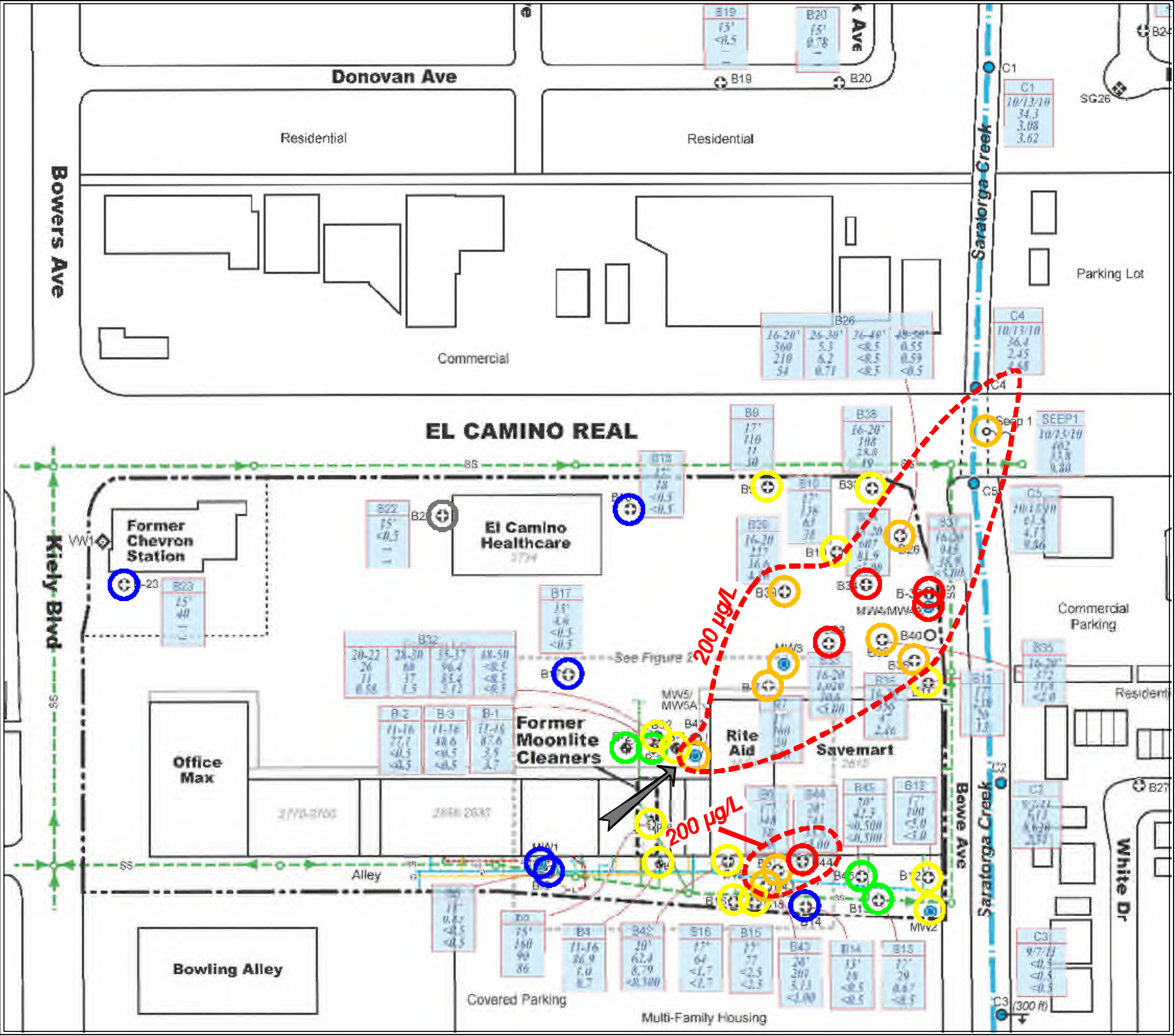


EXPLANATION

- ◉ Monitoring well location
- ● Water sample location
- Approximate PSI boring location
- P&D groundwater sample location
- ◇ P&D vapor well location
- ○ P&D lithologic boring location
- — G — Gas line
- — W — ● Water line / cleanout
- — SS — ▶ ○ Sanitary Sewer line / flow direction / manhole
- — E — Electrical line
- — - — Subject property line

B13	Sample ID
18'	Depth (feet)
<0.5	PCE
<0.5	TCE (µg/l)
<0.5	DCE

0 200 400

(Approximate Scale in Feet)

N

Approximate Lateral Extent of PCE in Groundwater at 200 µg/L and Above

Groundwater Gradient Direction (2012)

PCE Concentrations (µg/L) in Groundwater

- 🔴 > 500
- 🟠 > 200 - 500
- 🟡 > 50 - 200
- 🟢 20 - 50
- 🔵 0.05 - 20
- ⚪ < 0.05

Notes:

1. All locations are approximate.

Source:

Base Map Source: West, *Feasibility Study/Pilot Study Work Plan* (2012). P&D Environmental, *Quarterly Monitoring Report, Third Quarter 2012* (2012).

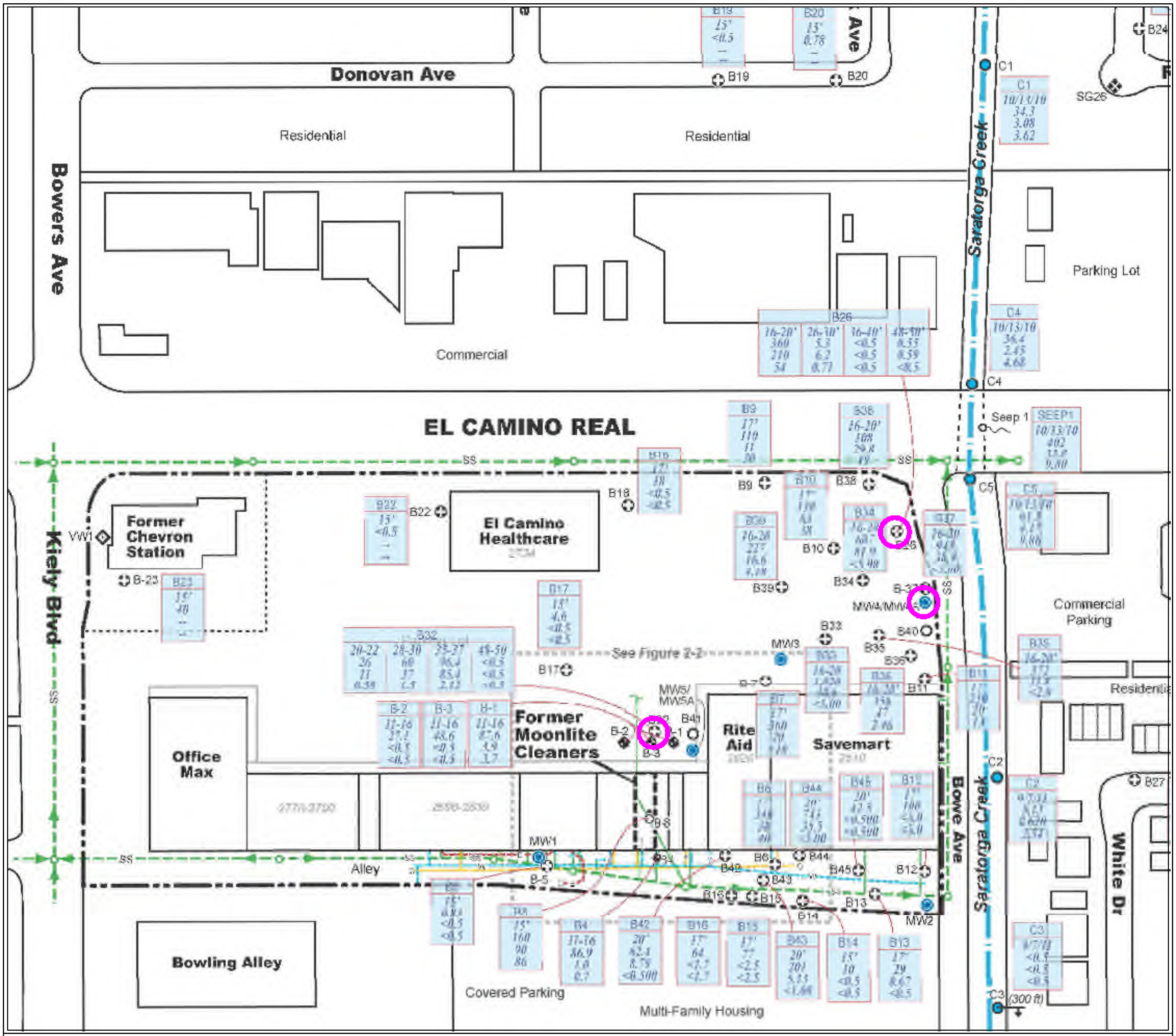
Erler & Kalinowski, Inc.

Approximate Extent of PCE in Groundwater and Groundwater Gradient Direction

Former Moonlite Cleaners
2640 El Camino Real
Santa Clara, CA

March 2013
EKI B10003.00

Figure 13



EXPLANATION

- ◉ Monitoring well location
- ● Water sample location
- ⊕ Approximate PSI boring location
- ⊕ P&D groundwater sample location
- ◇ P&D vapor well location
- ○ P&D lithologic boring location
- ---G--- Gas line
- ---W--- ● Water line / cleanout
- ---SS---▶○ Sanitary Sewer line / flow direction / manhole
- ---E--- Electrical line
- -·-·- Subject property line

B13	Sample ID
18'	Depth (feet)
<0.5	PCE
<0.5	TCE (µg/l)
<0.5	DCE

○ Sample >= 50' Below Gound Surface

0 200 400
(Approximate Scale in Feet)

N

Notes:

1. All locations are approximate.

Source:

Base Map Source: West, *Feasibility Study/Pilot Study Work Plan* (2012). P&D Environmental , *Quarterly Monitoring Report, Third Quarter 2012* (2012).

Erler & Kalinowski, Inc.

Approximate Location of Deep Groundwater Samples ~50 Feet Below Ground Surface

Former Moonlite Cleaners
2640 El Camino Real
Santa Clara, CA
March 2013
EKI B10003.00

Figure 14

G:\B10003.00\2013-02\Figures 01-14.dwg 3-12-13

ATTACHMENT A

Analysis of Gradient Direction 1990 – 2000
Former Shell Service Station, 2540 El Camino Real, Santa Clara, CA

EKI evaluated groundwater gradients in the vicinity of the property located at 2640 El Camino Real in Santa Clara, California (the “subject property” or “Site”) during the 1990s by examining groundwater levels measured at a corollary site located on the opposite side of Saratoga Creek at approximately the same distance. The corollary site, the former Shell Service Station site located at 2540 El Camino Real in Santa Clara, CA, had a network of groundwater monitoring wells from which depth-to-water ("DTW") measurements were collected on a roughly quarterly basis from September 1990 through January 2000. To evaluate groundwater gradient direction at that site, DTW data from three of the monitoring wells, those which had the longest period of record (wells MW-1, MW-2, and MW-3) and a favorable geometry for gradient determination, were analyzed.

The first step in the analysis was to convert the DTW data into groundwater elevation data. Although measuring point (i.e., top of casing) elevations for each well were given in the data table included in the Site Closure Summary report, it appears that a local vertical datum was used rather than a datum corresponding to mean sea level. Therefore, an adjustment of -23 feet was applied to the measuring point elevations to make them more consistent with ground surface elevations for the site (approximately 77 ft above mean sea level) determined from the USGS topographic map. The adjustment was applied equally to all three wells.[5] The adjusted measuring point elevations were used along with the DTW data to calculate groundwater elevations for each well on each measurement date. Groundwater gradient directions and magnitude were then calculated using the 3-point method.

Results from the analysis indicate that the groundwater gradient direction in the early 1990s was typically to the northeast on the east side of Saratoga Creek. Over the course of the decade, the direction shifted counterclockwise. By the end of the decade the gradient direction was approximately north-northwesterly. The total angular shift from 1990 to 2000 was approximately 60 degrees (see Table A-1, at back of Attachment A).

Table A-1: Calculation of Groundwater Gradients Based on Depth-To-Water Data from the Former Shell Service Station Located at 2540 El Camino Real, Santa Clara, CA

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[5] Note that this adjustment did not affect the gradient direction analysis in any way. However, it did allow comparison of groundwater elevation data from the former Shell Service Station to nearby features such as the bottom elevation of the Saratoga Creek streambed as discussed in Section 4.

TABLE A-1
CALCULATION OF GROUNDWATER GRADIENTS BASED ON DEPTH-TO-WATER DATA FROM THE FORMER SHELL SERVICE STATION LOCATED AT 2540 EL CAMINO REAL, SANTA CLARA, CA

Former Moonlite Cleaners
Santa Clara, California

Date	Former Shell Station Monitoring Well Groundwater Elevation (ft msl) (a)			Gradient Direction (deg) (b), (c)	Gradient Magnitude (%) (b)
	MW-1	MW-2	MW-3		
9/21/1990	68.13	68.08	68.1	78.5	0.10%
12/18/1990	68.12	68.04	68.07	80.3	0.16%
3/25/1991	71.32	71.17	71.21	87.9	0.30%
6/20/1991	71.16	71.12	71.19	12.1	0.15%
8/13/1991	70.7	70.67	70.69	58.9	0.06%
9/18/1991	70.44	70.41	70.45	23.4	0.08%
11/18/1991	70.58	70.53	70.57	49.8	0.10%
2/21/1992	74.66	74.51	73.99	149.2	1.51%
3/25/1992	76.98	76.14	76.21	-80.7	1.85%
5/21/1992	76.26	76.21	76.29	15.5	0.17%
6/17/1992	75.92	75.87	75.94	21.2	0.15%
8/24/1992	75.2	75.15	75.22	21.2	0.15%
9/24/1992	74.85	74.91	74.97	-46.9	0.25%
10/28/1992	74.86	74.81	74.89	15.5	0.17%
12/23/1992	76.03	75.95	76.01	53.1	0.16%
2/16/1993	80.1	80	80.09	43.5	0.21%
4/11/1993	82.15	82.1	82.05	133.1	0.21%
6/10/1993	82.04	81.95	82.06	27.6	0.23%
6/28/1993	81.92	81.87	81.83	129.7	0.19%
8/10/1993	81.16	81.11	81.17	28.5	0.13%
9/23/1993	81.03	80.97	81.05	23.4	0.17%
11/17/1993	80.9	81.87	81.23	-120.6	1.90%
12/21/1993	81.56	81.49	81.58	25.1	0.19%
2/4/1994	81.56	81.51	81.53	78.5	0.10%
5/2/1994	82.59	82.5	82.56	58.9	0.18%
6/21/1994	82.3	82.27	82.41	-9.3	0.32%
8/5/1994	81.92	81.86	81.96	13.9	0.21%
11/3/1994	81.08	81.09	81.07	-172.4	0.04%
2/16/1995	84.74	84.69	84.51	149.5	0.52%
5/4/1995	85.42	85.75	85.81	-67.8	0.85%
8/1/1995	85.36	85.47	85.21	-177.2	0.55%
11/2/1995	84.85	84.7	84.87	31.4	0.37%
1/26/1996	85.64	85.59	85.67	15.5	0.17%
5/2/1996	86.6	86.57	86.69	-7.4	0.27%
8/9/1996	86.16	86.05	86.25	10.7	0.41%
11/15/1996	85.84	85.28	85.93	30.1	1.40%
2/13/1997	88.26	87.65	88.49	21.9	1.76%
5/27/1997	87.45	87.52	87.44	-149.1	0.17%
8/15/1997	87.21	87.08	87.28	17.1	0.41%
10/31/1997	86.69	86.62	86.8	0.7	0.38%
1/30/1998	87.88	88.2	88.16	96.9	0.69%
5/4/1998	88.19	88.22	88.59	-23.3	0.96%
8/6/1998	87.91	87.89	88.32	-17.8	1.04%
10/30/1998	87.09	87.01	87.22	0.2	0.45%
2/16/1999	88.1	88.16	88.31	-34.2	0.46%
5/5/1999	87.94	87.85	88	13.9	0.31%
8/6/1999	87.54	87.46	87.82	-8.9	0.81%
11/2/1999	87.13	87.09	87.41	-14.0	0.75%
1/2/2000	87.17	87.09	87.22	14.9	0.27%

TABLE A-1
CALCULATION OF GROUNDWATER GRADIENTS BASED ON DEPTH-TO-WATER DATA FROM THE FORMER SHELL SERVICE STATION LOCATED AT 2540 EL CAMINO REAL, SANTA CLARA, CA

Former Moonlite Cleaners
Santa Clara, California

Abbreviations:

deg	degrees
ft msl	feet above mean sea level
SCVWD	Santa Clara Valley Water District

Notes:

(a) The groundwater elevations for the three monitoring wells at the former Shell Service Station (MW-1, MW-2, and MW-3) were calculated based on the measuring point elevations and depth-to-water measurements shown in the Table "Well Concentrations" in the Site Closure Report for the former Shell Station site (SCVWD, 2001). All groundwater elevation data were adjusted by -23 feet to account for the use of a local datum in the measuring point elevation rather than a ft msl datum. Monitoring well coordinates were determined from the figure "Offiste Plot Plan" in the Site Closure Report.

(b) Groundwater gradients were calculated using the 3-point method.

(c) Gradient directions, in degrees, are based on the following assignments to cardinal directions: North = 0, West = -90, East = 90, South = +/-180.

ATTACHMENT B

Summary of Unsaturated Flow and Transport Travel Time Analysis

In order to estimate the time that it would take a release of contaminated water to travel through the unsaturated zone and reach the groundwater table at the property located at 2640 El Camino Real in Santa Clara, California (the "subject property" or "Site"), an analysis of steady-state unsaturated flow and advective solute transport with retardation was performed. The analysis involved the following steps:

1) Determining a representative soil profile for the unsaturated zone region of interest, which extends from 5 ft bgs (i.e., the depth of the hypothetical leaking sewer pipe) to the bottom of the coarse (sand) soils at approximately 33.5 to 35 ft bgs;
2) Estimating a representative or reasonable value for the rate of leakage from the hypothetical leaking sewer pipe;
3) Determining the maximum steady-state vertical flow rate through the soil profile which is equivalent to the saturated hydraulic conductivity of the least permeable soil in the profile;
4) Setting the vertical flux rate to be the lesser of the rates determined in Steps 2 and 3;
5) Determining the water content of each soil type within the profile at the specified vertical flux rate through use of the van Genuchten (1980) equation for unsaturated soil water retention and conductivity;
6) Calculating the advective velocity of water through each soil type at the water content determined in Step 5;
7) Calculating a Retardation Factor for each soil based on the water content, bulk density, and partitioning coefficient for the contaminant of concern ("COC");
8) Calculating the advective velocity of the dissolved COC based on the advective velocity of water divided by the Retardation Factor;
9) Calculating the time required for the COC to travel through each layer based on the advective solute velocity and the layer thickness; and
10) Calculating the total transport time as the sum of the transport times through each individual layer within the soil profile.

Details of each step are provided in the paragraphs below.

