be demonstrated as follows:

hydraulic conductivity = K = 0.028 ft/day (a representative clayey sand, Fetter 3rd)
porosity = n = derived from onsite averaged bulk dry density and moisture content values. i = 0.007 ft/ft on January 30, 1998.

$$V = \frac{Ki}{n} = \frac{0.028\ ft/day\ (0.007\ ft/ft)}{0.39} = 0.0005\ ft/day$$

640

Since the distance between the site and State Well No. 272320 = ~~2,640~~ feet, then

$$640\ ft \times \frac{day}{0.0005\ ft} \times \frac{year}{365\ days} = 3{,}506\ years$$ to theoretically reach the supply well

This is a very conservative estimate as retardation, diffusion, and dispersion have not been taken into account. From a practical standpoint, however, it is very unlikely that the site's dissolved benzene contamination will ever reach the water supply well at Alameda High School. Since it was reported by Barney Chan that the water supply well extracts groundwater from depths as deep as 300 feet bgs, a further evaluation should be performed to determine if there is a hydraulic connection between the shallow contaminated groundwater and the deeper drinking water aquifer. If there is no hydraulic connection between the upper and lower aquifer and the lower aquifer is not designated for drinking water beneficial uses, then the level of groundwater cleanup will have to reflect this scenario. Only the Regional Board can interpret whether or not a particular groundwater body is designated for drinking water according to the Basin Plan.

3) Subsurface conduits

A storm drain inlet is located at the corner of Santa Clara Ave and Oak Street, immediately adjacent to MW-4 which was non-detect for dissolved benzene in the September 17, 2000 groundwater sampling event (Appendix B). The Sewer line runs down the center of Santa Clara Ave could be a conduit for the migration of dissolved benzene as indicated by the fact that the plume is not defined to the south of the site as indicated by 3000 ppb benzene identified in MW-3 as reported in the September 17, 2000 groundwater sampling event (Appendix C).

4) RBCA evaluation

MW-2 @10'
110 ppm B

Even though it has been established that the water supply wells in the vicinity of the subject contamination are not at risk, the following is an evaluation of a hypothetical water supply well which could be placed at the location of groundwater monitoring well MW-5. Also, water supplied by the hypothetical well, if used for showering or drinking would expose the human receptor to dermal and inhalation contact with benzene. In addition, exposure of onsite workers in a commercial scenario to benzene vapors which could enter into the first floor of buildings to be located on site has also been evaluated.

190 @ 9.5'

Calculation of Acceptable Risk

@ 10'

The indicator chemical chosen for risk evaluation is benzene. The highest concentration of benzene in soil is 250 PPM in MW-7 at the source. The concentration of dissolved benzene in MW-7 was recently identified at 21,000 ppb. In the direction of the closest drinking water supply (i.e. @ Alameda High School) is MW-5 which was recently identified with 490 ppb dissolved benzene in groundwater. Since the site is a commercial property the following evaluation is calculated for workers onsite.

? ? P4 ?

The acceptable risk due to ingestion of water from the hypothetical well at B-4 is based on the typical exposure of an adult who would work at the site for 47 years at 252 working days per year. The acceptable risk is based upon a one in a million cancer risk (Appendix D, page 1). The acceptable concentration of benzene in the hypothetical well would be CW=0.0008mg/L.

Site Specific Soil Parameters

No soil samples were colleted at the site in the field to establish site specific soil parameters, however, typical values were assumed for bulk density, moisture content, porosity, and organic carbon content which were representative of the clayey and silty sand soil identified in subsurface soils at the site were collected in the field during the second phase of the subsurface investigation (Appendix D, page 1).

Concentration Reduction Factors

The highest concentration of benzene identified in soil was 250 ppm @ MW-7. Concentration reduction factors were based on the supposition that benzene which would dissolve into groundwater from the residual benzene in soil at the source will decrease in the direction of the water supply well at Alameda High School. The concentration of benzene identified in groundwater was recently 21,000 ppb @ MW-7. As the benzene migrates in the direction of the supply well, a concentration of dissolved benzene was recently identified in groundwater at 490 ppb @ MW-5. The concentration reduction factor between the two wells evaluated is 1,030. A "backwards calculation" to determine the allowable benzene concentration in soil at the source revealed that the allowable concentration, and thus an estimated cleanup target level is 0.41 ppm (Appendix D, page 2).

Dermal and Inhalation Contact with Shower Water

The hypothetical well at MW-5 could supply water which would be used in a shower. Human workers could be exposed to benzene through inhalation of vapors and dermal contact with benzene in shower water (Appendix D, Page 3). In each evaluation, the allowable concentration is less than what is present in well MW-5. So the shower water would pose a human health risk.

Inhalation Risk to Onsite Workers in a Commercial Scenario

The site was used as an auto repair facility and will most likely be used as a one-story commercial facility in the future as is dictated by county zoning ordinances. The risk of benzene vapors collecting in doors is based upon an area weighted average for benzene in soil (i.e. 68.5 ppm). Since the allowable concentration C_A = 0.00002 mg/m³ and the actual benzene concentration is 1.315 mg/m³, the benzene in soil beneath the site does pose an inhalation health risk by many fold. This health risk evaluation is the most conservative of those applied in a RBCA and may not be representative (Appendix D, page 4).