Step 1

The representative soil profile was determined from the borehole logs for boreholes B32, B42, and MW5a. Boreholes B32 and MW5a were 50 and 44 ft deep, respectively, and so encompassed the entire unsaturated zone region of interest. Borehole B42 only extended to 30 ft bgs, and therefore it was assumed for this analysis, based on the conceptual cross section shown on Figure 6, that the soil type from 30 to 31 ft bgs was a silt and from 31 to 33.5 ft bgs was a sand.

Step 2

A representative or reasonable value for the rate of leakage from the hypothetical leaking sewer pipe is estimated based on the lower end of the range given in USEPA (1989b) for older vitrified clay pipes in northern California. The range given in USEPA (1989b) is 2,400 to 8,300 gallons per day per inch diameter per mile, and therefore the value assumed herein is, to be conservative, the lower end of the range – 2,400 gallons per day per inch diameter per mile, which translates to approximately 18 feet per year assuming the leakage spreads over a width of 10 feet. Obviously, when subsurface soils are unable to transmit water at this rate, the water will spread out to greater widths until the increased area is capable of transmitting this flux.

Step 3

The maximum steady-state vertical flow rate was determined to be 5.76 ft/year, based on the limiting hydraulic conductivity of the silty clay soil layers. Saturated hydraulic conductivity values for each soil type were based on the values in Carsel and Parrish (1988).

Step 4

The vertical flux rate is the lesser of the two rates determined in Steps 2 and 3, namely 5.76 ft/yr. Because the vertical flux rate turns out to be limited by the hydraulic conductivity of the silty clay soils, from Step 3, it does not matter that the lower end of the leakage rate range was used in Step 2.

Step 5

The water content of each soil type within the soil profile at the steady-state flux rate from Step 4 is determined using the van Genuchten (1980) equations. For the silty clay layers which are limiting in terms of the vertical flux rate, the water content is equal to the saturated water content. For all other soil types, the water content is unsaturated to some extent.

Step 6

The advective velocity of water through the soil type at the water content calculated from Step 5 is calculated using Darcy's Law as follows:

$$v_{water} = \frac{Qi}{\theta}$$

where v_{water} is the advective velocity of the water, Q is the vertical flux rate, i is the hydraulic gradient (equal to 1 in the case of vertical unsaturated steady-state flow), and $\boldsymbol{\theta}$ is the water content.

Step 7

The Retardation Factor for each soil type is calculated as follows:

$$R = 1 + \frac{\rho_b}{\theta} K_d$$

where R is the Retardation Factor, ρ_b is the bulk density, and K_d is the soil-water partitioning coefficient. For this analysis, K_d was assumed to equal 0.590 L/kg based on observed plume travel distance (discussed further in Attachment C), and ρ_b was calculated from the Carsel and Parrish (1988) saturated water content value and an assumed particle density of 2.65 g/cm^3.

Step 8

The advective velocity of the retarded solute is calculated as follows:

$$v_{solute} = \frac{v_{water}}{R}$$

where v_{solute} is the advective velocity of the retarded solute.

Step 9

The time required for the COC to travel through each layer is calculated as follows:

$$t_{layer} = \frac{z_{layer}}{v_{solute}}$$

where t_{layer} is the time required and z_{layer} is the layer thickness.

Step 10

The total time required for the COC, i.e., PCE, to travel through the soil profile is calculated as the sum of the travel times through each layer in the profile.

Results

Results of the analysis are presented in Table B-1. As shown on Table B-1 (at back of Attachment B), the time required for PCE to travel through the 5 to 35 ft bgs portion of the B32 soil profile is approximately 5.9 years. In the B42 soil profile, the required travel time through the 5 to 33.5 ft bgs portion is approximately 6.1 years. In the MW5a profile, the required travel time through the 5 to 35 ft bgs portion is approximately 5.7 years.

To provide an estimate of uncertainty in the travel time estimates, two single-parameter sensitivity analyses were performed. The first parameter that was adjusted for the sensitivity analysis was the saturated hydraulic conductivity, as that parameter is arguably the one with the greatest variability. The values of saturated hydraulic conductivity for each soil type were adjusted upwards and downwards by 20 percent from the original, "base case" values (i.e., the values shown in Table B-1, upon which the above travel time estimates are based). Because the vertical flux rate is limited by the minimum saturated hydraulic conductivity (see Step 4), the flux rate was also adjusted. The water content within each soil type is also dependent on the steady-state flux rate (see Step 5); however, the difference in water content between the different steady-state flux rates is negligible, and therefore the base case water content values were used in all cases. Table B-2 below shows the effect of those adjustments on the calculated travel times for the B32, B42, and MW5a soil profiles.

Table B-2. Sensitivity of Estimated Travel Time to Saturated Hydraulic Conductivity

Saturated Hydraulic Conductivity Relative to Base Case	**Estimated Travel Time for B32 Soil Profile (years)**	**Estimated Travel Time for B42 Soil Profile (years)**	**Estimated Travel Time for MW5a Soil Profile (years)**	**Average Estimated Travel Time (years)**	**Percent Difference from Base Case**
20 Percent Lower	7.4	7.6	7.1	7.4	+25%
Base Case	5.9	6.1	5.7	5.9	-
20 Percent Higher	4.9	5.1	4.8	4.9	-17%

As shown in Table B-2, the estimated travel time is slightly more sensitive to downwards adjustments to the soils' hydraulic conductivity than to upwards adjustments. It should be noted that, while the hydraulic conductivity of any particular soil type is subject to some uncertainty, it is unlikely that every soil within the profiles would be uniformly lower (or higher) than the base case values, and therefore the range of travel time estimates shown in Table B-2 is likely inclusive of all probable scenarios.

A second single-parameter sensitivity analysis was performed to investigate the effect of solute retardation on travel time. For this analysis, the value of the partitioning coefficient was adjusted upwards and downwards by 20 percent. Results from that sensitivity analysis are presented in Table B-3 below.

Table B-3. Sensitivity of Estimated Travel Time to Partitioning Coefficient

Partitioning Coefficient Relative to Base Case	**Estimated Travel Time for B32 Soil Profile (years)**	**Estimated Travel Time for B42 Soil Profile (years)**	**Estimated Travel Time for MW5a Soil Profile (years)**	**Average Estimated Travel Time (years)**	**Percent Difference from Base Case**
20 Percent Lower	4.9	5.2	4.8	5.0	-15%
Base Case	5.9	6.1	5.7	5.9	-
20 Percent Higher	6.9	7.0	6.7	6.9	+17%

The results shown in Table B-3 indicate that the travel time is somewhat less sensitive to changes in the partitioning coefficient than it is to changes in the saturated hydraulic conductivity.

If the hydraulic conductivity values and the partitioning coefficient values are adjusted simultaneously towards the ends of their ranges that produce shorter travel times (i.e., higher hydraulic conductivity and lower partition coefficient), the resulting travel times range from 4.0 to 4.3 years. If these parameters are adjusted simultaneously towards the ends of their ranges that produce longer travel times (i.e., lower hydraulic conductivity and higher partitioning coefficient), the resulting travel times range from 8.3 to 8.8 years.

Table B-1: Calculation of Unsaturated Flow and Transport Travel Time

TABLE B-1
CALCULATION OF UNSATURATED FLOW AND TRANSPORT TRAVEL TIME
Former Moonlite Cleaners
Santa Clara, California

Borehole B32

											Carsel and Parrish (1988) Unsaturated Hydraulic Property Data											
Top of Interval (ft bgs)	Bottom of Interval (ft bgs)	Interval Thickness (ft)	Top of Interval (m bgs)	Bottom of Interval (m bgs)	Interval Thickness (m)	Top of Interval (m below sewer pipe) (a)	Bottom of Interval (m below sewer pipe) (a)	USCS Code in Log	Soil Description in Log	Corresponding Carsel and Parrish (1988) Texture	Saturated Water Content (-)	Residual Water Content (-)	van Genuchten Alpha (1/m)	van Genuchten Beta ("n") (-)	van Genuchten "m" (-)	Saturated Hydraulic Conductivity (m/sec)	Saturated Hydraulic Conductivity (m/day)	Bulk Density (g/cm^3) (b)	Water Content at Maximum Flux Rate (-) (c)	Water Travel Time Through Layer at Maximum Flux Rate (days)	Retardation Factor (-)	Solute Travel Time Through Layer at Maximum Flux Rate (days)
0	5	5	0.00	1.52	1.52	-1.52	0.00	CL	silty clay	silty clay	0.36	0.07	0.5	1.09	0.0826	5.56E-08	4.80E-03	1.696	0.36	114	3.78	432
5	6.5	1.5	1.52	1.98	0.46	0.00	0.46	SW	gravelly sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	11	8.89	96
6.5	9	2.5	1.98	2.74	0.76	0.46	1.22	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	67	2.99	201
9	10	1	2.74	3.05	0.30	1.22	1.52	CL	clay	clay	0.38	0.068	0.8	1.09	0.0826	5.56E-07	4.80E-02	1.643	0.38	24	3.55	86
10	15	5	3.05	4.57	1.52	1.52	3.05	SW	gravelly sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	36	8.89	319
15	16	1	4.57	4.88	0.30	3.05	3.35	SP	fine sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	7	8.89	64
16	17	1	4.88	5.18	0.30	3.35	3.66	SW	gravelly sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	7	8.89	64
17	18	1	5.18	5.49	0.30	3.66	3.96	CL	silty clay	silty clay	0.36	0.07	0.5	1.09	0.0826	5.56E-08	4.80E-03	1.696	0.36	23	3.78	86
18	18.5	0.5	5.49	5.64	0.15	3.96	4.11	SP	fine sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	4	8.89	32
18.5	20	1.5	5.64	6.10	0.46	4.11	4.57	CL	silty clay	silty clay	0.36	0.07	0.5	1.09	0.0826	5.56E-08	4.80E-03	1.696	0.36	34	3.78	129
20	24.5	4.5	6.10	7.47	1.37	4.57	5.94	CL	silty clay	silty clay	0.36	0.07	0.5	1.09	0.0826	5.56E-08	4.80E-03	1.696	0.36	103	3.78	388
24.5	28	3.5	7.47	8.53	1.07	5.94	7.01	GW	sandy gravel	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	25	8.89	223
28	30	2	8.53	9.14	0.61	7.01	7.62	GC	clayey gravel	loamy sand	0.41	0.057	12.4	2.28	0.5614	4.05E-05	3.50E+00	1.5635	0.149	19	7.19	136
30	31.5	1.5	9.14	9.60	0.46	7.62	8.08	GW	sandy gravel	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	11	8.89	96
31.5	32	0.5	9.60	9.75	0.15	8.08	8.23	CL	sandy clay	sandy clay	0.38	0.1	2.7	1.23	0.1870	3.33E-07	2.88E-02	1.643	0.376	12	3.58	43
32	35	3	9.75	10.67	0.91	8.23	9.14	GC	clayey sandy gravel	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	22	8.89	191
35	36.5	1.5	10.67	11.13	0.46	9.14	9.60	SC	clayey sand	loamy sand	0.41	0.057	12.4	2.28	0.5614	4.05E-05	3.50E+00	1.5635	0.149	14	7.19	102
36.5	49.5	13	11.13	15.09	3.96	9.60	13.56	CL	clay	clay	0.38	0.068	0.8	1.09	0.0826	5.56E-07	4.80E-02	1.643	0.38	313	3.55	1,113
49.5	50	0.5	15.09	15.24	0.15	13.56	13.72	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	13	2.99	40

Total Travel Time from 5 ft bgs to 35 ft bgs			
404	days	2,153	days
1.1	years	5.9	years

Borehole B42

											Carsel and Parrish (1988) Unsaturated Hydraulic Property Data											
Top of Interval (ft bgs)	Bottom of Interval (ft bgs)	Interval Thickness (ft)	Top of Interval (m bgs)	Bottom of Interval (m bgs)	Interval Thickness (m)	Top of Interval (m below sewer pipe) (a)	Bottom of Interval (m below sewer pipe) (a)	USCS Code in Log	Soil Description in Log	Corresponding Carsel and Parrish (1988) Texture	Saturated Water Content (-)	Residual Water Content (-)	van Genuchten Alpha (1/m)	van Genuchten Beta ("n") (-)	van Genuchten "m" (-)	Saturated Hydraulic Conductivity (m/sec)	Saturated Hydraulic Conductivity (m/day)	Bulk Density (g/cm^3) (b)	Water Content at Maximum Flux Rate (-) (c)	Water Travel Time Through Layer at Maximum Flux Rate (days)	Retardation Factor (-)	Solute Travel Time Through Layer at Maximum Flux Rate (days)
0	0.5	0.5	0.00	0.15	0.15	-1.524	-1.372	-	asphalt/base rock													
0.5	3	2.5	0.15	0.91	0.76	-1.372	-0.610	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	67	2.99	201
3	7.5	4.5	0.91	2.29	1.37	-0.610	0.762	CL	clay	clay	0.38	0.068	0.8	1.09	0.0826	5.56E-07	4.80E-02	1.643	0.38	108	3.55	385
7.5	13	5.5	2.29	3.96	1.68	0.762	2.438	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	148	2.99	443
13	18.5	5.5	3.96	5.64	1.68	2.438	4.115	CL	clay	clay	0.38	0.068	0.8	1.09	0.0826	5.56E-07	4.80E-02	1.643	0.38	133	3.55	471
18.5	19.5	1	5.64	5.94	0.30	4.115	4.420	SM	silty fine sand	loamy sand	0.41	0.057	12.4	2.28	0.5614	4.05E-05	3.50E+00	1.5635	0.149	9	7.19	68
19.5	20	0.5	5.94	6.10	0.15	4.420	4.572	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	13	2.99	40
20	23	3	6.10	7.01	0.91	4.572	5.486	CL	silty clay	silty clay	0.36	0.07	0.5	1.09	0.0826	5.56E-08	4.80E-03	1.696	0.36	69	3.78	259
23	23.5	0.5	7.01	7.16	0.15	5.486	5.639	SM	silty fine sand	loamy sand	0.41	0.057	12.4	2.28	0.5614	4.05E-05	3.50E+00	1.5635	0.149	5	7.19	34
23.5	24	0.5	7.16	7.32	0.15	5.639	5.791	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	13	2.99	40
24	26	2	7.32	7.92	0.61	5.791	6.401	SM	fine sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	14	8.89	127
26	27	1	7.92	8.23	0.30	6.401	6.706	CL	silty clay	silty clay	0.36	0.07	0.5	1.09	0.0826	5.56E-08	4.80E-03	1.696	0.36	23	3.78	86
27	27.5	0.5	8.23	8.38	0.15	6.706	6.858	SM	silty fine sand	loamy sand	0.41	0.057	12.4	2.28	0.5614	4.05E-05	3.50E+00	1.5635	0.149	5	7.19	34
27.5	28	0.5	8.38	8.53	0.15	6.858	7.010	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	13	2.99	40
28	29.5	1.5	8.53	8.99	0.46	7.010	7.468	SM	fine sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	11	8.89	96
29.5	30	0.5	8.99	9.14	0.15	7.468	7.620	ML	silt	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	13	2.99	40
30	31	1	9.14	9.45	0.30	7.620	7.925	(d)	(d)	silt	0.46	0.034	1.6	1.37	0.2701	6.94E-07	6.00E-02	1.431	0.424	27	2.99	80
31	33.5	2.5	9.45	10.21	0.76	7.925	8.687	(d)	(d)	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	18	8.89	159

Total Travel Time from 5 ft bgs to 33.5 ft bgs			
575	days	2,233	days
1.6	years	6.1	years

TABLE B-1
CALCULATION OF UNSATURATED FLOW AND TRANSPORT TRAVEL TIME

Former Moonlite Cleaners
Santa Clara, California

Top of Interval (ft bgs)	Bottom of Interval (ft bgs)	Interval Thickness (ft)	Top of Interval (m bgs)	Bottom of Interval (m bgs)	Interval Thickness (m)	Top of Interval (m below sewer pipe) (a)	Bottom of Interval (m below sewer pipe) (a)	USCS Code in Log	Soil Description in Log	Corresponding Carsel and Parrish (1988) Texture	Carsel and Parrish (1988) Unsaturated Hydraulic Property Data						Saturated Hydraulic Conductivity (m/day)	Bulk Density (g/cm^3) (b)	Water Content at Maximum Flux Rate (-) (c)	Water Travel Time Through Layer at Maximum Flux Rate (days)	Retardation Factor (-)	Solute Travel Time Through Layer at Maximum Flux Rate (days)
											Saturated Water Content (-)	Residual Water Content (-)	van Genuchten Alpha (1/m)	van Genuchten Beta ("n") (-)	van Genuchten "m" (-)	Saturated Hydraulic Conductivity (m/sec)						
0	10.5	10.5	0.00	3.20	3.20	-1.524	1.676	CL	clay	clay	0.38	0.068	0.8	1.09	0.0826	5.56E-07	4.80E-02	1.643	0.38	253	3.55	899
10.5	15	4.5	3.20	4.57	1.37	1.676	3.048	SW	gravelly sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	32	8.89	287
15	15.5	0.5	4.57	4.72	0.15	3.048	3.200	SP	fine sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	4	8.89	32
15.5	20	4.5	4.72	6.10	1.37	3.200	4.572	SC	clayey gravelly sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	32	8.89	287
20	20.5	0.5	6.10	6.25	0.15	4.572	4.724	CL	clay	clay	0.38	0.068	0.8	1.09	0.0826	5.56E-07	4.80E-02	1.643	0.38	12	3.55	43
20.5	25.5	5	6.25	7.77	1.52	4.724	6.248	SM	silty gravelly sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	36	8.89	319
25.5	27	1.5	7.77	8.23	0.46	6.248	6.706	SM	silty fine sand	loamy sand	0.41	0.057	12.4	2.28	0.5614	4.05E-05	3.50E+00	1.5635	0.149	14	7.19	102
27	28.5	1.5	8.23	8.69	0.46	6.706	7.163	CL	silty clay	silty clay	0.36	0.07	0.5	1.09	0.0826	5.56E-08	4.80E-03	1.696	0.36	34	3.78	129
28.5	31	2.5	8.69	9.45	0.76	7.163	7.925	SP	gravelly sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	18	8.89	159
31	32	1	9.45	9.75	0.30	7.925	8.230	SM	clayey silty fine sand	loamy sand	0.41	0.057	12.4	2.28	0.5614	4.05E-05	3.50E+00	1.5635	0.149	9	7.19	68
32	35	3	9.75	10.67	0.91	8.230	9.144	SP	sand	sand	0.43	0.045	14.5	2.68	0.6269	8.25E-05	7.13E+00	1.5105	0.113	22	8.89	191
35	44	9	10.67	13.41	2.74	9.144	11.887	CL	clay	clay	0.38	0.068	0.8	1.09	0.0826	5.56E-07	4.80E-02	1.643	0.38	217	3.55	771

Total Travel Time from 5 ft bgs to 35 ft bgs			
346	days	2,087	days
0.9	years	5.7	years

Abbreviations:

ft bgs	feet below ground surface
g/cm^3	grams per cubic centimeter
K	hydraulic conductivity
m bgs	meters below ground surface
USCS	Unified Soil Classification System

Notes:

(a) The sewer pipe is approximately 5 feet below ground surface.
(b) Bulk density is calculated from the saturated water content and an assumed particle density of 2.65 g/cm^3.
(c) The maximum flux rate through the unsaturated zone is equal to the minimum saturated hydraulic conductivity within the soil profile.
(d) The soil type in borehole B42 from 30 to 31 ft bgs is assumed to be the same as the soil type observed from 29.5 to 30 ft bgs (silt). Below 31 ft bgs, the soil type is assumed to be sand.