▸ 5) Trend Analysis

The recent groundwater monitoring event performed in September 2000 indicates that the dissolved benzene plume has migrated to the east and is now situated beneath the commercial building next door. Since the concentrations of benzene in groundwater are far less and at the same approximate depth below the ground surface, a separate inhalation risk of benzene vapors which could collect indoors was not evaluated because its resultant values representing the need for cleanup would be less conservative than the values derived from an area weighted average of benzene in soil within the smear zone.

▸ 6) Future Site Development

Various real estate developers have shown an interest in purchasing the property for development as a single story commercial building with parking which would extend to the east, across the property currently occupied by a two story structure. If the structures on the Chun properties (i.e. the subject site and the adjacent property to the east) are demolished, a new structure could be built over the existing site as long as a vapor barrier was place beneath the new building prior to construction. The residual benzene plume beneath the future parking areas would not pose a significant risk to human health. According to the data collected to date, it does not

appear that the benzene plume has entered any public utility lines or associated conduits and would therefore not pose a health threat to public utility line workers. A simple soil gas survey of nearby public utility line would resolve any concerns to this effect. If the property is to be developed in the aforementioned manner, an amended health risk assessment evaluation should be performed to determine what the extent of exposure to residual benzene would be to construction workers onsite. This calculation was not performed in this evaluation because it is not known how long construction workers would be onsite. The proposed method of remediation (i.e. dual phase extraction), can be performed without distraction to commercial operations onsite.

7) Conclusions

Based on our RBCA evaluation, the soil should be remediated to a minimum of 0.41 ppm benzene based upon the concentration reduction factors generated based upon the highest levels of benzene identified in soil and the most recent concentrations of dissolved benzene identified in groundwater. Groundwater should be remediated to a minimum of 3.8 ppb benzene based upon a hypothetical dermal exposure to benzene in shower water derived from a hypothetical onsite water supply well.

too conservative since off pathways are unlikely

8) Recommendations

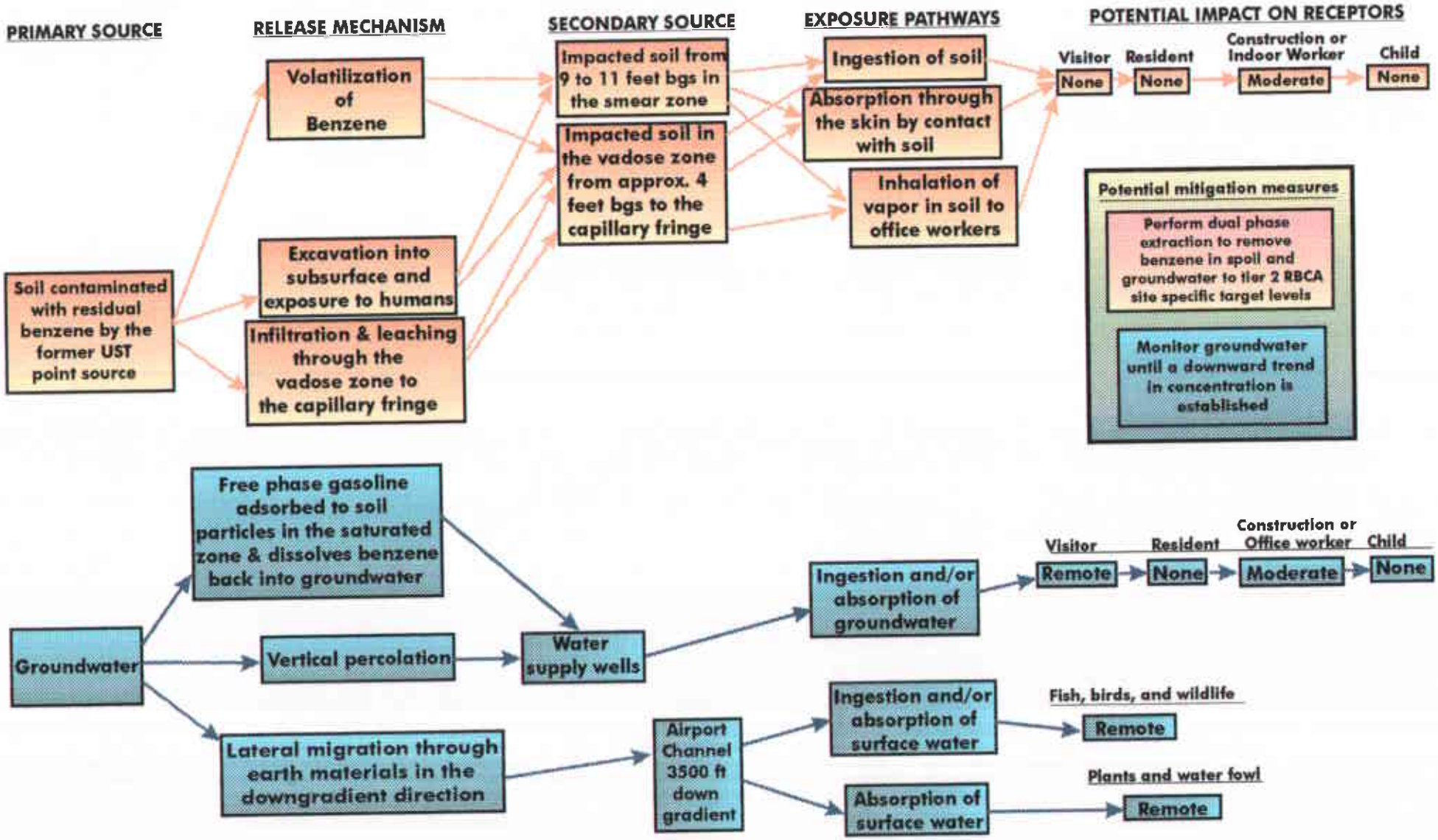
A pilot vapor extraction test and a multiple observation well aquifer test should be performed to validate the previous Remedial Action Plan submitted by Geosolv, LLC. In addition, since the dissolved benzene plume has migrated to some extent beneath the neighbor's building to the east, the RAP groundwater extract well layout strategy should be modified to address this change in contaminant distribution. In addition, since the dissolved benzene plume his migrated to the east, some modifications to the RAP will have to be made. For instance, groundwater injection wells to be used for hydraulic control may not be required to be located across Oak Street; instead, they will probably only need to be placed in the sidewalk along Oak Street. The eastern extent of the plume will most likely require a line of groundwater injection well to be located further to the east on the opposite site of the two story structure to the east.