ATTACHMENT C

Summary of Chemical Transport in Groundwater Calculations

An analysis of the evolution of chemical of concern ("COC") concentrations in groundwater was performed for the specific scenario of flushing of a COC plume with COC-free water following a shift in groundwater gradient direction. This scenario is based on what would be expected to have occurred if a COC release had occurred at the property located at 2640 El Camino Real in Santa Clara, California (the "subject property" or "Site")during the period of UATC ownership or tenancy, between 1962 and 1978. Under this scenario, a plume with a northwest orientation would have been created due to the prevailing northwest groundwater gradients. Then, in the mid-1990s, as the groundwater gradient direction shifted to its current northeast direction, the northwest-oriented plume would be subject to flushing by COC-free groundwater flowing from the upgradient (southwest) direction.

To evaluate the scenario described above, the REMCHLOR model (Falta, 2007) was used. REMChlor is a model of advective-diffusive-reactive transport specifically designed for chlorinated solvents such as PCE and its daughter products. The model allows for simulation of the fate of a COC source of a user-specified mass and concentration. The reader is directed to Falta (2007) for more information on the REMChlor model. The model set-up and results for this analysis are described below.

Model Setup

This section describes the REMChlor model input parameters. Parameterization was based on site specific data, where available, and on professional judgment otherwise. It should be noted that certain input parameters, or the parameters on which they are based (e.g., hydraulic conductivity, soil-water partitioning coefficient, source zone mass), are inherently uncertain, and therefore results should be considered approximations rather than exact predictions of COC fate and transport processes at the Site.

Source Parameters

Source parameters in REMChlor include the source zone concentration (i.e., the flow-averaged concentration of the chemical leaving the source zone); the source zone mass; a parameter, Γ, which controls the rate of change in source zone concentration as source zone mass is depleted; the source zone width and vertical height; the effective porosity; and parameters related to source remediation. For this evaluation, the parameters were set as follows:

- Source zone concentration: 1,000 micrograms per liter ("ug/L")
- Source zone mass: 4.97 kg, based on the calculated concentration of PCE sorbed to the soil within a 5,400-m^3 source zone (60 m wide x 30 m long x 3 m thick), assuming an aqueous concentration of 1,000 ug/L and a partitioning coefficient of 0.590 L/kg. The source zone dimensions were approximated based on the observed dimensions of the core of the current northeast-trending plume.

- Γ parameter: 1, based on the default value; this value results in a linear relationship between the change in source zone mass and source zone concentration. Other values of Γ were used as well, with little effect on the overall results.
- Source zone width: 60 m
- Source zone height: 3 m
- Effective porosity: 0.353, based on the difference between the saturated and residual water content for loamy sand from the Carsel & Parrish (1988) soil property database
- Source remediation: none, i.e., no mechanisms for source zone mass depletion except for flushing

Transport Parameters

REMChlor uses the concept of one-dimensional streamtubes to model the advection-dispersion transport process. The user specifies a number of streamtubes and the model applies a log-normally distributed velocity field over the streamtube to represent hydrodynamic dispersion. Transport parameters in REMChlor include the Darcy velocity; the Retardation Factor; a parameter, sigmav, equal to the coefficient of variation for the velocity field, which allows for scale-dependent dispersivity; minimum and maximum normalized streamtube velocities; the number of streamtubes; and the dispersivity in the transverse horizontal and vertical directions. For this evaluation, the parameters were set as follows:

- Darcy velocity: 7.285 m/yr, based on a hydraulic gradient of 0.0057 (from the 3rd Quarter 2012 Groundwater Monitoring Report; P&D, 2012) and a hydraulic conductivity of 3.5 m/day, from the Carsel & Parrish (1988) soil properties database
- Retardation factor: 3.611, based on the observed travel distance (375 ft) of the center of mass of the current northeast-trending plume, a travel time of 20 years, and a groundwater velocity of 68 ft/yr, calculated from the Darcy velocity and effective porosity
- sigmav: 0.44721, based on REMChlor guidance and resulting in a longitudinal dispersity which is 0.1 times the average travel distance
- Minimum normalized streamtube velocity: 0, based on REMChlor
- Maximum normalized streamtube velocity: 3, based on REMChlor guidance
- Number of streamtubes: 100
- Transverse horizontal dispersivity: 1 m
- Transverse vertical dispersivity: 0.1 m

Simulation Parameters

Simulation parameters in REMChlor include the spatial and temporal discretization. For this analysis the spatial domain was discretized using 2-m intervals in the longitudinal direction, 3-m intervals in the transverse horizontal direction, and had a single layer in the vertical direction. The modeled domain was 300 m in length and 60 m wide. The total simulated time was 50 years with a timestep of 0.25 years.

Plume Reaction Parameters

For this analysis, the output variable of interest is the total concentration of chlorinated solvent COCs, rather than individual compounds such as PCE. Therefore, in the interest of simplicity, the reaction parameters were set to zero so that no reactions that transform the source zone COC into daughter products occur.

Results

Given that the purpose of this analysis is to assess whether the absence of significant concentrations in the area to the northwest of the Site is evidence that a northwest-trending plume never existed, the results of the REMChlor simulations were evaluated in terms of the maximum total chlorinated solvent concentrations that would be expected to be present following 10, 15, and 20 years of flushing of a northwest-trending plume by COC-free groundwater. Table C-1 below shows the maximum total chlorinated solvent concentrations at 10 years, 15 years, and 20 years along the plume centerline as well as 15 m and 30 m away from the plume centerline.

Table C-1. Simulated Maximum Total Chlorinated Solvent Concentrations

	Simulated Maximum Concentration (ug/L)		
Elapsed Time Since Release	**Centerline of Plume Axis**	**15 m Away from Plume Centerline**	**30 m Away from Plume Centerline**
10 years	227	216	114
15 years	140	126	71
20 years	94	84	49

The REMChlor simulation results shown in Table C-1 above indicate that detectable concentrations of chlorinated solvent COCs would be expected to be present even following 20 years of flushing of the source zone and even at distances of 30 m (approximately 100 ft) away from the plume centerline.

References

Carsel, R.F., and Parrish, R.S., 1988. *Developing Joint Probability Distributions of Soil Water Retention Characteristics*, Water Resources Research, v. 24, no. 5, p. 755-769.

Falta, R.W., 2007, *REMChlor Remediation Evaluation Model for Chlorinated Solvents, User's Manual Version 1.0*, 7 September 2007.

P&D, 2012. *Quarterly Monitoring Report, Third Quarter 2012, Former Moonlite Cleaners, 2640 El Camino Real, Santa Clara, California*, P&D Environmental, Inc., 30 October 2012.

EXHIBIT E

United States
Environmental Protection
Agency

Ground Water Issue

Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites

Bernard H. Kueper* and Kathryn L. Davies**

1.0 - Introduction

Groundwater contamination from classes of chemicals such as chlorinated solvents, polychlorinated biphenyls (PCBs), creosote, and coal tar is frequently encountered at hazardous waste sites (40, 43). These types of contaminants have low solubilities in water and have densities greater than that of water. Therefore, they can exist in the subsurface as Dense, Non-Aqueous Phase Liquids (DNAPLs) and have the potential to migrate as a separate liquid phase to significant distances below the water table in both unconsolidated materials and fractured bedrock. Because of the physicochemical properties associated with DNAPLs, they migrate through the subsurface in a very selective and tortuous manner (13, 27, 29). Thus, the majority of DNAPL present in the subsurface may not be found immediately below the entry location and directly encountering DNAPLs with conventional drilling techniques may be difficult.

Determining the presence or absence of a DNAPL is an important component of the conceptual site model and is critical to the proper selection of the remediation approach. Subsurface DNAPL acts as a long-term source for dissolved-phase contamination and determines the spatial distribution and persistence of contaminant concentrations within the dissolved-phase plume. Once it has been determined that DNAPL exists within the subsurface, subsequent characterization activities are typically conducted to better delineate the boundaries of the DNAPL source zone. The DNAPL source zone is the overall volume of the subsurface containing residual and/or pooled DNAPL. It should be recognized that there will be uncertainty associated with the delineation of the DNAPL source zone. In addition to the DNAPL, there may be significant amounts of contaminant mass that have diffused into low permeability zones. Back diffusion of contaminant mass from these zones may sustain dissolved-phase plumes for significant periods of time, even after DNAPL has been removed. Establishing the presence and locations of such non-DNAPL sources is beyond the scope of this document.

In January 1992, EPA published a Fact Sheet entitled 'Estimating Potential for Occurrence of DNAPL at Superfund Sites' (42) with the goal to help site personnel determine if DNAPL-based characterization strategies should be employed at a particular site. In September 1994, EPA issued a subsequent Fact Sheet entitled 'DNAPL Site Characterization' (39) discussing direct and indirect methods to assess the presence of DNAPL in the subsurface. Since the publication of the initial fact sheets, there have been advancements in characterization tools, site investigation approaches (14) and knowledge of DNAPL source zone architecture within the subsurface. This document builds on information from the previous fact sheets to provide a framework for not only assessing the presence of DNAPL, but also for delineating the spatial extent of the DNAPL source zone, a priority at many sites due to the more prevalent use of *in-situ* remediation technologies (38). The strategy described in the present document utilizes converging lines of evidence that incorporate the scientific advancements in the field and expands the applicability of the document to include both unconsolidated deposits and fractured bedrock. An iterative, flexible site investigation approach (7) is encouraged.

2.0 - Nature of the DNAPL Source Zone

Upon release to the subsurface, DNAPL will distribute itself in the form of disconnected blobs and ganglia of organic liquid referred to as residual DNAPL, and in connected distributions referred to as pooled DNAPL (Figure 1). Residual DNAPL is found both above and below the water table within the pathways of DNAPL migration, and typically occupies between 5% and 30% of pore space in porous media (6, 27, 44) and in rock fractures (21). Residual DNAPL is trapped by capillary forces, and typically will not enter an adjacent monitoring well, even under the influence of aggressive groundwater pumping (6, 27).

Pooling of DNAPL can occur above capillary barriers, which are typically layers and lenses of slightly less permeable material (Figure 1). Pooling can therefore occur at any elevation in the subsurface, and not just at the base of permeable zones. Absence of pooling above clay aquitards and bedrock may be due to the presence of dipping fractures, bedding planes, joints and faults which may allow the continued downward migration of the DNAPL. Pools represent a continuous distribution of DNAPL, and typically correspond to DNAPL saturations of between 30% and 80% of pore space in both porous media and fractures. The frequency of pool occurrence and the thickness of pools are increased by the presence of horizontal capillary barriers, lower DNAPL density, higher interfacial tension, and an upward component to groundwater flow (17, 22). The thickness of pools typically ranges from fractions of an inch to a few feet, depending on fluid and media properties (36) as well as the volume released. Because pools represent a connected distribution of DNAPL, the pooled DNAPL is susceptible to mobilization through drilling activities and can short-circuit along existing monitoring wells and piezometers. In addition, pools may also be mobilized in response to changes in hydraulic gradient. The gradient required to mobilize a pool is a function of the DNAPL-water interfacial

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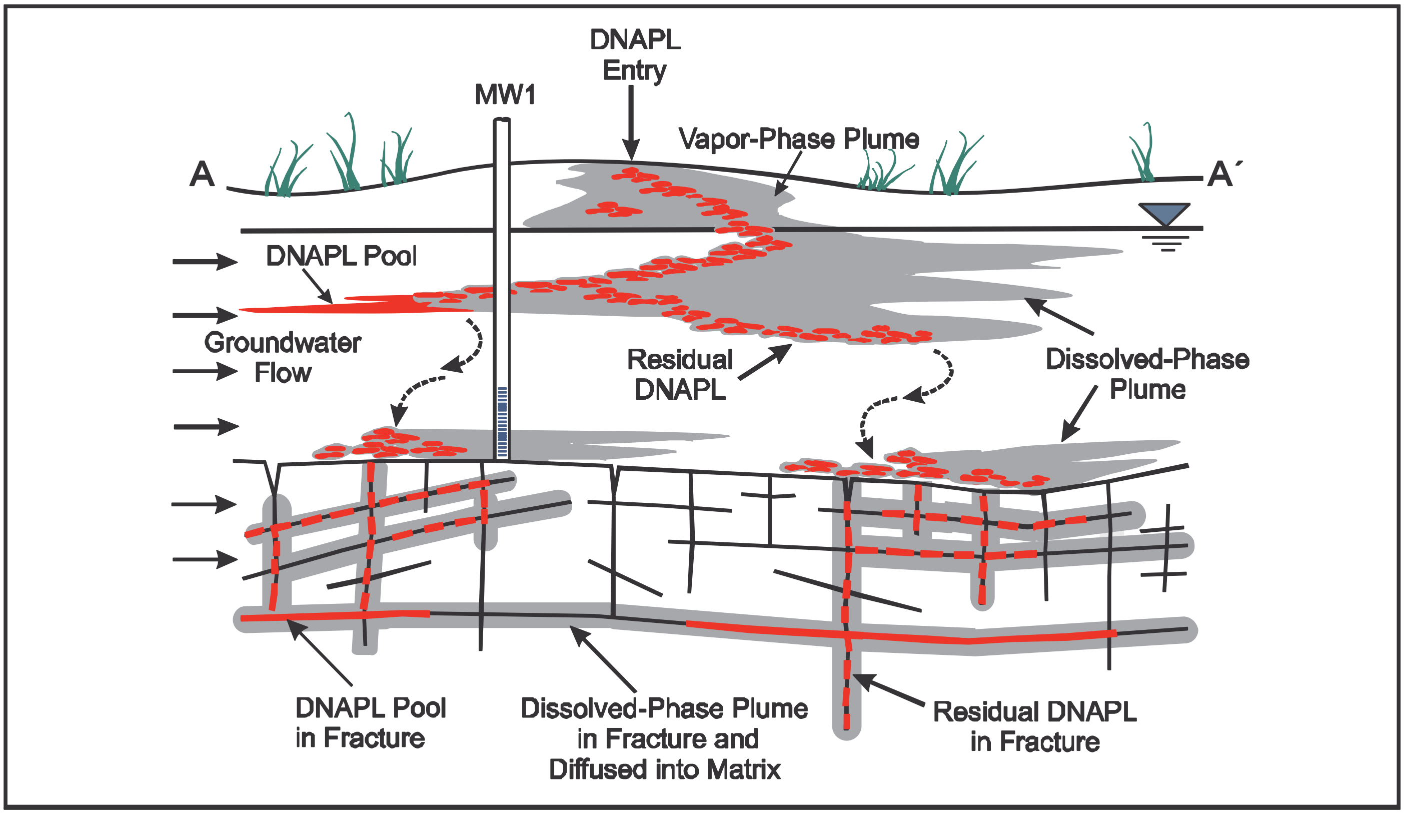

Figure 1 – Schematic illustration of contamination associated with a DNAPL release. Note that DNAPL migrates in three dimensions, and that residual DNAPL accumulated above bedrock is the result of the release at ground surface. The reader is referred to Figure 2 for a depiction of matrix diffusion. Figure is not to scale.

tension, the pool length, and the permeability of the surrounding material (6, 27). Pumping groundwater from beneath DNAPL pools, for example, can lead to an increase in capillary pressure and subsequent downward DNAPL mobilization.

The spatial distribution of residual and pooled DNAPL is strongly influenced by geology, and also by DNAPL properties and release history (frequency, intensity, duration, volume and location). DNAPL migration can occur through lenses and laminations of porous media at the scale of inches or less (17, 29). For DNAPLs that are non-wetting (see wettability in glossary) with respect to water (which is usually the case), migration below the water table is typically through the larger pores (and hence higher permeability regions) in unconsolidated media and larger aperture fractures in bedrock. The orientation of stratigraphic and structural features will largely determine the degree of lateral and vertical DNAPL spreading. DNAPL migration from the release location can occur in any direction, and is typically not greatly influenced by low ambient hydraulic gradients except for creosotes and coal tars which have densities close to that of water.

The overall region of the subsurface containing residual and pooled DNAPL is referred to as the DNAPL source zone. For high density and low viscosity DNAPLs (such as chlorinated solvents), migration in relatively permeable media can cease as soon as a few months to a few years following the time of release (3, 17, 27, 29). Some geological conditions, such as horizontal to sub-horizontal fractures, gently dipping strata and sand seams in low permeability media can give rise to longer time scales for migration of chlorinated solvent DNAPLs, particularly for large volume DNAPL sources. For low density and high viscosity DNAPLs (such as creosote and coal tar), migration has the potential to continue for many decades (12). The overall depth of DNAPL migration is dependent not only on the presence or absence of capillary barriers, but also on the volume released, the interfacial tension, the degree of lateral spreading, and the bulk retention capacity (see glossary) of the medium. Because fractured rock has very low bulk retention capacity, small volumes of DNAPL can migrate greater distances in bedrock in comparison to the same volume released into unconsolidated deposits (18).

Groundwater flowing past residual and pooled DNAPL will result in dissolved-phase plumes of contamination. Complete dissolution of all DNAPL as a result of natural groundwater flow is expected to take from several decades to hundreds of years for most DNAPLs. For multi-component DNAPLs, the presence of more than one component typically suppresses the aqueous solubility of the other components in the DNAPL (6, 27). Exceptions to this can occur, however, when co-solvents such as alcohols are present in the DNAPL. In the absence of co-solvents, the concentration of any particular component dissolving into groundwater can often be approximated using Raoult's Law (2, 6, 27). Early in the dissolution process, the plume chemistry will be dominated by the higher effective solubility components which tend to be those present in the largest mass fraction within the DNAPL, and those with the highest single-component (handbook) solubility values (24). The concentration of any or all components in groundwater downgradient of a multi-component-DNAPL source zone will typically be lower than expected using a single component solubility limit. With time, both the DNAPL composition and the plume composition will change in response to the dissolution process. The dissolved components that comprise the plume will migrate in groundwater subject to advection, dispersion, sorption, volatilization, and degradation processes.

Both residual and pooled DNAPL, and dissolved-phase plumes that are in direct contact with clays, silts, or a porous bedrock matrix, can diffuse into the low permeability media (forward diffusion). If concentrations outside of the low permeability zone become lower than those inside, diffusion will occur back into the higher permeability zone (back diffusion) and can result in plume persistence (5, 33). The forward and back diffusion processes are collectively referred to as matrix diffusion (Figure 2). The persistence of DNAPL in fractures in bedrock, saprolite and clay can be shortened by the matrix diffusion process (19, 28). In addition, the rate of advance of a dissolved-phase plume in fractured rock with a porous matrix can be strongly attenuated by the matrix diffusion process (20, 35). The influence of matrix diffusion on dissolved-phase plume migration in fractured rock and clay relative to other processes such as advection, dispersion, sorption, and possible degradation processes will vary depending on site specific geological conditions and contaminant properties. In general, matrix diffusion has a greater influence on dissolved-phase plume migration in the case of wider fracture spacing, smaller fracture aperture, lower hydraulic gradient, higher matrix porosity, and higher matrix organic carbon.