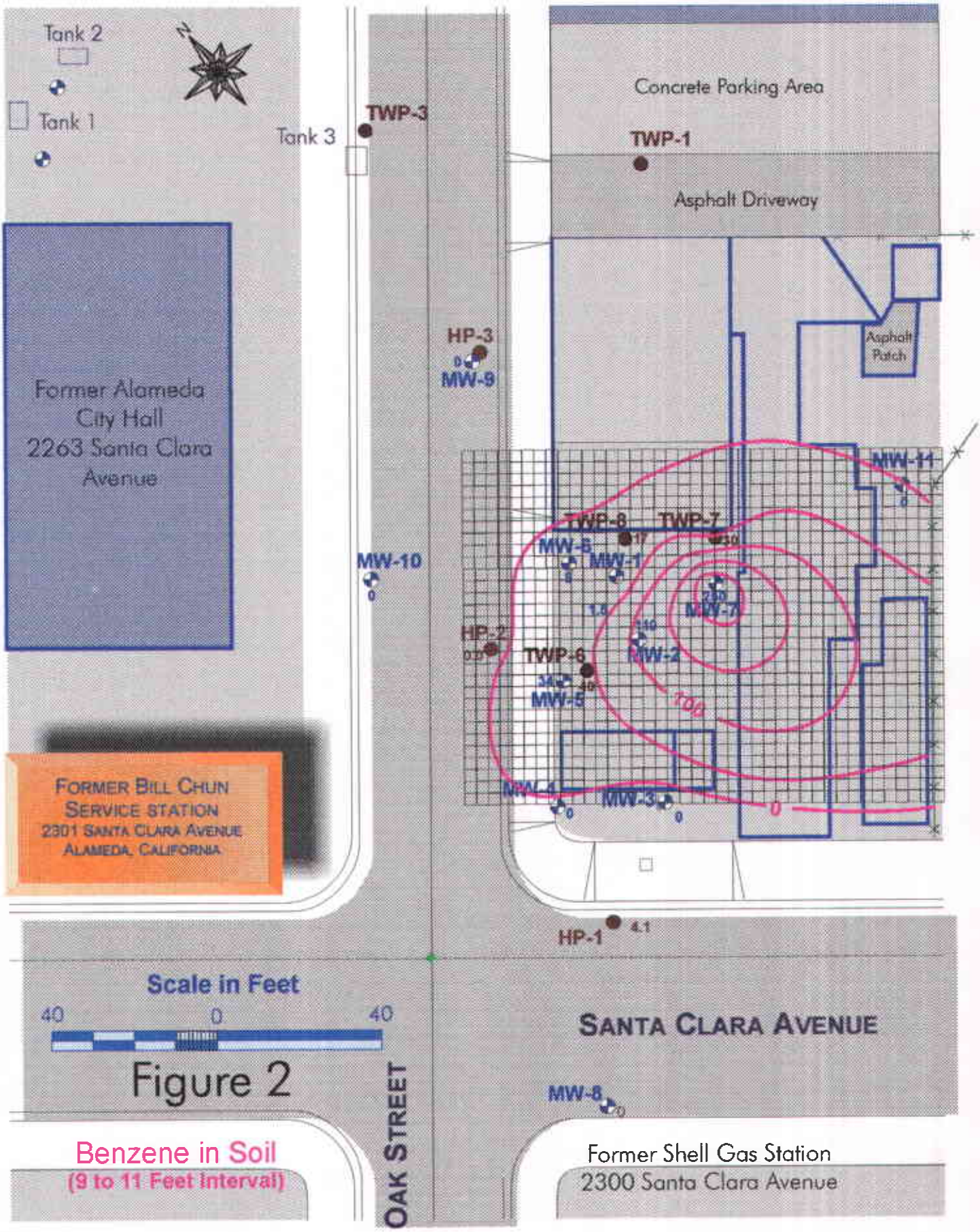
9) Limitations

This report has been prepared in accordance with generally accepted environmental, geological and engineering practices. No warranty, either expressed or implied, is made as to the professional advice presented herein. The analyses, conclusions and recommendations contained in this report are based upon site conditions as they existed at the time of the investigation and they are subject to change.