Above the water table, volatile DNAPL can vaporize into air filled pore spaces (Figure 1). For DNAPLs with significant vapor pressure, this can lead to expanded vapor-phase plumes in the unsaturated zone. The concentration of contaminants in the vapor phase will be governed by the vapor pressure, and for a multi-component DNAPL can often be approximated using Raoult's Law. In relatively warm and dry environments, the persistence of some DNAPLs (e.g., chlorinated solvents) can be relatively short (on the order of months to a few years) in unsaturated media. The absence of residual and pooled DNAPL in the unsaturated zone may not, therefore, be sufficient evidence to conclude that DNAPL has not migrated below the water table at the site of interest.

3.0 - Types of DNAPLs

Coal Tar is a complex mixture of hydrocarbons produced through the gasification of coal that was produced as a by-product of manufactured gas operations as early as 1816 in the United States. It is still produced as a by-product of blast furnace coke production. Coal tar contains hundreds of hydrocarbons, including light oil fractions, middle oil fractions, heavy oil fractions, anthracene oil, and pitch. The low density (typically 1.01 g/cc to 1.10 g/cc

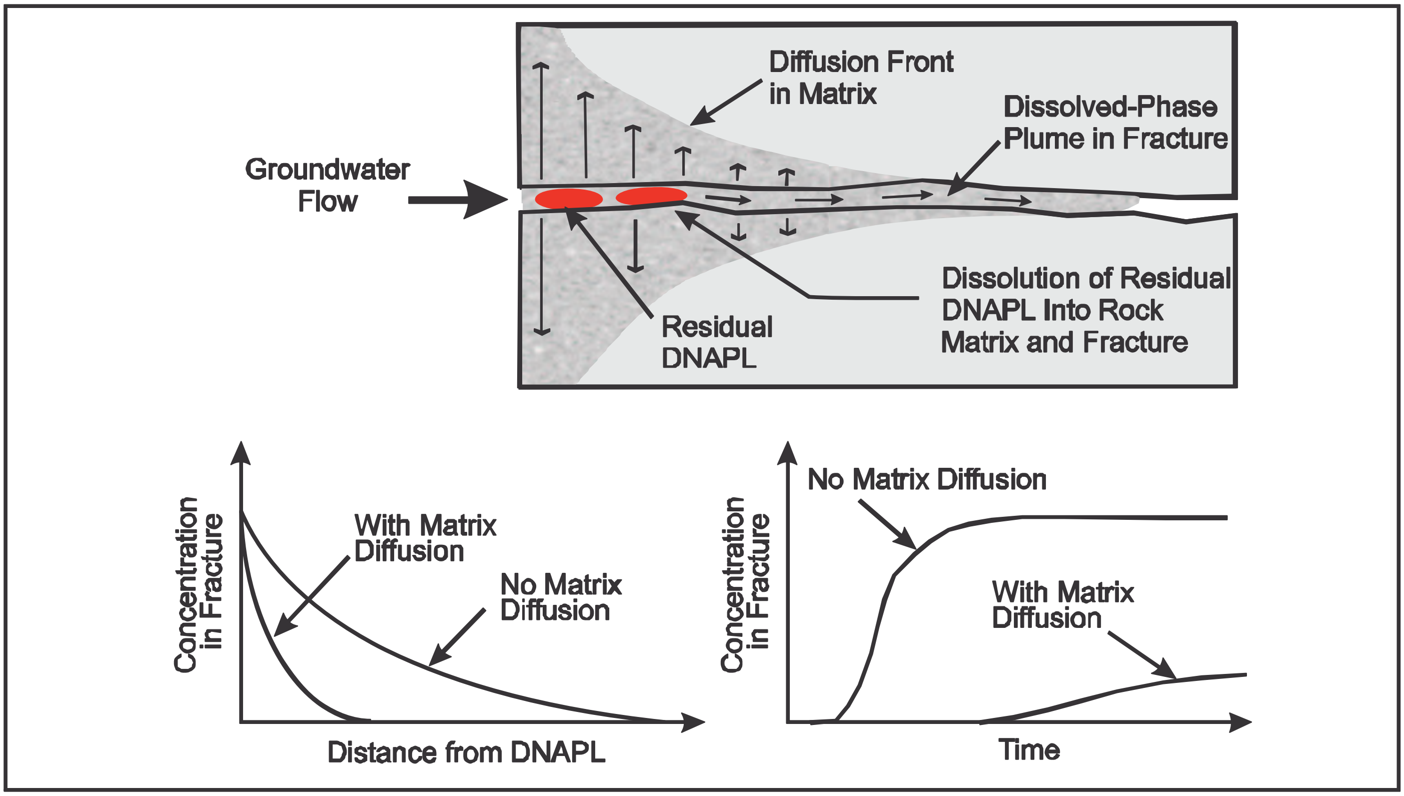

Figure 2 – Matrix diffusion of dissolved-phase contaminants adjacent to DNAPL and along length of plume in fracture. Matrix diffusion can attenuate the rate of plume advance in fractured rock (bottom left concentration vs distance plot), and can result in delayed breakthrough curves (bottom right concentration vs time figure). These factors need to be considered when relying upon groundwater concentration data to assess DNAPL presence.

compared to 1.00 g/cc of water [at 4°C]) and high viscosity (up to 200 to 300 times, or more, than that of water) facilitate long time-scales of migration, with the possibility of movement continuing for many decades following initial release. Due to the lengthy list of compounds present in coal tar, many investigators select a sub-set of coal tar compounds based on mobility and toxicity to assess water quality. These compounds may include benzene, toluene, ethylbenzene, xylenes (BTEX), benzo[a]pyrene, naphthalene, and phenanthrene. Depending on the age of the DNAPL and groundwater velocity, some of the lower molecular weight and more soluble compounds of the coal tar may have been leached out of the DNAPL by the time a site investigation is initiated. Naphthalene is often the dominant compound in present day coal tar (9). In addition, the various components in the plume will migrate at different velocities because of varying degrees of sorption and degradation (often aerobic conditions). The lower molecular weight, less sorbing compounds (e.g., BTEX) can migrate significantly further in groundwater than the higher molecular weight, more sorbing compounds (e.g., PAHs).

Creosote is composed of various coal tar fractions and was commonly used to treat wood products. It is still used today in certain wood treating operations and as a component of roofing and road tars. Creosote is a multi-component DNAPL that contains many hydrocarbons, primarily polycyclic aromatic hydrocarbons (PAHs), phenolic compounds, and carrier fluids such as diesel. The low density (typically 1.01 g/cc to 1.13 g/cc) and high viscosity (typically 20 to 50 times that of water) of creosote facilitate long time-scales of migration, with the possibility of movement continuing for many decades following initial release. Most investigators select a sub-set of creosote compounds, based on mobility and toxicity to characterize water quality, such as naphthalene, benzo(a)pyrene, and phenanthrene.

Polychlorinated Biphenyls (PCBs) are a class of 209 chemical compounds referred to as congeners, in which between one and ten chlorine atoms are attached to a biphenyl molecule. The majority of PCBs were manufactured between 1930 and 1977 under the trade-name Aroclor for use in capacitors, transformers, printing inks, paints, pesticides, and other applications. Aroclors differ based on the amount and types of congeners present. PCBs by themselves are DNAPLs, and were often blended with carrier fluids such as chlorobenzenes and mineral oil prior to distribution. The density of most PCB oils ranges from 1.10 g/cc to 1.50 g/cc, while the viscosity ranges from 10 to 50 times that of water. Most congeners are very hydrophobic and their transport can be retarded strongly relative to the rate of groundwater migration. In some cases, however, PCB transport in groundwater can be facilitated through the formation of emulsions or the presence of colloids.

Chlorinated Solvents such as trichloroethene (TCE), tetrachloroethene (PCE) and carbon tetrachloride (CT) have been produced in large quantities since the mid 1900's. Some chlorinated solvents contain trace amounts of stabilizers, preservatives and impurities. Typical uses vary widely and include dry cleaning, metal degreasing, pharmaceutical production, pesticide formulation, and chemical intermediates. Chlorinated solvents can be encountered as single component DNAPLs (e.g., as primarily PCE at a dry cleaning facility, or as primarily TCE at a vapor degreasing facility), or as part of a multi-component DNAPL containing other organic compounds. The relatively high density (typically 1.10 g/cc to 2.20 g/cc) and low viscosity (typically ranging from half to twice that of water) of chlorinated solvents can result in a relatively short time-scale of migration following release compared to coal tar and creosote. In a dissolved-phase plume, most chlorinated solvents are not retarded strongly relative to the rate of groundwater flow.

Mixed DNAPLs A DNAPL that contains two or more compounds is referred to as a multi-component DNAPL (e.g., creosote). A mixed DNAPL is a multi-component DNAPL that contains a wide variety of organic compounds as a result of blending and mixing prior to disposal operations, or as a result of cotemporaneous disposal. Examples include DNAPLs encountered at former solvent recycling facilities and industrial disposal sites. Such DNAPLs can contain aromatic compounds normally associated with LNAPLs (e.g., toluene) along with chlorinated solvents, PCBs, alcohols, ketones, and tetrahydrofuran. The density of mixed DNAPLs typically ranges from 1.01 g/cc to 1.60 g/cc, and the dissolved-phase plumes associated with mixed DNAPLs usually contain a wide variety of compounds with varying mobility.

4.0 – DNAPL Source Zone Investigation Methods

This section presents various site investigation methods and related interpretation techniques that can be useful when characterizing a DNAPL source zone. These methods and techniques will be relied upon in Sections 5 (Assessing DNAPL Presence) and 6 (Delineation of the DNAPL Source Zone). Additional information is provided in (6, 26, 37).

A Visual Observation

DNAPL obtained from the bottom of a monitoring well or as an emulsion from a pumped water sample is conclusive evidence of DNAPL presence (pooled DNAPL). Monitoring wells can be sampled for DNAPL using bottom loading bailers lowered to the bottom of the well or pumping from the bottom of the well. If an interface probe indicates DNAPL presence, then the sample should be retrieved and it should be confirmed (visually, or through laboratory analysis) that the substance is DNAPL. If DNAPL is visually observed in drill cuttings or in a soil sample for the first time, then a sample should be sent to the laboratory for confirmatory evidence. This line of evidence is applicable in both unconsolidated deposits and fractured rock, but it should be noted that visual observation of DNAPL in rock core is rare because of the aggressive flushing nature of the drilling process. Because of the typically sparse and tortuous nature of DNAPL distribution in the subsurface, DNAPL is not encountered and visually observed within many DNAPL source zones.

B Chemical Concentrations in Soil Above Threshold DNAPL Saturation

Chemical concentrations in soil exceeding the value corresponding to a threshold DNAPL saturation are conclusive evidence of DNAPL presence (see Calculation 1). The threshold DNAPL saturation for use in Calculation 1 should be set to be between 5% and 10% of pore space for all DNAPL types. The particular threshold saturation chosen should result in a chemical concentration in soil that is an order of magnitude higher than that determined in line of evidence C. It follows that high organic carbon content soils and highly hydrophobic chemicals may require the use of threshold saturations toward the higher end of the above range. This method is applicable to unconsolidated media both above and below the water table, but is not applicable in fractured rock. The calculation requires knowledge of site-specific parameters and a quantitative chemical analysis of the soil. Care should be taken to sample soil horizons in core exhibiting the highest headspace readings and the strongest visual indication of DNAPL presence. The use of fixed depth intervals or compositing from several depth intervals is discouraged when collecting soil samples to evaluate the presence of DNAPL. Methanol preservation or a similar technique to reduce VOC losses during handling and transport of soil samples should be employed.

C Chemical Concentrations in Soil Above Partitioning Threshold

Chemical concentrations in soil exceeding the value corresponding to equilibrium partitioning relationships (see Calculation 2) are consistent with DNAPL presence (11). The composition of the DNAPL need not be known (see Calculation 4). The calculation is applicable to unconsolidated media both above and below the water table, but is not applicable in fractured rock. The calculation requires knowledge of site-specific parameters and a quantitative chemical analysis of the soil. Measured concentrations that only marginally exceed the calculated partitioning threshold may be false positives primarily because of uncertainty associated with estimating the soil-water partition coefficient.

D Site Use/Site History

Investigations during the past 30 years have shown that the subsurface occurrence of DNAPL is often associated with the industries, practices, and processes outlined in Table 1. Site Use/Site History can be ascertained using methods such as employee interviews, company purchase and sale records, aerial photographs, and building plans. Former lagoons, underground tanks, floor drains and leach fields are sometimes coincident with the location of DNAPL source areas.

E Vapor Concentrations

The location of a vapor-phase plume may be coincident with the current or former presence of DNAPL in the vadose zone. Mapping the vapor-phase plume may be useful in deciding where to collect additional data. Because some DNAPLs can completely vaporize in relatively short time periods (yet the vapors will persist much longer), the presence of vapors and the mapping of a vapor-phase plume should generally not be used in isolation to conclude that DNAPL is present in the vadose zone, or to delineate the spatial extent of the DNAPL source. Care should also be taken to avoid mistaking vapors derived from off-gassing of a groundwater plume with vapors derived from DNAPL sources. In-situ vapor concentrations can be sampled using invasive techniques (soil vapor surveys), and can be monitored during drilling. This line of evidence is not applicable to DNAPLs lacking a significant vapor pressure (e.g., coal tar, creosote, PCBs).

F Hydrophobic Dye Testing

Hydrophobic dyes such as Oil Red O will partition into DNAPL, imparting a red color to the organic liquid. Dye techniques are particularly useful when encountering a colorless DNAPL. Hydrophobic dye techniques include the jar shake test in which a soil or water sample is placed into a jar with a small amount of dye (6), and down-hole samplers that force a dye-impregnated absorbent ribbon against the borehole wall in either fractured rock or a direct push borehole (30). It should also be noted that the absence of staining on a down-hole ribbon sampler is not evidence of the absence of DNAPL, since only pooled DNAPL can migrate towards the sampler (residual DNAPL may be present in the formation adjacent to the sampling interval, and remain undetected).

Table 1 – Industries and Industrial Processes Historically Associated With DNAPL Presence (modified after USEPA, 1992).

Industry	*Industrial Process*
Manufactured gas plant, Wood preservation (creosote), Electronics manufacturing, Solvent production/recycling, Pesticide/Herbicide manufacturing, Dry cleaning, Instrument manufacturing, Metal product manufacturing, Engine manufacturing, Steel industry coking operations (coal tar), Chemical production, Airplane maintenance, Transformer oil production	Storage of solvents in uncontained drum storage areas, Metal cleaning/degreasing, Metal machining, Tool and die operations, Paint stripping, Use of vapor and liquid degreasers, Storage and transfer of solvents in above and below ground tanks and piping, Burning waste liquids, Storage and treatment of waste liquids in lagoons, Use of on-site disposal wells, Loading and unloading of solvents, Transformer reprocessing, Disposal of solvents in unlined pits.

The following lines of evidence G1 through G6 all make use of groundwater quality data and can be evaluated every sampling round.

G1 Magnitude of Groundwater Concentrations

Sampled groundwater concentrations in excess of 1% effective solubility (see Calculation 3) indicate that the sampled groundwater may have come in contact with DNAPL. If the composition of the DNAPL is not known, Calculation 6 can be used. The distance to the possible DNAPL locations cannot be determined from the magnitude of the concentration alone. Sampled groundwater concentrations downgradient of a DNAPL source zone can be significantly less than the effective solubility because of hydrodynamic dispersion, wellbore dilution, non-optimal monitoring well placement, and degradation processes. In cases where significant degradation is occurring in the dissolved-phase plume, daughter product concentrations can be converted to equivalent parent product concentrations before comparing to the 1% effective solubility threshold (see Calculation 8). However, it should be noted that daughter product compounds may also be part of a multi-component DNAPL. Monitoring well points where groundwater concentrations exceed 1% effective solubility can also be useful in locating additional sampling points potentially nearer to the possible DNAPL source zones. The interpretation of groundwater concentrations exceeding 1% effective solubility is discussed further in (27).

G2 Persistent Plume

The presence of a contiguous and persistent plume extending from suspected release locations in the downgradient direction is evidence of a continuing source (e.g., DNAPL). If ‘sufficient time’ has passed since the last possible introduction of contaminant to the subsurface and the plume has not ‘detached’ itself from the suspected release locations, a DNAPL source may be present. The ‘sufficient time’ is dependent on site-specific conditions such as groundwater velocity and the amount of sorption occurring (see Calculation 7). This line of evidence is applicable to both unconsolidated deposits and fractured rock, but can be inconclusive in environments subject to significant amounts of back diffusion (e.g., fractured bedrock with a porous matrix, fractured clay). Significant amounts of back diffusion can be the source of a persistent plume even if DNAPL is not present. This line of evidence is therefore most applicable to high permeability settings.

G3 Presence of Contamination in Apparently Anomalous Locations

The presence of contaminated groundwater in locations that are not downgradient of known or suspected sources may be evidence of DNAPL presence hydraulically upgradient of the monitoring point in question. An example includes the presence of dissolved-phase contamination in groundwater that is older than the potential contaminant release (using age dating) or in groundwater on the other side of a flow divide located between the monitoring location and suspected release locations. In Figure 1, for example, the presence of contamination in the illustrated monitoring well cannot be explained without the upgradient presence of DNAPL. This line of evidence is not contingent on any concentration threshold. Temporal changes in hydraulic heads and groundwater flow directions, as well as changes in historic pumping patterns should be considered at sites where groundwater extraction has, or is, occurring. Consideration should also be given to the presence of unknown or off-site sources that may account for the observed contamination.

G4 Groundwater Concentration Trends with Depth

Abrupt reversals of groundwater contaminant concentration levels with depth or increasing concentrations with depth can be associated with DNAPL presence. Concentration trends can be best detected using small interval sampling techniques [e.g., direct push sampling devices; short well screens; multilevel completions; cone penetrometer equipped with measurement probes (16, 26)]. Multilevel monitoring completions can be incorporated into open holes in bedrock to provide concentration as a function of depth. Other methods in bedrock include the use of temporary straddle-packer assemblies to sample specific depth intervals, and the use of diffusion bag samplers placed at specific depths. Use of these latter methodologies should be made only when intraborehole flow conditions have been adequately characterized.

G5 Groundwater Concentration Trends with Time

Groundwater downgradient of a multi-component DNAPL may exhibit a temporal decline in the concentration of the higher effective solubility compounds and a stable or increasing trend in time of the lower effective solubility compounds. Highly soluble and mobile compounds, such as low molecular weight alcohols, furans, ketones and some solvents such as methylene chloride may show a decreasing concentration versus time signature downgradient of a DNAPL source zone while at the same time higher molecular weight alcohols and semi-volatile compounds may show a stable concentration trend. This line of evidence is primarily applicable to mixed DNAPLs. Consideration should be given to compound specific biodegradation, which may result in the concentration of certain compounds decreasing and others (such as low molecular weight daughter products) increasing within the plume. Dissolved-phase concentrations downgradient of a single component DNAPL may decline due to removal of some of the source mass during dissolution; a declining concentration versus time signature does not preclude the presence of DNAPL.