The conclusions presented in this report are professional opinions based solely upon visual observations of the site and vicinity, and interpretation of available information as described in this report. Geosolv, LLC, recognizes that the limited scope of services performed in execution of this investigation may not be appropriate to satisfy the needs, or requirements of other state agencies, or of other users. Any use or reuse of this document or its findings, conclusions or recommendations presented herein, is done so at the sole risk of the said user.

Figure 1 Site Conceptual Model for the former Bill Chun's Service Station Site, Alameda, CA




Tank 2
Tank 1
Tank 3
TWP-3
Concrete Parking Area
TWP-1
Asphalt Driveway
Asphalt Patch
HP-3
MW-9
Former Alameda City Hall 2263 Santa Clara Avenue
MW-10
MW-11
TWP-8
TWP-7
MW-6
MW-1
MW-7
HP-2
TWP-6
MW-2
MW-5
100
MW-4
MW-3
HP-1
4.1
FORMER BILL CHUN SERVICE STATION
2301 SANTA CLARA AVENUE
ALAMEDA, CALIFORNIA
Scale in Feet
40
0
40
Figure 2
Benzene in Soil
(9 to 11 Feet Interval)
OAK STREET
SANTA CLARA AVENUE
MW-8
Former Shell Gas Station
2300 Santa Clara Avenue

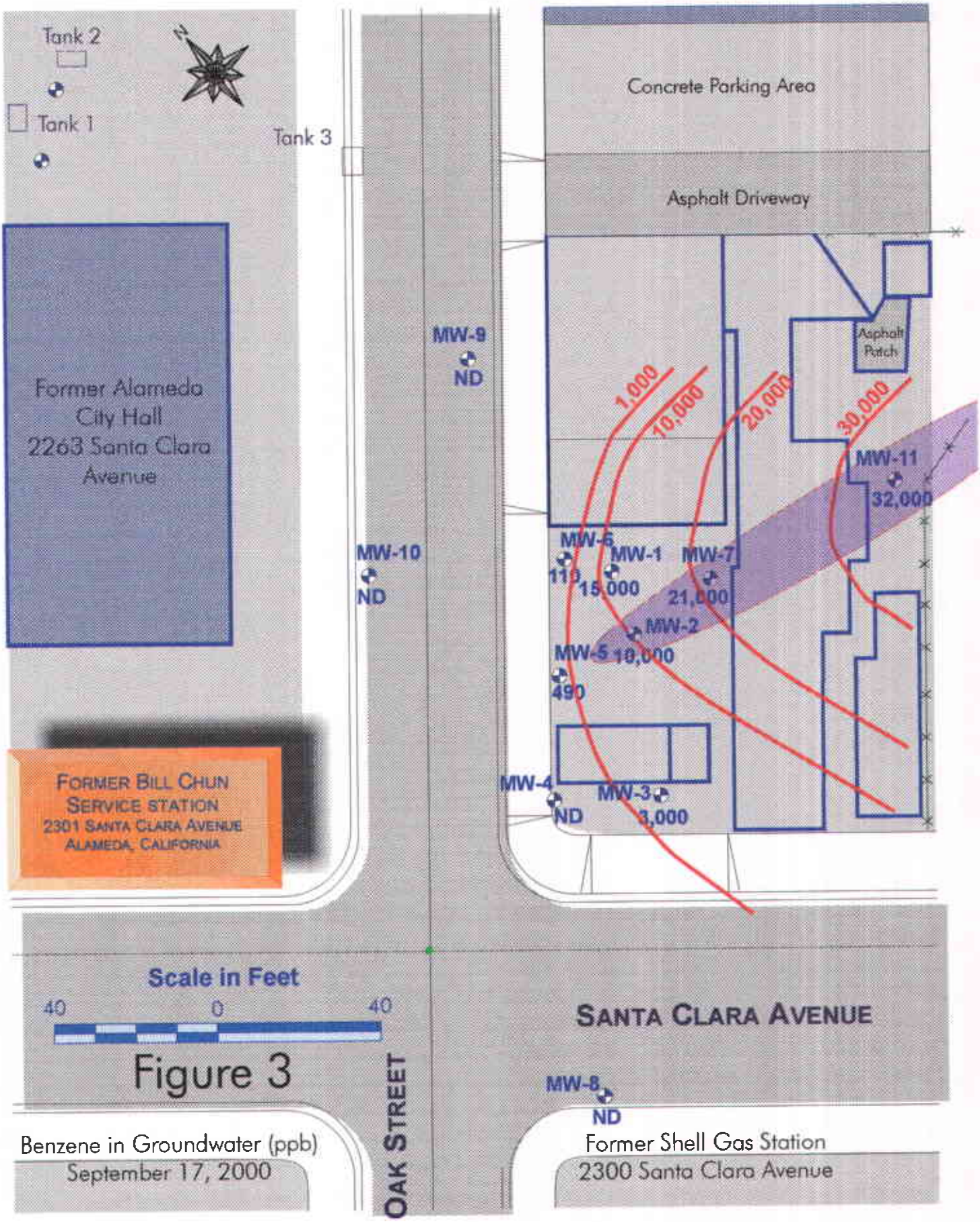


Figure 3

Benzene in Groundwater (ppb)
September 17, 2000

APPENDIX A

State DWR Supply Well Driller Logs

CONFIDENTIAL

STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

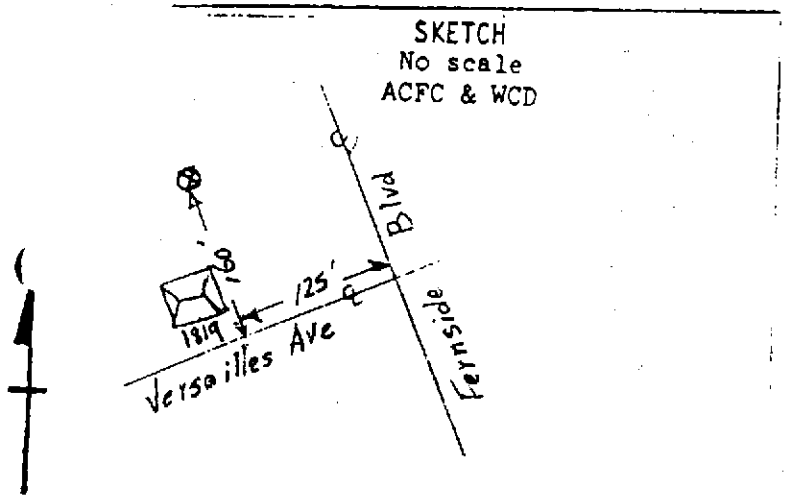
CONFIDENTIAL

STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

32158

SKETCH
No scale
ACFC & WCD



CONFIDENTIAL

STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

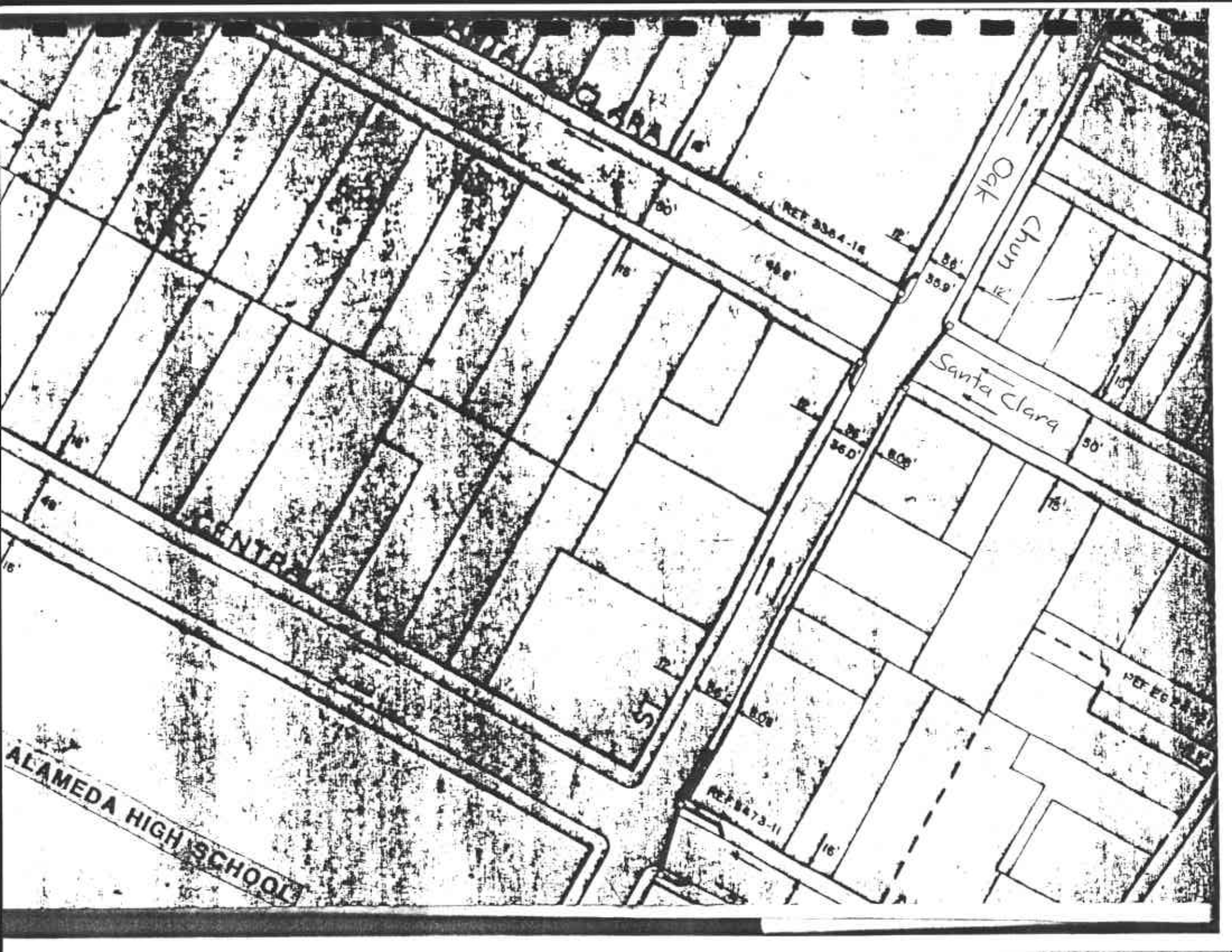
CONFIDENTIAL

STATE OF CALIFORNIA DWR
WELL COMPLETION REPORT
(WELL LOGS)