G6 Detection of Highly Sorbing Compounds in Groundwater

The detection of highly sorbing and low solubility compounds which have low mobility in groundwater may be associated with a nearby DNAPL source. This line of evidence can be useful in delineating the extent of the DNAPL in the downgradient direction. Examples of compounds that have very low mobility in groundwater (absent transport facilitated by colloids, cosolvents, or emulsions) include PCBs and high molecular weight PAHs.

H

Other Types of Methods

Partitioning interwell tracer tests (PITTs) [1, 4, 15] involve the injection and withdrawal of a tracer that has the ability to partition into the DNAPL. While the method can be used to detect the presence of DNAPL, given the significant effort involved in conducting tracer tests, PITTs are typically employed after some level of source zone characterization has been completed. Literature sources suggest (for certain sites with appropriate geologic conditions and contaminant properties) measuring a depletion of Radon-222 in groundwater (34). Direct push platforms can be used to deploy a variety of probes to vertically profile contaminant concentrations. These probes include laser induced fluorescence (LIF) measurement devices (6, 31, 32) such as ROST (rapid optical screening tool) and TarGOST (tar-specific green optical screening tool), which is specifically designed for detecting the presence of coal tar and creosote (32); and probes employing Raman methods (31). LIF techniques respond well to the presence of NAPLs containing aromatic hydrocarbons, but may not be suitable for many chlorinated solvent DNAPLs. Direct push platforms can also be used to deploy a membrane interface probe (MIP) or a hydrosparge probe (8), both of which transfer contaminants to a flowing gas stream for analysis at the surface. Another measurement probe is the precision injection/extraction (PIX) device (23). The use of measurement probes with direct push platforms is becoming increasingly popular, but care should be taken in interpreting results with respect to DNAPL presence given that most of these devices provide a relative measure of total concentration. Consideration of the potential for, and consequences of, false positives should be given to each of these methods.

5.0 - Assessing DNAPL Presence

Determining the presence or absence of DNAPL is an important component of the site characterization process and subsequent development of a conceptual site model. The length of time and degree of effort required to determine the presence or absence of DNAPL will vary from site to site. Once it has been determined that DNAPL resides in the subsurface, the objectives for further investigation and potential remediation strategies can be established. This section focuses on methods to assess the presence of DNAPL; Section 6 of this document focuses on methods to delineate the DNAPL source zone.

Converging lines of evidence can be used to determine whether or not DNAPL is present in the subsurface. Figure 3 presents a graphical summary of the converging lines of evidence approach. Example calculation procedures are contained in Appendix A. All lines of evidence are discussed in Section 4, and are applicable to both unconsolidated deposits and fractured rock, unless noted otherwise. As indicated in Figure 3, either line of evidence A or B will lead to the conclusion that DNAPL is present. If A and B are both found to be negative, then the determination of whether DNAPL is present must be made on the basis of a weight of evidence approach, with multiple converging lines of evidence

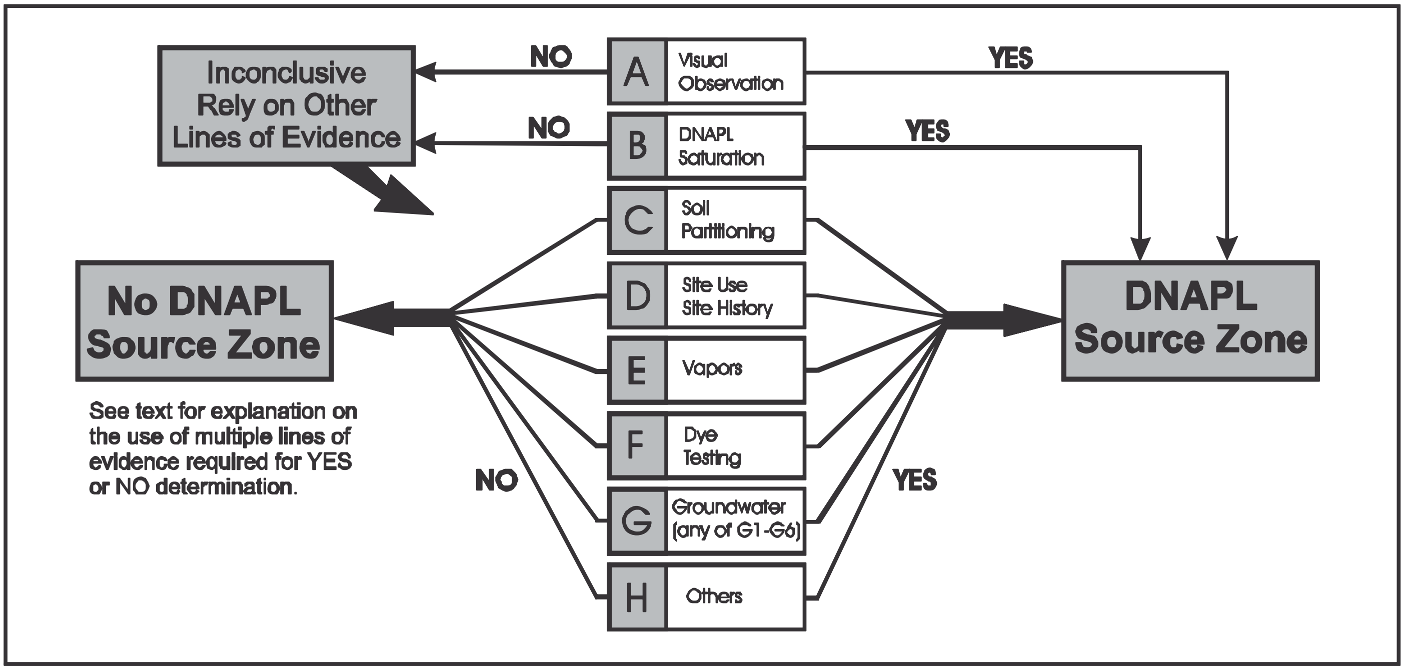

Figure 3 – Converging lines of evidence approach to assessing DNAPL presence. Methods B and C are not applicable to fractured rock.

combining to form either a positive or negative determination. Note that it is not likely that all of C through H will be satisfied at any one particular site, and that neither A nor B are necessary requirements to conclude that DNAPL is present. Most confirmed DNAPL source zones will have some of A through H determined to be negative. Because conditions vary from site to site, this document does not prescribe a specific number of lines of evidence that must be satisfied to arrive at either a positive or negative determination.

If the various lines of evidence contradict each other, it may be necessary to collect more data. It is possible that a minority of positive determinations can outweigh a majority of negative determinations if the positive lines of evidence cannot be explained without the presence of DNAPL. It should also be noted that not all sites lend themselves to collecting all of the types of data outlined here. In fractured rock, for example, soil vapor data and partitioning calculations would not be relied upon.

Evaluating the presence of DNAPL is an iterative process that incorporates new data as they are obtained. It is recognized here that certain types of data are more likely to be collected in the early stages of site investigation, while others (e.g., groundwater concentrations) can be collected on a routine basis throughout the investigation process. The fact that a number of lines of evidence are outlined in Figure 3 does not suggest that they should all be pursued at any one particular site. Site specific conditions will dictate what lines of evidence should be pursued. Care should be taken, however, to ensure that a negative response to the various lines of evidence is not simply attributable to inadequate characterization and an insufficient amount of data.

6.0 - Delineation of the DNAPL Source Zone

Depending on the spatial density of sampling points installed during initial investigation efforts, the general area within which the DNAPL resides may have been identified. Once it has been determined that DNAPL is present in the subsurface, the objectives for delineation of the source zone can be established. These objectives can vary from site to site, but typically involve one or more of the following:

- Delineation of the DNAPL source zone to ensure that the flow paths and quality of the groundwater downgradient of the source zone are monitored for the presence of dissolved-phase contaminants to assess protection of current and potential receptors.
- Delineation of the DNAPL source zone to facilitate proper design of containment systems involving groundwater extraction and/or physical barriers.
- Delineation of the DNAPL source zone to facilitate implementation of DNAPL mass removal technologies.
- Delineation of the DNAPL source zone as part of establishing boundaries for institutional controls.
- Delineation of the DNAPL source zone as part of Technical Impracticability assessments (41).

Given the selective nature of DNAPL migration, it is not feasible to determine the exact location and extent of individual DNAPL migration pathways within the overall confines of the source zone in either unconsolidated deposits, or fractured bedrock. Because data collection efforts typically involve a finite number of local-scale measurements taken at discrete locations (e.g., water quality samples, soil samples, etc.), some uncertainty will exist regarding the delineated spatial extent of the source zone.

To address the issue of uncertainty, it is recommended that both a ‘Confirmed/Probable’ DNAPL source zone be delineated, as well as a ‘Potential’ DNAPL source zone (see Figure 4). The Confirmed/Probable source zone is the volume within which compelling and multiple lines of evidence indicate that DNAPL is present. Note that what may be a compelling line of evidence at one site may not be so at another site (e.g., G2 Persistent Plume, is a stronger line of evidence in a high permeability setting than at a site where back-diffusion may dominate). The Potential source zone is of larger spatial extent, and is defined as that volume of the subsurface within which some lines of evidence indicate that DNAPL may be present, but the lines of evidence are not as numerous, consistent, or compelling as within the Confirmed/Probable source zone. Defining a Potential source zone outside of the Confirmed/Probable source zone addresses the uncertainty associated with finite amounts of data. This can be particularly useful in the hydraulically downgradient direction where it is often difficult to determine the distance to the edge of the DNAPL source zone based on groundwater quality data (e.g., using lines of evidence G1 through G6).

With respect to the various criteria for assessing DNAPL presence outlined in Section 4, lines of evidence A and B will both fall within the Confirmed/Probable source zone. All other lines of evidence (C through H) could fall within either the Confirmed/Probable source zone, or the Potential source zone. Note also that positive determinations for lines of evidence A and B are not necessary to define a Confirmed/Probable source zone. The defining feature of the Confirmed/Probable source zone is that multiple lines of evidence indicate that DNAPL is present. In practice, this will manifest itself as various lines of evidence all plotting within the same general spatial area on plan view and cross-section figures (see Figure 4 for plan view example). Within the Potential source zone, there will be fewer lines of evidence, and their occurrence may not be as contiguous as within the Confirmed/Probable source zone. Consideration should be given to known DNAPL release locations and structural aspects of the geology (e.g., dipping beds, dipping fractures) when delineating both the Confirmed/Probable and Potential source zones.

There is no prescriptive number of lines of evidence that separate the two source zone delineations. The individual lines of evidence cannot be weighted either, as the strength of the uncertainty/certainty determination is dependent on how often more than one line of evidence occurs at a particular location and how many contiguous locations have multiple lines of evidence; assigning a weighting factor to each line would negate this objectivity. Furthermore, many factors influence the transport of the DNAPL and the associated concentration of the dissolved-phase constituents such that a weighting factor could not be fairly assigned for all types of hydrogeologic environments and types of DNAPL contaminants.

The amount of acceptable uncertainty in delineating the source zone boundaries is likely to be dependent on the remedial actions considered. If hydraulic or physical containment of the DNAPL source zone were a component of the remedial actions, for example, an accurate delineation of the Potential source zone would be war-

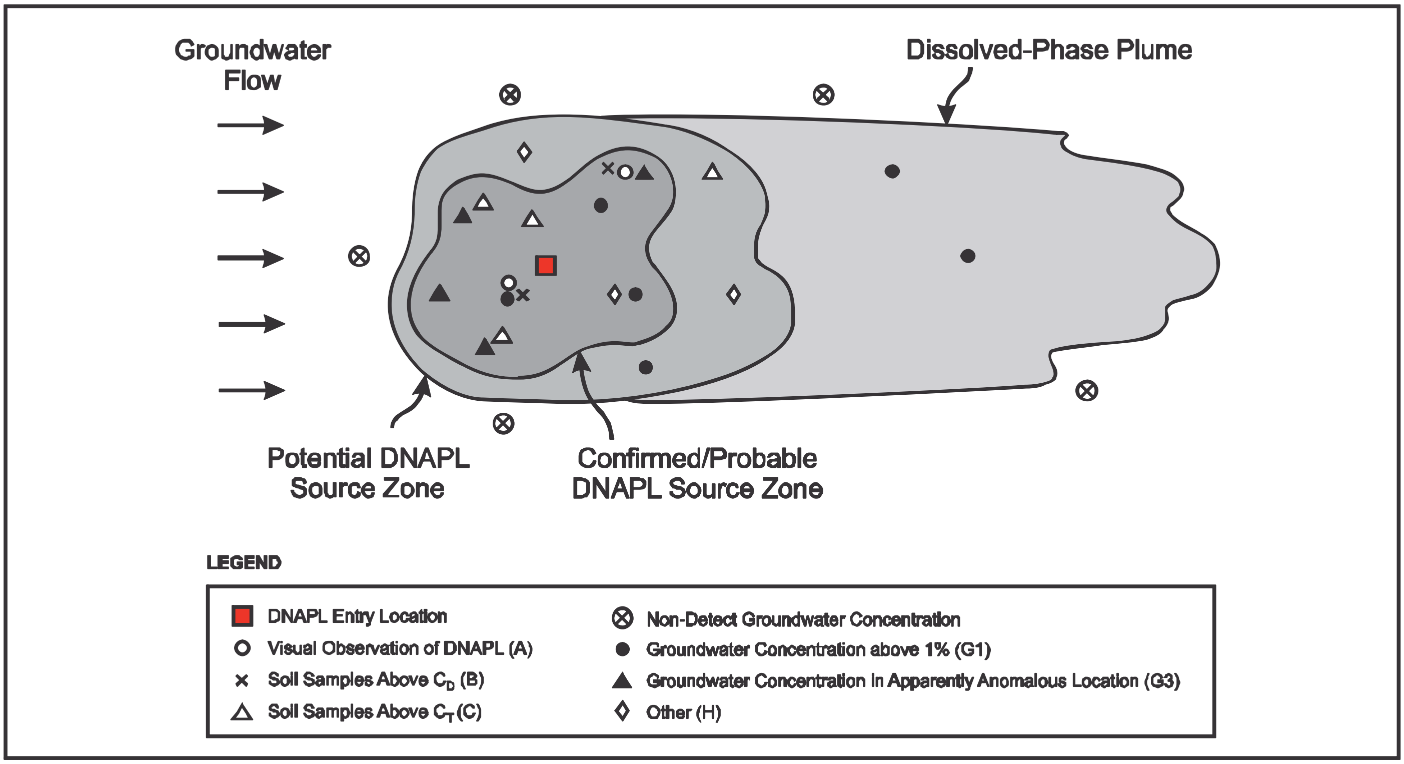

Figure 4 – Example of plan view schematic illustrating confirmed/probable and potential DNAPL source zones. Note that not all lines of evidence are depicted. Types and distribution of lines of evidence will vary from site to site.

ranted (the likely target for hydraulic containment) and accurate delineation of the Confirmed/Probable source zone may not be necessary. If the remedial actions included implementation of a DNAPL mass removal technology, however, then an accurate delineation of the Confirmed/Probable DNAPL source zone (the likely target for mass removal) would be warranted. A similar approach may be appropriate for designating a zone of technical impracticability (TI). Overestimating the size of the Confirmed/Probable source zone could overstate costs for technology application and may result in a particular technology being screened out. Underestimating the size of the Confirmed/Probable source zone, on the other hand, could lead to underestimation of costs and the perception of poor performance following completion of technology application. Monitoring points outside of an underestimated source zone may provide data showing little, if any, benefit resulting from source zone removal or treatment.

Typically, to refine the locations of the boundaries, additional drilling and sampling may be required between the Confirmed/Probable and Potential DNAPL areas. Figure 5 depicts an iterative process of data collection. Usually the degree of uncertainty in delineating these two zones will be greater in a more complex hydrogeologic environment. Although additional sampling points may be easily installed in shallow, unconsolidated materials, the same level of effort may not be feasible or may be cost prohibitive in deep fractured rock. Care must also be taken to ensure that drilling and sampling activities do not mobilize DNAPL deeper in to the subsurface. Strategies in place of extensive drilling to depth within the source zone include drilling adjacent to the suspected source zone and using lines of evidence such as G1 through G6 to infer DNAPL presence in the upgradient direction.

In all environments, the risks of potentially mobilizing the DNAPL and the associated incremental costs of additional sampling points should be compared to the benefits of increased ability to evaluate the spatial extent of the DNAPL. Additionally, site investigators should have a DNAPL Contingency Plan on hand in the field to address actions to be taken if pooled DNAPL is encountered during drilling. At some sites, it may be desirable to adopt an 'outside in' approach to reduce the number of invasive borings that need to be placed within the DNAPL source zone.

In addition to delineating the spatial extent of the source zone, investigators may need to assess whether or not DNAPL is still migrating within the subsurface. The assessment of mobility can be carried out using screening calculations (27) and observations such as an expanding area of lines of evidence indicating DNAPL presence. Other features of the source zone that may be of interest include the mass of DNAPL present, the mass flux downgradient of the source zone, and the relative proportions of residual versus pooled DNAPL. Calculation 1 can be used to distinguish between residual and pooled DNAPL in soil samples by selecting a saturated threshold above which DNAPL is considered pooled. Also of note is the fact that residual DNAPL will not enter monitoring wells, implying that the accumulation of DNAPL in a well indicates the presence of pooled DNAPL in the formation. Details regarding how to estimate the mass of DNAPL present in a source zone or the distribution of mass flux downgradient of the source zone, however, are beyond the scope of this document.

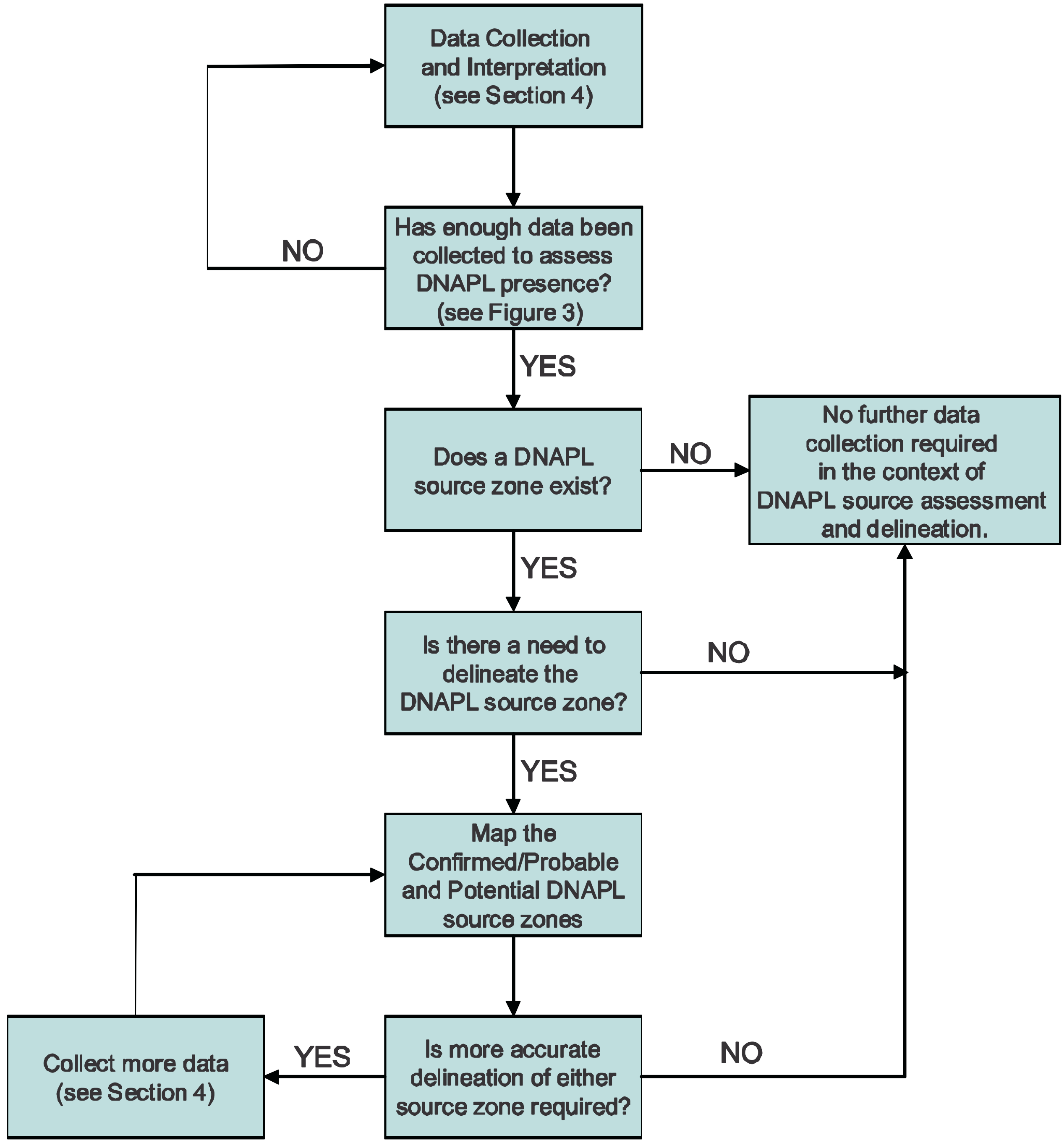

Figure 5 - Flowchart depicting iterative data collection process used in refining the DNAPL source zone boundaries.

7.0 - Glossary

Bulk Retention Capacity is defined as the total volume of DNAPL that has been retained as residual and pooled DNAPL in a unit volume of the subsurface. The bulk retention capacity accounts for the fact that not all lenses, laminations and geological units within a source zone contain DNAPL (27), and it is a function of the release history, geology and DNAPL properties. In unconsolidated media, the bulk retention capacity can be in the range from 0.005 to 0.03 (36). In fractured media, the bulk retention capacity can be in the range of 0.0002 to 0.002 (36). Fractured rock and clay cannot retain as much DNAPL per unit volume as unconsolidated deposits.

Capillary Barriers are fine grained lenses, layers and laminations upon which lateral spreading and pooling of DNAPL can occur. Even if the capillary barrier is penetrated by the DNAPL, it is likely that lateral spreading will have occurred along the top surface of the barrier prior to the capillary pressure having exceeded the entry pressure of the barrier. The finer grained the capillary barrier, the higher the pool height of DNAPL that it can support (17).

Capillary Pressure is the pressure difference between two immiscible liquids and arises because of interfacial tension. It is calculated as the non-wetting phase pressure minus the wetting phase pressure. If the DNAPL is the non-wetting phase and water is the wetting phase, for example, the capillary pressure would be the DNAPL pressure minus the water pressure.

DNAPL (Dense, Non-Aqueous Phase Liquid) is an organic liquid that is more dense than water and does not mix freely with water. A ***single-component DNAPL*** is composed of only one chemical. A ***multi-component DNAPL*** is composed of two or more chemical components.

DNAPL Source Zone The DNAPL source zone is the overall volume of the subsurface containing residual and/or pooled DNAPL. Not all portions (e.g., lenses, laminations, or fractures) of the source zone will contain residual and/or pooled DNAPL. The ***Confirmed/Probable DNAPL Source Zone*** is the part of the source zone within which it is known or highly likely that DNAPL exists. The ***Potential DNAPL Source Zone*** is the part of the source zone within which it is possible that DNAPL exists, but the lines of evidence indicating DNAPL presence are either fewer or are not as strong as those associated with the Confirmed/Probable DNAPL Source Zone.

Dissolved-phase Plume The zone of contamination containing dissolved-phase constituents resulting from groundwater flowing past residual and pooled DNAPL. The contaminants present in the plume are subject to advection, dispersion, and possibly sorption, decay, and matrix diffusion. Dissolved-phase plumes can be sustained by back diffusion from low permeability regions in the absence of DNAPL.

Effective Solubility For a multi-component DNAPL, the equilibrium solubility in water of any component of the DNAPL is referred to as the component's effective solubility. In general, the various components of a DNAPL suppress each other's aqueous solubility implying that effective solubilities are typically less than single-component (handbook) solubilities. For structurally similar compounds, the effective solubility can be estimated using Raoult's Law (2).

Interfacial Tension (IFT) is a tensile force that exists in the interface separating DNAPL and water. Because of interfacial tension, DNAPLs do not mix freely with water and exist in the subsurface as a separate liquid phase. IFT is a site-specific value that can be assessed with a simple laboratory test if a sample of DNAPL can be obtained. Literature values tend to overestimate the IFT encountered at sites. In general, higher IFT leads to more lateral spreading of DNAPL in horizontally bedded deposits, stronger capillary trapping forces, and a greater tendency for DNAPL pooling.

Mole Fraction refers to the proportion of a component, on the basis of moles, in a multi-component DNAPL. The sum of all the mole fractions is unity. Mass fractions, as provided by laboratory analysis, can be converted to mole fractions using the molecular weight of each component (see calculation 5).

1% Rule of Thumb is a generality that sampled groundwater concentrations in excess of 1% effective solubility (see Calculation 3) indicate that DNAPL may be present in the vicinity of (any direction) the monitoring point of interest. The distance between the monitoring point in question and the DNAPL source zone varies from site to site and is generally difficult to quantify with a high degree of accuracy.

Pooled DNAPL refers to local, continuous distributions of DNAPL that accumulate above capillary barriers. The capillary barriers are typically lower permeability horizons, and they can occur at any elevation in the subsurface. Within the pool, the DNAPL saturation is typically between 30% and 80% of pore space in both porous media and fractures (27). Because pools are contiguous through the pore structure they are potentially mobile and can migrate into monitoring wells, and can be mobilized by increases in the hydraulic gradient or lowering of IFT.

Raoult's Law is given by $C_i = m_i S_i$ where C_i is the effective solubility (mg/l) of component i, m_i is the mole fraction (unitless) of component i in the DNAPL, and S_i is the single-component (handbook) solubility of component i (2). This expression assumes ideal partitioning behavior and is used to estimate the maximum concentrations in groundwater immediately adjacent to residual and pooled DNAPL.

Residual DNAPL refers to disconnected blobs and ganglia of the DNAPL, trapped by capillary forces in the pore space of both porous media and fractures (21, 27, 44). The blobs and ganglia are typically from 1 to 10 grain diameters in size in unconsolidated deposits (44), and are left behind in the pathways that DNAPL has migrated through.

Residual Saturation refers to the volume of residual DNAPL present in a unit volume of pore space. Residual DNAPL saturations typically vary between 5% and 30% of pore space in both porous media and fractures (21, 27, 44).

Source Zone Architecture refers to (i) the overall shape and dimensions of the source zone, (ii) the ratio of residual to pooled DNAPL (also referred to as the ganglia to pool ratio), (iii) the lateral continuity of zones of residual DNAPL and DNAPL pools, (iv) the thickness of zones of residual DNAPL and DNAPL pools, and (v) the portion of lenses and layers containing DNAPL versus those void of DNAPL. The source zone architecture influences the downgradient dissolved-phase plume concentrations and mass flux distribution.

Wettability refers to the affinity of the DNAPL for a solid surface in the presence of water (6, 27). Many DNAPLs are non-wetting, implying that they will preferentially occupy the pore spaces within coarser grained lenses and laminations, and larger aperture fractures. Some DNAPLs are wetting with respect to water, however, implying that they will preferentially coat the aquifer materials and thereby occupy the pore spaces of the finer grained media. Coarser grained horizons and larger aperture fractures represent capillary barriers to DNAPLs that are wetting with respect to water.

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Notice

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References

1) Annable, M.D., Rao, P.S.C., Graham, W.D., Hatfield, K. and Wood, A.L., 1998. Use of partitioning tracers for measuring residual NAPL: Results from a field-scale test. *J. Environmental Engineering*, 124(6), pp. 498-503.

2) Banerjee, S., 1984. Solubility of organic mixtures in Water. *Environmental Science & Technology*, 18, 587-591.

3) Brewster, M.L., Annan, A.P., Greenhouse, J.P., Kueper, B.H., Olhoeft, G.R., Redman, J.D., and Sander, K.A., 1995. Observed migration of a controlled DNAPL release by geophysical methods. *J. Ground Water*, 33(6), 977-987.

4) Brooks, M.C., Annable, M.D., Rao, P.S.C., Hatfield, K., Jawitz, J.W., Wise, W.R., Wood, A.L. and Enfield, C.G., 2002. Controlled release, blind tests of DNAPL characterization using partitioning tracers. *J. Contaminant Hydrology*, 59, pp. 187-210.

5) Chapman, S.W. and Parker, B.L., 2005. Plume persistence due to aquitard back diffusion following dense nonaqueous phase liquid source removal or isolation. *Water Resources Research*, 41, W12411.

6) Cohen, R.M. and Mercer, J.W., 1993. *DNAPL Site Evaluation*. C.K. Smoley, CRC Press.

7) Crumbling, D.M., Lynch, K., Howe, R., Groenjes, C., Shockley, J., Keith, L., Lesnik, B., Van E, J. and McKenna, J., 2001. Managing uncertainty in environmental decisions. *Environmental Science & Technology*, 35(19), pp. 404A-409A.

8) Davis, W.M., Wise, M.B., Furey, J.S. and Thompson, C.V., 1998. Rapid detection of volatile organic compounds in groundwater by in situ purge and direct-sampling ion-trap mass spectrometry. *Field Analytical Chemistry & Technology*, 2(2), pp. 89-96.

9) Electric Power Research Institute, 2008. *MGP Site Characterization Best Practices Manual for Bedrock*. EPRI, Palo Alto, CA; PSEG, Newark, NJ; NYSEG, Binghamton, NY; and FirstEnergy, Madison, NJ; 1018276.

10) Falta, R.W., P.S. Rao, and N. Basu, 2005. Assessing the impacts of partial mass depletion in DNAPL source zones. I. Analytical modeling of source strength functions and plume response. *J. Contaminant Hydrology*, 78, 259-280.

11) Feenstra, S., Mackay, D.M., and Cherry, J.A., 1991. Presence of residual NAPL based on organic chemical concentrations in soil samples. *Ground Water Monitoring & Remediation*, 11(2), 128-136.

12) Gerhard, J.I., Pang. T. and Kueper, B.H., 2007. Time scales of DNAPL migration in sandy aquifers examined via numerical simulation. *J. Ground Water*, Vol. 45, No. 2, pp. 147-157.

13) Huling, S.G. and J.W. Weaver, 1991. Dense Nonaqueous Phase Liquids, USEPA Ground Water Issue Paper, EPA/540/4-91/002.

14) Interstate Technology and Regulatory Council (ITRC), 2003. *An Introduction to Characterizing Sites Contaminated with DNAPLs*. Washington, DC: ITRC Dense Nonaqueous Phase Liquids Team.

15) Jin, M., Delshad, M., Dwarakanath, V., McKinney, D.C., Pope, G.A., Sepehrnoori, K., Tilburg, C.E., and Jackson, R.E., 1995. Partitioning tracer tests for detection, estimation and remediation performance assessment of subsurface non-aqueous phase liquids. *Water Resources Research*, 31(5), 1201-1211.

16) Kram, M.L., Keller, A.A., Rossabi, J., and Everett, L.G., 2001. DNAPL characterization methods and approaches, Part 1, Performance comparisons. *Ground Water Monitoring & Remediation*, Fall, 109-123.

17) Kueper, B.H., Redman, J.D., Starr, R.C., Reitsma, S. and Mah, M., 1993. A field experiment to study the behavior of tetrachloroethylene below the watertable: Spatial distribution of residual and pooled DNAPL. *J. Ground Water*, 31(5), 756-766.

18) Kueper, B.H. and McWhorter, D.B., 1991. The behavior of dense, non-aqueous phase liquids in fractured clay and rock. *J. Ground Water*, 29(5), 716-728.

19) Lenczewski, M., McKay, A., Pitner, A., Driese, S., and V. Vulava, 2006. Pure-Phase transport and dissolution of TCE in sedimentary rock saprolite. *J. Ground Water*, 44(3), 406-414.

20) Lipson, D., Kueper, B.H. and Gefell, M.J., 2005. Matrix diffusion–derived plume attenuation in fractured bedrock. *J. Ground Water*, 43(1), 30–39.

21) Longino, B.L. and Kueper, B.H., 1999. Non-wetting phase retention and mobilization in rock fractures. *Water Resources Research*, 35(7), 2085-2093.

22) Longino, B.L. and Kueper, B.H., 1995. The use of upward gradients to arrest downward DNAPL migration in the presence of solubilizing surfactants. *Canadian Geotechnical Journal*, 32(2), 296-308.

23) Looney, B.B., Jerome, K.M., and Davey, C., 1998. Singe well DNAPL characterization using alcohol injection/extraction. *Proc. First Int. Conf. on Remediation of Chlorinated and Recalcitrant Compounds.* Battelle Press, Columbus, OH, 113-118.

24) Mackay, D., Shiu, W.Y. and Ma, K.C., 1992. *Illustrated handbook of physical-chemical properties and environmental fate for organic chemicals*, Volumes 1 – 3. Lewis Publishers.

25) Mariner, P.E., Jin, M., and Jackson, R.E., 1997. An algorithm for the estimation of NAPL saturation and composition from typical soil chemical analyses. *Ground Water Monitoring & Remediation*, 17(2), 122-129.

26) Nielsen, D. (editor), 2006. *Practical Handbook of Environmental Site Characterization*. CRC Press, Boca Raton, FL.

27) Pankow, J.F. and Cherry, J.A., Editors, 1996. *Dense Chlorinated Solvents and other DNAPLs in Ground Water*. Waterloo Press, Portland, OR.

28) Parker, B.L., Gillham, R.W., and Cherry, J.A., 1994. Diffusive disappearance of dense immiscible phase organic liquids in fractured geologic media. *J. Ground Water*, 32, 805-820.

29) Poulsen, M. and Kueper, B.H., 1992. A field experiment to study the behavior of tetrachloroethylene in unsaturated porous media. *Environmental Science & Technology*, 26(5), 889-895.

30) Riha, B.D., Rossabi, J., Eddy-Dilek, C.A., Jackson, D., and Keller, C., 2000. DNAPL characterization using the ribbon NAPL sampler: Methods and results. *Proc. Second Int. Conf. on Remediation of Chlorinated and Recalcitrant Compounds.* Battelle Press, Columbus, OH, 33-40.

31) Rossabi, J., Riha, B.D., Eddy-Dilek, C.A., Lustig, A., Carrabba, M., Hyde, W.K., and Bello, J., 2000. Field tests of a DNAPL characterization system using cone penetrometer – base Raman spectroscopy. *Ground Water Monitoring & Remediation*, 20(4), 72-81.

32) St. Germain, R., Adamek, S. and Rudolph, T., 2006. In situ characterization of NAPL with TarGOST at MGP sites. *Land Contamination and Reclamation*, 14(2), pp. 573-578.

33) Sale, T., Newell, C., Stroo, H., Hinchee, R. and Johnson, P., 2008. Frequently asked questions regarding management of chlorinated solvents in soils and groundwater. Environmental Security Technology Certification Program (ESTCP), U.S. Department of Defense, Washington, DC.

34) Semprini, L.M., Cantaloub, M., Gottipati, S., Hopkins, O., and Istok, J., 1998. Radon-222 as a tracer for quantifying and monitoring NAPL remediation. *Proc. First Int. Conf. on Remediation of Chlorinated and Recalcitrant Compounds.* Battelle Press, Columbus, OH, 137-142.

35) Sudicky, E.A. and Frind, E.O., 1982. Contaminant transport in fractured porous media: analytical solutions for a system of parallel fractures. *Water Resources Research*, 18, 1634–1642.

36) United Kingdom Environment Agency, 2003. *An Illustrated Handbook of DNAPL Transport and Fate in the Subsurface.* R&D Publication 133, ISBN 1844320669.

37) USEPA, 2004. *Site characterization technologies for DNAPL investigations*. EPA/542/R-04/017.

38) USEPA, 2003. *The DNAPL Remediation Challenge: Is There a Case for Source Depletion*, EPA/600/R-03/143.

39) USEPA, 1994. *DNAPL Site Characterization*, OSWER Publication 9355.4-16FS, EPA/540/F-94/049.

40) USEPA, 1993. *Evaluation of the likelihood of DNAPL presence at NPL sites, national results*. OSWER Publication 9355.4-13, EPA/540-R-93-073.

41) USEPA, 1993. *Guidance for Evaluating Technical Impracticability of Ground-Water Restoration.* OSWER Directive 9234.2-25. EPA/540-R-93-080.

42) USEPA, 1992. *Estimating Potential for Occurrence of DNAPL at Superfund Sites*, OSWER Publication 9355.4-07FS.

43) USEPA, 1992. *Dense Nonaqueous Phase Liquids - A Workshop Summary*, Dallas, TX, April 17-18, 1991, EPA/600/R-92/030.

44) Wilson, J.L., Conrad, S.H., Mason, W.R., Peplinski, W. and Hagen, E., 1990. *Laboratory Investigation of Residual Liquid Organics.* USEPA/600/6-90/004, R.S. Kerr Lab., Ada, OK.

Appendix A - Example Calculations

Note that the following calculations are generally subject to uncertainty because of input parameter variability. This variability may stem from spatial or temporal variation in site-specific conditions, or variation in textbook parameters such as contaminant chemical properties. The investigator is advised to make conservative choices with respect to input parameters and consider using a range of either measured or estimated values when performing calculations.

Calculation 1 – Chemical Concentration in Soil Corresponding to Threshold DNAPL Saturation

$$C_D = \frac{S_r \phi \rho_N 10^6}{\rho_b} + C^T$$

C_D = soil concentration (mg/kg) corresponding to threshold DNAPL saturation [calculated],

S_r = threshold DNAPL saturation [set between 0.05 and 0.10],

ϕ = effective porosity (unitless) [site specific measurement],

ρ_N = DNAPL density (g/cc) [site specific measurement],

ρ_b = dry soil bulk density (g/cc) [site specific measurement],

C^T = amount of contaminant (mg/kg) present in the soil sample in the aqueous, vapor, and sorbed phases [see Calculation 2 to evaluate C^T].