REMOVED

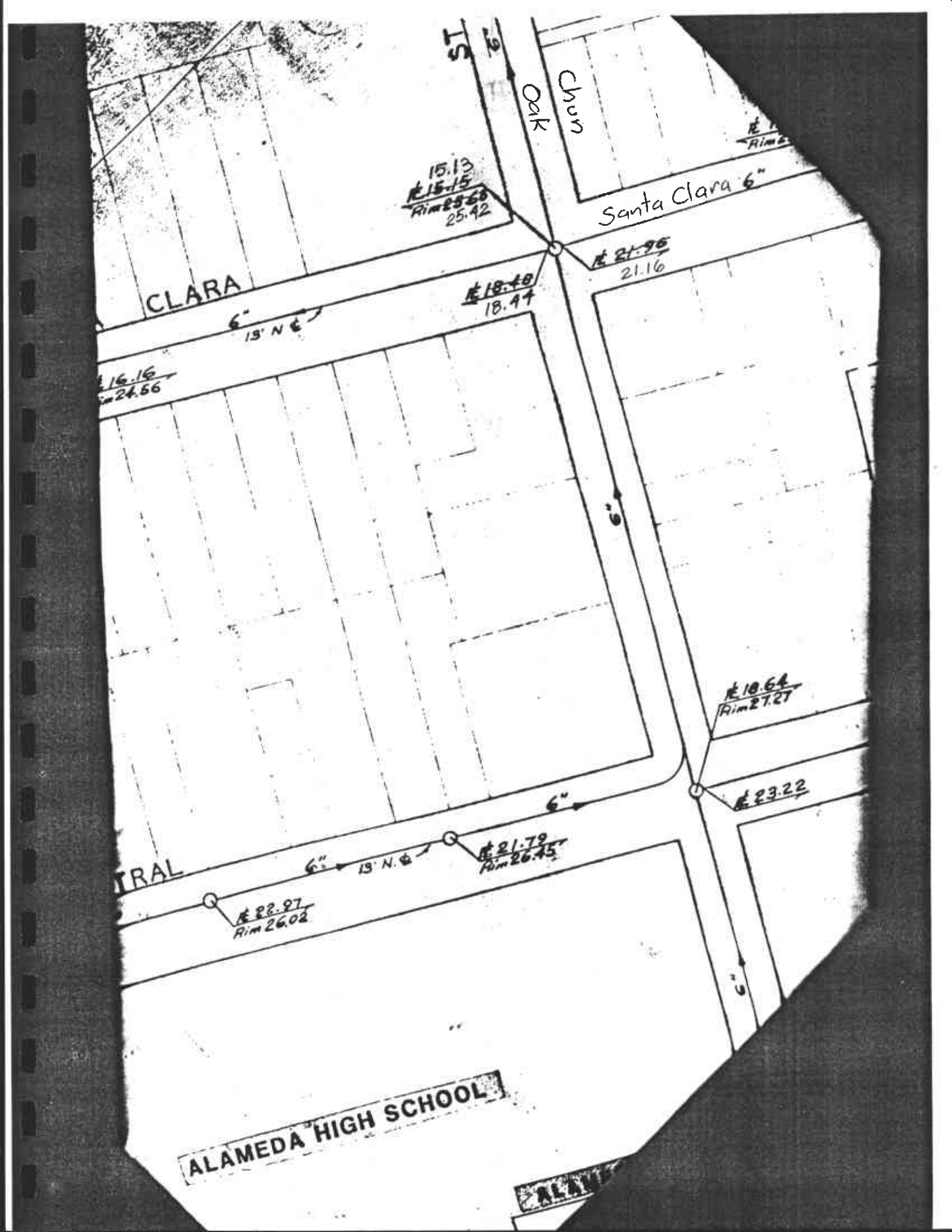
APPENDIX B

Map of Storm Drain Inlet


CLARA
REF. 3384-14
Oak
Santa Clara
CENTRAL
ST
REF. 8473-11
ALAMEDA HIGH SCHOOL

APPENDIX C

Map of Sewer Line


ST
Oak
Chur
15.13
15.15
Rim 25.68
25.42
Santa Clara 6"
21.96
21.16
CLARA
18.48
18.44
6"
13' N ¢
16.16
Rim 24.56
6"
18.64
Rim 27.27
23.22
6"
6" 13' N. ¢
21.79
Rim 26.45
TRAL
22.97
Rim 26.02
6"
ALAMEDA HIGH SCHOOL

APPENDIX D

RBCA Calculations

The indicator chemical chosen for risk evaluation is benzene. The highest concentration of benzene in soil is 250 PPM in MW-7 at the source. The concentration of dissolved benzene in MW-7 was recently identified at 21,000 ppb. In the direction of the closest drinking water supply (i.e. @ Alameda High School) is MW-5 which was recently identified with 490 ppb dissolved benzene in groundwater. Since the site is a commercial property the following evaluation is calculated for workers onsite.