Example Calculation

PCE DNAPL (ρ_N = 1.62 g/cc) in a soil sample with $S_r = 0.05$, $\phi = 0.25$ and ρ_b = 2.0 g/cc corresponds to (ignoring the C^T fraction) C_D = 10,125 mg/kg. Note that the quantity C^T is typically negligible compared to the DNAPL saturation term. The above equation is applicable to single-component DNAPLs in unconsolidated porous media. See reference (25) for the relationship between C_D and DNAPL saturation for a multi-component DNAPL. It should be noted that $0.05 \leq S_r \leq 0.10$ is suitable for geologic deposits having typical ranges of f_{oc} values (i.e., less than 2%). In general, the value of S_r should be chosen such that the resulting C_D is at least an order of magnitude higher than the C^T in calculation 2 arrived at using the highest f_{oc} value measured at the site.

Calculation 2 – Threshold Chemical Concentration in Soil Based on Partitioning Relationships (see Ref. 11)

$$C_i^T = \frac{C_i}{\rho_b}\left(K_d \rho_b + \theta_w + H'\theta_a\right)$$

C_i^T = soil concentration (mg/kg) threshold for component *i* [calculated],

C_i = effective solubility (mg/l) [see Calculation 3] of component *i* [calculated],

ρ_b = dry soil bulk density (g/cc) [site specific measurement],

K_d = soil-water partition coefficient (ml/g) [calculated using $K_d = K_{oc} f_{oc}$],

θ_w = water-filled porosity (unitless) [calculated from site specific measurement of moisture content],

H' = unitless Henry's constant [handbook],

θ_a = air-filled porosity (unitless) [site specific measurement],

K_{oc} = organic carbon - water partition coefficient (ml/g),

f_{oc} = fraction organic carbon (unitless) [site specific measurement].

C_i^T represents the maximum amount of contaminant *i* that can be present in a porous media sample in the sorbed, aqueous, and vapor phases without a DNAPL phase present. The calculation can be applied below the water table by setting $\theta_a = 0$. Note that the water-filled porosity and the air-filled porosity sum to the total porosity. Note also that the calculation of C_i^T is typically more sensitive to f_{oc} than it is to the porosity values.

Example Calculation

Consider a single-component DNAPL composed of TCE (C_i = 1100 mg/l, K_{oc} = 126 ml/g, H' = 0.31) in a soil sample having θ_w = 0.15, θ_a = 0.10, ρ_b = 2.0 g/cc, and f_{oc} = 0.003. The corresponding value of C^T is 515 mg/kg. For a multi-component DNAPL, a separate value of C_i^T would be calculated using the above equation for each component detected in the soil sample.

Calculation 3 – Effective Solubility Calculated Using Raoult's Law (see Ref. 2)

$$\boxed{C_i = m_i S_i}$$

C_i = effective solubility (mg/l) of component *i* [calculated],

m_i = mole fraction (unitless) of component *i* in the DNAPL [site specific measurement],

S_i = single-component solubility (mg/l) of component *i* [handbook].

Example Calculation

Consider a 3-component DNAPL composed (by mass) of 25% TCE (S_i = 1100 mg/l), 35% PCE (S_i = 200 mg/l), and 40% toluene (S_i = 500 mg/l); the corresponding mole fractions (see Calculation 5) are 0.23, 0.25, and 0.52 respectively, and the corresponding effective solubilities are 250 mg/l, 50 mg/l, and 260 mg/l respectively. Sampled groundwater concentrations in excess of 1% of any of these effective solubilities are evidence of possible DNAPL presence in the vicinity of the monitoring point. The distance to the DNAPL cannot be determined on the basis of the magnitude of the groundwater concentration alone. In cases where some of the components of the DNAPL are not known, the unknown mass fraction can be assigned an estimated molecular weight, or the average of the molecular weights of the known components.

Calculation 4 – Threshold Chemical Concentration in Soil Based on Partitioning Relationships Where Composition of DNAPL is Not Known

$$\boxed{\sum_{i=1}^{n} \frac{C^T_{obs,\,i}}{C^T_{S,\,i}} \geq 1}$$

$C^T_{obs,\,i}$ = reported concentration (mg/kg) of component *i* [site specific measurement],

$C^T_{S,\,i}$ = single component soil partitioning concentration (mg/kg) of component *i* (see C^T_i in Calculation 2),

n = number of components observed in the soil sample [site specific measurement].

For a multi-component DNAPL of unknown composition, the sum of the mole fractions must equal unity. DNAPL will therefore be present in a soil sample if sum of $\frac{C^T_{obs,i}}{C^T_{S,i}}$ exceeds unity.

Note that $C^T_{S,\,i}$ is calculated for each component in the summation using Calculation 2 with the single-component solubility as input. The presented technique can be prone to false negatives in cases where the soil sample was not analyzed for some of the components of the DNAPL. Because of this, it may be prudent in some cases to only use the calculation for demonstrating that DNAPL was present in a soil sample and not rely upon it to demonstrate that DNAPL was absent from a soil sample.

Example Calculation

The table below provides an example calculation for a soil sample in which 5 components have been detected. The sample is characterized by a porosity of 25%, a fraction organic carbon of 0.003, and a dry bulk density of 1.99 g/cc. The last column of the table sums to greater than 1.0, indicating that DNAPL was present in the soil sample.

Compound	$C^{T}_{obs,\,i}$ (mg/kg)	K_{OC} (l/kg)	Handbook Solubility (mg/l)	$C^{T}_{S,\,i}$ (mg/kg)	$\frac{C^{T}_{obs,i}}{C^{T}_{S,i}}$
Trichloroethylene	145	126	1100	554	0.262
Tetrachloroethylene	155	364	200	244	0.636
Carbon Tetrachloride	200	439	790	1140	0.175
Chlorobenzene	177	330	500	558	0.317
1,1,1-Trichloroethane	213	152	1320	768	0.277
				SUM =	**1.668**

Calculation 5 – Mole Fraction (n-component DNAPL)

$$m_i = \frac{\dfrac{ms_i}{mw_i}}{\dfrac{ms_i}{mw_i} + \dfrac{ms_{i+1}}{mw_{i+1}} + \dots \dfrac{ms_n}{mw_n}}$$

m_i = mole fraction of component i (unitless) in the DNAPL [calculated],

ms_i = mass fraction of component i (unitless) in the DNAPL [measured],

mw_i = molecular weight (g/mol) of component i [handbook].

Example Calculation

Consider a 3-component DNAPL composed by mass of 25% TCE (*mw* = 131.5 g/mol), 35% PCE (*mw* = 165.8 g/mol), and 40% toluene (*mw* = 92.1 g/mol). The corresponding mole fractions are 0.23, 0.25, and 0.52 respectively. In cases where some of the components of the DNAPL are not known, the unknown mass fraction can be assigned an estimated molecular weight, or the average of the molecular weights of the known components.

Calculation 6 – 1% Effective Solubility Threshold Not Knowing DNAPL Composition

$$\sum_{i=1}^{n} \frac{C_i^{obs}}{S_i} = \boldsymbol{\alpha}$$

C_i^{obs} = sampled groundwater concentration (mg/l) of component i [site specific measurement],

S_i = single-component solubility (mg/l) of component i [handbook],

α = cumulative mole fraction of the sample [set],

n = number of components in groundwater sample.

Calculation assumes that the degree of borehole dilution, dispersion, and degradation is identical for each component of interest in an obtained groundwater sample. If the 1% rule-of-thumb is used, DNAPL may be present in the vicinity of a monitoring well if $\alpha > 0.01$. The procedure can be applied on a sample-by-sample basis without having to make the assumption that the DNAPL composition is spatially uniform in the subsurface. If it is believed that a value other than 1% effective solubility indicates DNAPL presence, α can be set to the corresponding value. The presented technique can be prone to false negatives where the groundwater sample was not analyzed for some of the components of the DNAPL. Because of this, it may be prudent in some cases to only use the calculation for demonstrating that α has been exceeded in a sample and not rely upon it to demonstrate that α was not exceeded in a sample.

Example Calculation

The table below presents an example calculation for 5 components. Although each component has been detected at a concentration less than 1% of S_i, the cumulative mole fractions sum to 3.4%, providing evidence of possible DNAPL presence in the vicinity of the monitoring location. If the groundwater sample is not analyzed for all components present in the DNAPL, or if any compounds are degrading in the aqueous phase, the calculation procedure will underestimate the likelihood of DNAPL presence.

Compound	C_i^{obs} ***(mg/l)***	S_i ***(mg/l)***	$\frac{C_i}{S_i}$
Trichloroethene	4.4	1100	0.004
Tetrachloroethene	1.8	200	0.009
Toluene	3.5	500	0.007
Chlorobenzene	4.0	500	0.008
Trichloromethane	48.0	8000	0.006
$\sum \frac{C_i^{obs}}{S_i}$			**0.034**

Calculation 7 – Plume Detachment Time

$$\boxed{t = \frac{LR}{v}}$$

t = time (yrs) required for contaminants to migrate through source zone of length L in the direction of groundwater flow,

v = average linear groundwater velocity (m/yr) [site specific],

R = retardation factor (unitless) for the contaminant of interest [site specific measurement – see calculation below],

L = length (m) of source zone in direction of flow [site specific measurement].

Calculation assumes unidirectional, steady-state flow conditions subject to advection and sorption only (dispersion and matrix diffusion are ignored). The calculation assumes that contaminant mass is not being added to the saturated flow system from any unsaturated zone sources (e.g., leaching and desorption). Note that R is often approximated in unconsolidated media by

$$R = 1 + \frac{\rho_b}{\phi} K_{oc} f_{oc}$$

where ρ_b is the dry bulk density (g/cc), ϕ is the porosity (unitless), K_{oc} is the organic-carbon partition coefficient (ml/g), and f_{oc} is the fraction organic carbon (unitless). Calculations considering dispersion and degradation can be found in (10).

Example Calculation

Using L = 50 m, v = 25 m/yr, and R = 5, the source zone should be flushed of dissolved and sorbed contaminants in approximately 10 years following the last release of contaminants. Dispersion, which always occurs, will lengthen this time as will back-diffusion, if it is occurring. In cases where complicated flow conditions exist and where it is desired to account for dispersion and back-diffusion, numerical models can be used to perform the assessment.

Calculation 8 – Conversion to Parent Compound

Daughter product concentrations can be converted to equivalent parent product concentrations by converting the daughter mass/volume concentrations to moles/volume, attributing that number of moles to the parent, and then converting the parent concentration to mass/volume.

Example Calculation

Consider a groundwater sample containing 500 ppb PCE, 400 ppb TCE, 1300 ppb cis-1,2 DCE and 44 ppb VC at a site where it is known that only PCE was released to the subsurface. It is assumed that biodegradation has not progressed beyond VC. The PCE concentration of 500 ppb is less than 1% of the PCE solubility (1% PCE solubility is 2000 ppb). Given TCE, cis-1,2 DCE and VC molecular weights of 131.5, 97.0 and 62.5 g/mol, respectively, the groundwater concentrations of these compounds are equal to 3.042E-06 mol/l, 1.340E-05 mol/l and 7.040E-07 mol/l, respectively. Assuming that each mole of daughter product derives from one mole of parent product, the equivalent total concentration of parent product is 2.016E-05 mol/l. This corresponds to an equivalent parent (PCE) concentration of 3343 ppb (PCE molecular weight 165.8 g/mol), which exceeds the 1% solubility value of 2000 ppb.

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Environmental Protection
Agency

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EXHIBIT F

Chemicals Used In Drycleaning Operations

January, 2002
Revised July 2009

Chemicals Search Menu

The following resource was developed for the State Coalition for Remediation of Drycleaners (SCRD) using material safety data sheets (MSDS) and other sources. The report was prepared by Bill Linn, Florida Department of Environmental Protection (FDEP). Scott Stupak, North Carolina Superfund Section, provided technical support for database development.

INTRODUCTION

A wide variety of chemicals has been used and is currently utilized in drycleaning operations. Using material safety data sheets (MSDS) and other sources; a drycleaning chemical data base was developed that includes many of the chemicals that have been used in drycleaning operations. These data and the accompanying text are intended to aid those engaged in the assessment and remediation of contaminated drycleaning sites and to assist regulators conducting compliance inspections at drycleaning facilities. Some of the chemicals/products listed on the spreadsheet are no longer manufactured, marketed or used in drycleaning operations.

Drycleaning Chemical Data Spread Sheet

The spread sheet is divided into the following categories:

- Chemical product or trade name (as listed on the MSDS)
- Chemical manufacturer or distributor
- Use or function of the product
- Additional information
- Chemical constituent(s) as listed on the MSDS
- Chemical Abstract Numbers (CAS #s) for listed constituents
- Relative concentration of the constituent in the product

All product ingredients or constituents that appear on the MSDS were listed on the spread sheet – both hazardous and non-hazardous. The manner in which product constituents are reported on MSDS varies widely. Many manufacturers/vendors simply list all ingredients as being proprietary (trade secrets). Others indicate that there are hazardous constituents in the product, but do not identify the constituents. Some MSDS include statements to the effect that there are no hazardous constituents in the product based on current regulations as they (the vendor/manufacturer) interpret them. Therefore, some of the products listed on the spreadsheet have no data listed for constituents. Some of the chemical manufacturers, however, do offer fairly comprehensive data on constituents in their MSDS.

Chemicals used in drycleaning operations can be grouped into five broad categories:

- Drycleaning Solvents
- Other Chemicals Used In the Drycleaning Machine
- Pre-cleaning/Spotting Agents
- Garment Treatment Chemicals
- Chemicals Used In Solvent & Equipment Maintenance

DRYCLEANING SOLVENTS

Historically, a number of different chemicals have been utilized as drycleaning solvents. These include: camphor oil, turpentine spirits, benzene, kerosene, white gasoline, petroleum solvents (primarily petroleum naphtha blends), chloroform, carbon tetrachloride, perchloroethylene, trichloroethylene, 1,1,2-trichlorotrifluoroethane, glycol ethers, 1,1,1-trichloroethane, decamethylcylcopentasiloxane, n-propyl bromide and liquid carbon dioxide.

Petroleum Drycleaning Solvents

Petroleum-based compounds have been the most widely used solvents in drycleaning. At the beginning of the twentieth century, raw white gasoline was the drycleaning solvent of choice in the United States. Because of fires and explosions associated with the use of gasoline, drycleaning facilities were unable to obtain insurance and many cities banned drycleaning operations within their city limits. Due to these circumstances, a drycleaner from Atlanta named William Joseph Stoddard worked with Lloyd E. Jackson of the Mellon Research Institute and the petroleum refining industry to develop a less volatile petroleum drycleaning solvent in 1924 which is now known as Stoddard solvent. In 1928, the U.S. Department of Commerce promulgated Commercial Standard CS3-28 which required that petroleum drycleaning solvents must have a minimum flash point of 100 degrees Fahrenheit. Drycleaners began using Stoddard solvent in 1928 (Martin, 1958). From the late 1920s until the late 1950s Stoddard solvent was the predominant drycleaning solvent in the United States.

Stoddard solvent is a mixture of petroleum distillate fractions (petroleum naphtha) which is composed of over 200 different compounds. These solvents are composed predominantly of alkanes and cycloalkanes, with some aromatic compounds. Although many people refer to any petroleum drycleaning solvent as Stoddard solvent, this is incorrect. More properly, Stoddard solvent is a mixture of C_5 – C_{12} petroleum hydrocarbons containing 30 – 50% straight- and branched –chained alkanes, 30 – 40% cycloalkanes, and 10 – 20 % alkyl aromatic compounds (Sciences International, 1995).

The high aromatic content petroleum solvents are no longer widely used in drycleaning (Schreiner, 2001). Since the introduction of Stoddard solvent, the industry trend has been towards the development of higher flash point petroleum drycleaning solvents which have little to no aromatic hydrocarbon content. In 1950, the National Institute of Cleaning and Dyeing worked with the U.S. Bureau of Standards to develop standards for a higher flash point petroleum drycleaning solvent known as 140-F solvent (Michelsen, 1957). Beginning in the early 1990s petroleum drycleaning solvents with even higher flash points were developed such as:

- **Drycleaning Fluid-2000 or DF-2000™ Fluid:** This solvent is manufactured by ExxonMobil Chemical Company and was first marketed by Exxon Chemicals in 1994. It is described as synthetic, hydro-treated aliphatic hydrocarbons. More specifically, it is composed of C_{11} to C_{13} hydrocarbons (isoparaffins and cycloparaffins). It contains no aromatic compounds. It has a flash point of 147° F.

- **EcoSolv® Dry Cleaning Fluid:** This solvent is manufactured by Chevron Phillips Chemical Company LP. It was originally marketed under the name of HC-DCF High Flash. It is described as a mixture of aliphatic hydrocarbons, but more specifically it is composed of a mixture of $C_{10} – C_{13}$ isoparaffins. It has a flash point of 142°- 144° F.

- **Hydroclene® Drycleaning Fluid:** This solvent is manufactured by Shell Chemical Company but is marketed by Caled Chemical. It "…is a mixture of normal-, iso- and cyclo-paraffins…" (CARB, 2005). It has a flash point of 145° F.

- **Shell Sol 140 HT:** This solvent is manufactured by Shell Chemical Company. It is mixture of predominantly $C_9 – C_{12}$ hydrocarbons. It has a flash point of 145° F.

One of the problems associated with petroleum drycleaning solvents is biodegradation. Bacteria introduced into the drycleaning system through the clothing or in water introduced into the system will feed on the petroleum solvent, detergents, oils and fatty acids producing "sour smells". To combat this problem, bactericides or antioxidants are added to the system, normally in detergents. The biocides used today are reportedly similar to those used in shampoos, laundry products and cosmetics. In the past, PCE was added to drycleaning soaps used with petroleum drycleaning solvents as a bacterial inhibitor (Albergo, 1997). Butylated hydroxytoluene (BHT), an anti-oxidant or oxygen stabilizer is added (10 ppm) to EcoSolv®, the high-flash petroleum drycleaning solvent manufactured by Chevron Phillips Chemical Company LP (CARB, 2005).

Two products currently marketed to inhibit biodegradation of petroleum drycleaning solvents include:

- Desolan NT: This product is manufactured by SEITZ GmbH Chemische Fabrik and is described as an odor eliminator. It contains an ingredient described as "bacteriostatics".

- Varnicide: This product is manufactured by Adco, Inc. It is described as an "antioxidant/microbial – to prevent the development of rancid odors."

Carbon Tetrachloride

Carbon tetrachloride was the first chlorinated solvent used in drycleaning operations. It was first imported to the United States from Germany by Ernest C. Klipstein in 1898 and was sold as a drycleaning and spot-removing agent under the trade name of Carbona (Doherty, 2000). It was commonly used in drycleaning by the 1930s. By 1940 annual carbon tetrachloride use by the U.S. drycleaning industry was estimated to be 45 million pounds versus 12 million pounds of Perchloroethylene and 5 million pounds of trichloroethylene (Michelsen, 1957). Carbon tetrachloride was sometimes blended with other solvents for use as a drycleaning solvent. Because of its high toxicity and tendency to contribute to machinery corrosion, carbon tetrachloride is no longer used in drycleaning operations. Carbon tetrachloride was phased out as a drycleaning solvent in the early 1950s (Kirk-Othmer, 1965).