The total acceptable risk due to ingestion of water is 1×10^{-6}. The slope factor for benzene in California is 0.1.

$$\text{Allowable Dose} = \frac{1 \times 10^{-6}}{0.1} = 1 \times 10^{-5} \text{ mg/kg Days} = I$$

Assumptions: CW= Allowable Receptor Point Concentration $= 1 \times 10^{-5}$
ED= 47 years, maximum working career for an adult.
R = 2 liters/day for adults EF = 252 working days/yr.
BW= 70 kg, weight of adult. AT = 365 days/yr X 70 yrs.

$$I_{\text{water}}^{\text{intake}} = \frac{CW \times IR \times EF \times ED}{BW \times AT} = 1 \times 10^{-5} = \frac{CW \times 2.0 \times 252 \times 47}{70 \times 70 \times 365}$$

CW = 0.0008 mg/L of benzene is allowable in drinking water at a hypothetical drinking water supply well in the direction of the well at Alameda High School based upon a concentration of benzene in soil (250 PPM) at the source. "CW" is used for the calculation of the "allowable leachate concentration" of benzene located at the soil source @ P4.

The following is calculation of the potential leachate concentration of benzene of 250 PPM in soil, which could leach out into groundwater, based on site specific soil parameters (i.e. Soil porosity [n], bulk dry density, moisture content [%m], and organic carbon content [foc]). No soil parameter laboratory testing has been found in past reporting. The the dissolved benzene plume will migrate within the most permeable silty sand soils which lie predominantly below 11 feet bgs.

The site specific soil parameters for a typical silty sand with clay are listed as follows:

ρ = Bulk Dry Density = 1.6 g/cm^3
Soil Porosity = n = $\ominus$ = 0.39
Soil Moisture = $\ominus_w$ = %m = 0.14

Organic Carbon Content = foc = 0.011
koc = 38 mg/L (for benzene)
K_d = foc X Koc = 0.011 X 38 = 0.418

(CONTINUED PAGE 2)

CALCULATION OF CONCENTRATION REDUCTION FACTORS (CRF)

Highest concentration of benzene identified in soil = 250 ppm @ MW-7

Benzene decreases in concentration in groundwater from the source towards the Water supply well at Alameda High School

Concentration of benzene identified in groundwater = 21,000 ppb @ MW-7

Concentration of benzene identified in groundwater = 490 ppb @ MW-5

Determination of leachate concentration in MW-7

$$C_L = C_{T_W}\left[\frac{\rho_1\Theta_W + \rho_b}{\rho_b K_d + \Theta_w + (\Theta - \Theta_w) H'}\right]$$

Where: C_L = leachate concentration $\left(\frac{mg}{L}\right)$

C_{T_W} = Benzene in soil $\left(\frac{mg}{Kg}\right)$ 250

ρ_b = Bulk Dry Density $\left(\frac{g}{cm^3}\right)$ 1.60

2.01

$$= 250\left[\frac{1.0\ (0.14) + 1.60}{1.6\ (0.418) + 0.14 + (0.39 - 0.14)\ 0.22}\right]$$

K_d = foc X Koc (for benzene)

foc = 0.011

koc = 38 mg/L

K_d = 0.011 X 38 = 0.418

H' = 2.2×10^{-1} Henry's Law Constant for benzene

n = Θ = 39%

Θ_w = 14%

C_L = estimated leachate concentration = 503.6 mg/L = 503,600 ppb

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$CRF_{unsaturated} = \frac{C_L}{C_{WT}} = \frac{503,600}{21,000} = 24.0$

$CRF_{saturated} = \frac{C_{WT}}{C_{well}} = \frac{21,000}{490} = 42.9$

C_L = estimated leachate concentration = 503,600 ppb

C_{wt} = estimated concentration of benzene in water at the water table below the point source = 880 ppb benzene

CRF_{Total} = CRF sat X CRF unsaturated = 24 X 42.9 = 1,030

Allowable Leachate Concentration @ the Soil Source

C_{well} = concentration in down gradient well MW-5 is 490 ppb

$C_L = CRF_{Total} \times C_W$ = 1,030 X 0.0008 mg/L

C_L = [illegible] Allowable Leachate Concentration

Back Calculation of Allowable concentration of Benzene in Soil

$$C_L = C_{T_W}\left[\frac{\rho_1\Theta_W + \rho_b}{\rho_b K_d + \Theta_w + (\Theta - \Theta_w) H'}\right]$$

$0.824 = C_{T_W}$ (2.01)

* C_{T_W} = 0.41mg/kg allowed in soil at the point source.

* Note: Since the actual soil concentration at the point source is 250 ppm and the allowable is 0.41 ppm, the soil must be remediated.

(CONTINUED PAGE 3)

Dermal contact with benzene could occur from exposure to shower water in the commercial (we will use values for a residence to be concervative) buildings in the future. There are no showers on site at present, and there are no plans to install any. Included, here in, is inhalation risk during showering.

Allowable Dose for Dermal Conact $= \frac{1 \times 10^{-6}}{0.1} = 1 \times 10^{-5}$ mg/kg

Assumptions:
EF = 365 days/yr exposure at building
CF = 30 yrs of exposure at one residence

$$1 \times 10^{-5} \text{ mg/kg Day} = \frac{CW \times SA \times PC \times ET \times EF \times CF}{BW \times AT}$$

$$1 \times 10^{-5} \text{ mg/kg Day} = \frac{CW \times 19{,}400 \text{ cm}^2 \times 0.11 \text{ cm/hr.} \times 0.2 \text{ hr.} \times 365 \text{ days} \times 30 \text{ yrs} \times 10^{-3}}{70 \text{ kg} \times 70 \text{ yrs} \times 365 \text{ days/Yr}}$$

CW = 0.0038 mg/L

CW = 3.8 ppb is the allowable concentration of benzene in water and the actual concentration of benzene in MW-5 is 490 ppb. So groundwater remediation would be necessary.

Inhalation contact with benzene in air.

$$\text{Allowable concentration of benzene in water } \left(\frac{mg}{L}\right) = \text{Allowable concentration of benzene in air } \left(\frac{mg}{m^3}\right) \times \frac{V}{f \times Q \times T}$$

V = Volume of Shower
f = fraction of volatilized benzene
Q = 300 L/hr.
T = $\frac{12 \text{ min}}{60 \text{ hr.}}$
CA = Concentration of benzene in air

$$0.0038 \text{ mg/L} = CA \times \frac{1.5m \times 2m \times 2m}{\frac{0.7 \times 300 \times 12}{60}}$$

CA = 0.0266 mg/m^3 of benzene in air allowable
Actual concentration of benzene in air from water extracted from MW-5 is 0.490 mg/m^3
So groundwater remediation would be necessary.

(Continued Page 4)

Vapor Diffusion of Benzene into a Commercial Building from Subsurface Soil

L_B [cm] – volume/surface ratio
L_{crack} [cm] – thickness of slab
L_S [cm] – depth to contamination
n – soil porosity
$V_{F_{sesp}}$ – vapor diffusion of into a commercial building from subsurface soil
V_{sesp} – site specific subsurface soil to enclosed-space volatile factor
η – fraction of cracks

Input parameters for Benzene:

D_{air} = 0.093 cm^2/sec
D_{wat} = 0.000011 cm^2/sec
K_d = K_s = 0.418
H' = 0.22 (Henry's law constant)
η = 0.01 (fraction of cracks in slab)
E_R = 0.00027778 (building air exchange rate)

Θ_{acap} = 0.038
Θ_{acrack} = 0.26
Θ_{wcap} = 0.342
Θ_{wcrack} = 0.12
Θ_{as} = 0.24
Θ_{ws} = 0.14

Site specific input parameters

L_{crack} = 10.2 cm
L_S = 305 cm
L_B = 370 cm

Θ_T = 0.39
ρ_s = 1.60

$$D_s^{eff} = D^{air}\frac{\Theta_{as}^{3.33}}{\Theta_T^2} + \left[\frac{D^{wat}}{H'}\right]\left[\frac{\Theta_{ws}^{3.33}}{\Theta_T^2}\right] = 0.0053$$

$$D_{crack}^{eff} = D^{air}\frac{\Theta_{ncrack}^{3.33}}{\Theta_T^2} + \left[\frac{D^{wat}}{H'}\right]\left[\frac{\Theta_{w\,crack}^{3.33}}{\Theta_T^2}\right] = 0.0069$$

(Continued from Page 4)

$$V_{F_{sesp}} = \frac{\dfrac{H'\rho_s}{\left[\Theta_{ws} + K_s\rho_s + H'\Theta_{as}\right]} \dfrac{D_s^{eff}/L_s}{E_R L_B}}{1 + \left[\dfrac{D_s^{eff}/L_s}{E_R L_B}\right] + \left[\dfrac{D_s^{eff}/L_s}{\left(D_{crack}^{eff}/L_{crack}\right)\eta}\right]} 10^3 = 0.0192$$

Allowable Inhalation of Benzene Vapors to Commercial Worker in Building

Input

slope factor for Benzene = 0.1

$$I = \frac{0.000001}{Slope\ Factor} = 0.00001$$

I_R = 20 $^{m3}/_{day}$
E_F = 252 days

E_D = 25 years
B_W = 70 kg
A_T = 365 days x 70 yrs
E_T = 8 $^{hrs}/_{day}$

$$C_A = \frac{IB_W A_T}{I_R E_T E_F E_D} = 0.00002 \text{ mg/m}^3$$

The area weighted average for benzene concentrations in soil for the following is 68.5 ppm.

V_{sesp} = (0.0192) (68.5 mg/kg) = 1.315 mg/m^3

= 0.02 kg/m^3

Since allowable concentration C_A = 0.00002 mg/m^3 and the actual benzene concentration is 1.315 mg/m^3, the benzene in soil beneath the site does pose an inhalation health risk.

Jie 1 Rick 10^{-6} risk = 6.49 $\mu g/m^3$