Trichloroethylene

In 1930, trichloroethylene (TCE) was introduced as a drycleaning solvent in the United States (Martin, 1958). TCE causes bleeding of some acetate dyes at temperatures exceeding 75 degrees Fahrenheit. It was never widely used in this country as a primary drycleaning solvent. TCE is, however, still widely used as a dry-side pre-cleaning or spotting agent and in water repellent agents. TCE is the principle ingredient in Fast PR, 2-1 Formula, Picrin, Puro, SemiWet Spotter, Spra-Dri and Volatile Dry spotter (V.D.S.).

Perchloroethylene

The first commercial production of perchloroethylene (PCE) in the United States occurred in 1925 (U.S. E.P.A., 1989). However, the first documented use of PCE as a drycleaning solvent in the United States was in 1934 (Martin, 1958). The superior cleaning ability of PCE, coupled with some municipal fire codes prohibiting the use of petroleum solvents in drycleaning operations resulted in the increasing use of PCE in drycleaning operations. By 1948, perchloroethylene replaced carbon tetrachloride as the leading chlorinated solvent used in drycleaning (Chemical Week, 1957). In 1962, PCE became the drycleaning solvent of choice in the United States and drycleaning accounted for 90% of PCE consumption (Chemical Engineering News, 1963).

In general, there are four grades of manufactured PCE: a drycleaning grade, a vapor degreasing grade for metal degreasing, a technical grade for the manufacture of other chemicals and a high purity grade used for extraction. Drycleaning-grade PCE is produced in the United States by Dow Chemical (trade name DowPer™), Vulcan Chemicals (trade name PerSec®), and PPG Industries, Inc. Drycleaning-grade PCE is also produced by ICI (Ineos Chlor Americas) under the trade names Perklone™ D and Perklone™ DX, and exported to the United States.

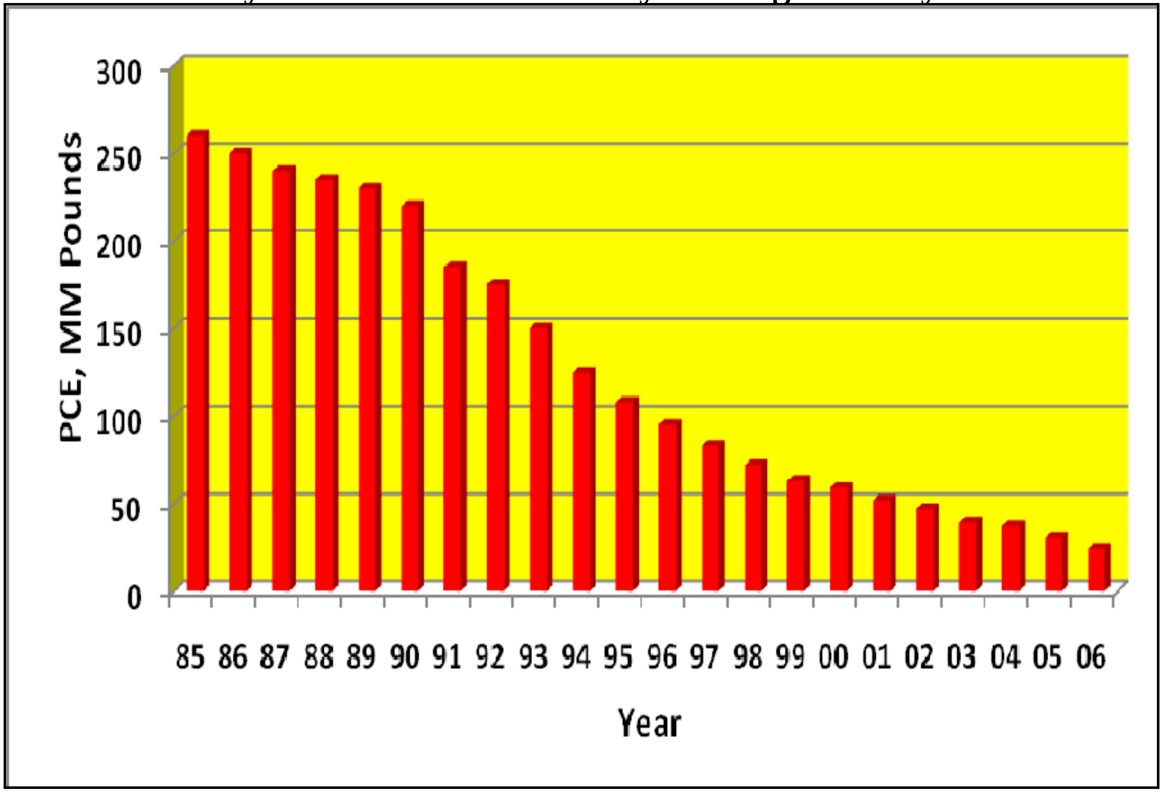
Material Safety Data Sheets for drycleaning-grade PCE indicate that it has a purity ranging from 99% to 99.9%. Some of the documented impurities are: 1,1,1-trichloroethane, carbon tetrachloride, dicholoromethane, trichloroethylene, water and other chlorinated solvents (European Communities, 2005). Perchloroethylene is a highly oxidized compound and has been called the most stable of the chlorinated solvents. However, PCE degrades in the presence of light, heat and oxygen to form trichloroacetyl chloride and tetrachloroethylene oxide. If water is present hydrochloric acid is generated (Knight, 1969). Water is present in the drycleaning machine and distillation of spent solvent at high temperatures can result in PCE breakdown. The presence of impurities in PCE, such as 1,1,1-trichloroethane and trichloroethylene and the presence of those compounds in some dry-side spotting and pre-cleaning agents used in drycleaning contributes to the formation of hydrochloric acid and corrosion of metals in the drycleaning machine. Both 1,1,1-trichloroethane and trichloroethylene degrade at lower temperatures than PCE.

To combat this problem, drycleaning solvent manufacturers add stabilizers to PCE. These stabilizers function as antioxidants or oxidation inhibitors and acid acceptors, neutralizing the acidic PCE. Some of the early drycleaning-grade PCE stabilizers were benzotriazole related compounds (Knight, 1969). Other compounds that have been used to stabilize drycleaning-grade PCE are 4-methylmorpholine, diallylamine, tripropylene, cyclohexane oxide, betaethoxyproprionitrile, and 4-methoxyphenol. Concentrations of stabilizers in PCE range from 0.005% to 0.5% (by volume). In general, the concentrations of stabilizers in drycleaning grade PCE are lower than the concentrations of stabilizers in PCE and PCE/solvent blends using in degreasing operations. Other compounds that have been used as PCE stabilizers are 2,3-epoxypropyl isopropylether, 2,6-bis (1,1-dimethylethyl)-4-methylphenol, 2,4-di-tert-butylphenol, di-isopropylamine, tert-amylphenol and tert-butyl-glycidylether (European Community, 2005).

Some drycleaners purchase and use reclaimed PCE. This reclaimed solvent has a reported purity of 95 – 99%. Typical impurities in reclaimed PCE are: methyl ethyl ketone, mineral spirits, toluene, 1,1,1-trichloroethane and other chlorinated solvents. The spent PCE that is reclaimed does not come solely from drycleaning operations. Generally, stabilizers are not added to reclaimed PCE prior to it being sold. Reclaimed PCE is often blended by the drycleaner with commercial (stabilized) PCE prior to use in drycleaning. Drycleaning wholesale supply facilities sell PCE stabilizers. An example of such a product is Perchlor Type 236, marketed by PPG Industries, Inc. It is described as a perchloroethylene stabilizer concentrate and contains cyclohexane oxide, beta-ethoxy proprionitrile, n-methyl morpholine, and 4-methoxyphenol (PPG Industries, 1999).

PCE use in the United States peaked in 1980 and drycleaning was the largest user of PCE (Dougherty, 2000). Based on data collected in the 1980 Census, approximately 86.7% of U.S. drycleaners used PCE in 1980 (USDC, 1986). In 1990, the United States Environmental Protection Agency (U.S. E.P.A.) proposed national emission standards to limit PCE emissions from drycleaning plants. More drycleaners replaced transfer machines with dry-to-dry machines and improvements in the design of these machines resulted in reduced PCE emissions and higher solvent mileage, the amount of fabric cleaned per a quantity of solvent. As late as 1996, the drycleaning industry was still the largest user of PCE in the United States (Leder, 1999). In September of that year, E.P.A. issued National Emission Standard Hazardous Air Pollutants (NESHAP) Requirements which obligated PCE drycleaners to monitor emissions and keep records of drycleaning machine maintenance. In January of 2006, the California Air Resources Board voted to phase out PCE drycleaning by 2023 (California E.P.A., 2007). Under the Final Rule - National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities, transfer machines could no longer be used in PCE drycleaning operations after July 27, 2008 (E.P.A., 2006). These actions have resulted in a decline in the amount of PCE used by drycleaners and stimulated the introduction of alternative drycleaning solvents. According to the Halogenated Solvents Industry Alliance, by 2007, PCE was used by approximately 70% of U.S. commercial drycleaners and only 10% of the PCE used in the U.S. was for drycleaning/textile processing (HSIA, 2008).

Perchloroethylene Demand in U.S. Drycleaning Industry 1985 - 2006



Source: Textile Care Allied Trades Association

1,1,2-Trichlorotrifluoroethane

In 1964 E.I. DuPont de Nemours & Company introduced a chlorofluorocarbon drycleaning solvent known as 1,1,2-trichlorotrifluoroethane or Freon 113 (Johnson, 1971). Its trade name was Valclene®. Since the vapor pressure of Valclene® is approximately 20 times that of PCE, clothes cleaned in Valclene® could be dried at lower temperatures and it was therefore promoted as the solvent of choice for the drycleaning of delicate fabrics. Freon 113 is one of the chlorofluorocarbons subject to the Montreal Protocols and is no longer manufactured. It was never widely used in drycleaning and Valclene® drycleaning operations have either shut down or converted to other solvents.

1,1,1-Trichloroethane

In the early 1980s, Dow Chemical began marketing 1,1,1-trichloroethane (a.k.a. methyl chloroform or TCA) as a drycleaning solvent under the name Dowclene LS®. It was used particularly in leather cleaning operations. Reportedly, only approximately fifty (50) drycleaning plants in the United States ever used TCA as a primary solvent. TCA is not a very stable solvent and was heavily stabilized. Despite this, there were problems with machine and equipment corrosion. TCA has been used as a pre-cleaning and spotting agent. It has also been used as a carrying agent in fabric waterproofing and in stain repellents.

Glycol Ethers

- **RYNEX® Biodegradable Dry Cleaning Solution:** Rynex® was the first glycol ether based drycleaning solvent. It was first marketed in 1999 (Hayday, 2007). It is a mixture or blend of aliphatic propylene glycol ethers. An earlier formulation of Rynex® reportedly contained propylene glycol t-butyl ether (PGtBE). The current product reportedly contains dipropylene glycol tert-butyl ether (DPTB) and is called Rynex® 3 (CARB, 2008). Rynex® has a flashpoint of >200° F and a specific gravity of 0.91.

- **Impress™** is described as aliphatic propylene glycol ethers. It has a flash point of 190.4° F and a relative density of ~ 0.922. It is manufactured by Lyondell Chemical Company and was first marketed in April of 2004 (Liotta, 2007).

- **GEN-X Drycleaning Fluid** is a blend of aliphatic Propylene Glycol Ether and hydrotreated heavy naphtha. It has a flashpoint of 160° F and a relative density of 0.830. It is marketed by Caled Industries.

- **Solvair™ Drycleaning System** is actually a drycleaning process that uses Solvair™ Fluid or dipropylene glycol n-butyl ether (dripropylene glycol normal butyl ether or DPnB) as a base cleaning fluid and then utilizes liquid carbon dioxide to rinse the garments. The system is marketed by R.R. Street.

Decamethylcylcopentasiloxane (GreenEarth™)

GreenEarth is a silicon-based solvent which was first marketed as a drycleaning solvent in 1999 (Maxwell, 2007). The chemical name for GreenEarth is decamethylcylcopentasiloxane, a.k.a D5. Its molecular formula is $C_{10}H_{30}O_5Si_5$. GreenEarth has a flash point of 170.6° F. and a specific gravity of 0.95.

n-Propyl Bromide

In October 2006 Drycleaning Technologies™, a division of Environ Tech International, Inc. began marketing Dry-Solv™, an n-propyl bromide (1-bromopropane) based drycleaning solvent (Roccon, 2007). The molecular formula for n-propyl bromide is C_3H_7Br. It has a specific gravity of 1.33. The MSDS for Dry-Solv™ indicates that the product is greater than 95% by weight n-propyl bromide. Dry-Solv™ is stabilized with nitromethane (<0.6%) and 1,2-butylene oxide (<0.6%).

In 2008, Tech Chem began marketing Tech Kleen for Dry Cleaning. Based on its MSDS, Tech Kleen for Drycleaning is >94% n-propyl bromide by weight and is stabilized with 1,2-epoxy butane (<1%).

PureDry™

PureDry™ was developed by Niran Technologies and was first marketed in 2000 (Eastern Research, 2005). It is described as a "hybrid" solvent and is a mixture containing 95% isoparaffinic hydrocarbons, (C_9 – C_{12} hydrocarbons), hydrofluoroethers (HFEs) and perfluoroisobutylethers (Eastern Research, 2005). PureDry™ has a flashpoint of 350 degrees F and a specific gravity of 0.80.

Liquid Carbon Dioxide

Liquid carbon dioxide is a cleaning process whereby carbon dioxide in a liquid state (operating under a pressure of between 700 to 800 pounds per square inch) is utilized as a solvent. The first commercial liquid carbon dioxide drycleaning plant opened in Wilmington, North Carolina in 1999 (Wentz, 2001).

OTHER CHEMICALS USED IN THE DRYCLEANING MACHINE

Detergents

Detergents are used in the drycleaning process. They perform three different functions:

- carry moisture to aid in the removal of water soluble soils;
- suspend soil after it has been removed from the fabric;
- and act as a spotting agent to penetrate the fabric so that the solvent and water can remove stains.

Based on their charge and how they carry water, there are three classifications of detergents:

- anionic detergents – are negatively charged and carry water by means of solubilization;
- non-anionic detergents - carry no charge and carry water by solubilization;
- cationic detergents – are positively charged and carry water by means of an emulsion. Most cationic detergents are pre-charged with moisture.

Detergents are introduced into the drycleaning machine by two different systems:

- In charged systems, detergent is added to the solvent or "charged" as a certain percentage of the solvent (normally 1 to 2%) to maintain a continuous concentration of detergent. Charged systems use anionic detergents. "Pre-charged solvent" (solvents containing the detergent) have been marketed in the industry, particularly for use in coin-operated drycleaning machines.

- In injection systems, also known as batched detergent injection, solvent is added to the wheel of the drycleaning saturating the garments and then detergent is injected into the flow line or into the drum of the drycleaning machine by a pump or dump method. Cationic detergents are used in injection systems.

The earliest drycleaning detergents were soaps. There were three different types: paste soaps, gel soaps and liquid soaps. Most of these soaps were composed of surfactants, Stoddard solvent, free fatty acids and some moisture to create an emulsion. When filtration was first utilized in the drycleaning process to purify dirty solvent, it was discovered that paste and gel soaps, also known as "true soaps", tended to plug or "slime" the filters, so these soaps became obsolete. The liquid soaps, also known as "filter soaps", sometimes contained a co-solvent such as butyl cellosolve, hexylene glycol, isopropanol, cyclohexanol, ethanolamine or n-butanol, which was used to disperse moisture. By the early 1950s, the industry trend was from liquid soaps to the use of synthetic detergents.

Synthetic detergents are surfactants or mixtures of surfactants with solvents. The following surfactants have been used in commercial drycleaning detergents: soap-fatty acid mixtures; "mahogany" or petroleum sulfonates; sodium sulfosuccinates; sodium alkylarenesulfonates; amine alkylarenesulfonates; fatty acid esters of sorbitan, etc; ethoxylated alkanolamides; ethoxylated phenols; and ethoxylated phosphate esters (Kirk-Othmer, 1965).

The constituents listed for the drycleaning detergents in the drycleaning chemical data spreadsheet include surfactants: phosphate esters, linear alkylbenzenesulfonic acid salt, oxyethylated isononylphenol, diethanolamine, alkearyl sulfonate, sodium sufonate, and sulfosuccinate. They also include drycleaning solvents and co-solvents that function as carriers. These include perchloroethylene, petroleum solvents and the following cosolvents – butyl cellosolve, hexylene glycol, 2-propanol, isopropyl alcohol, 2-butoxyethanol, diethylene glycol monobutylether, dipropylene glycol monomethylether and glycol ether. The most common solvent contained in the drycleaning detergent mixtures listed on the spreadsheet is petroleum drycleaning solvent (petroleum naphtha blends).

Sizing

Sizing is a type of finish used in drycleaning to restore shape, body and texture to a fabric. Sizing is actually applied to fabrics when they are manufactured and is depleted after several fabric cleanings. Most sizing used in drycleaning operations today is composed of hydrocarbon resins (plastic-based). Alpha methylstyrene and styrene have been used in sizing in the past. There are two forms of sizing used in drycleaning operations, a solid (in a powder or bead form), and a liquid. The solid form of sizing - the bead form - is commonly used in PCE drycleaning systems. Most of the liquid sizing used today has a petroleum solvent carrier. It is not uncommon for liquid sizing to contain over 50% petroleum solvent (petroleum naphtha blends) by volume. Anti static agents and optical brighteners are commonly added to sizing.

Sizing can be applied in three different ways: by a continuous bath in the drycleaning machine; by dipping garments in a tank of sizing; or by spraying sizing in an aerosol form (generally containing a propane/isobutane carrier) on the garments after they have been drycleaned.

In the continuous bath application method a 0.5 to 1.5% charge of sizing is added to the drycleaning machine. The concentration of sizing used in the dipping application method ranges from 1 to 4% (Eisenhauer).

Other Chemicals

Other chemicals used in the drycleaning machine include: optical brighteners, bactericides, fabric conditioners, and anti-static/anti-lint agents

Optical brighteners, also known as fluorescent whitening agents, optical bleaches or optical dyes are used to "make whites whiter". These chemicals absorb the ultraviolet and violet region of colors in a fabric. These chemicals are normally added to drycleaning detergents or sizing. Optical brighteners have been widely used in laundry detergents for many years. In recent years, they have been used in drycleaning.

Some fabric conditioners are added to the drycleaning process. These are used primarily to condition or restore luster and shine to suede, leathers and silks. These products are typically solvent based – petroleum naphtha or perchloroethylene.

Anti-static agents and anti-lint agents (to prevent lint buildup and retention) are available for drycleaning operations. Some chemicals used in anti-static agents are sulfonated polystyrene or sulfonated polystyrene/maleic anhydride polymers.

PRE-CLEANING/SPOTTING AGENTS

The greatest number and variety of chemicals used in drycleaning operations are used in pre-cleaning and spot cleaning or operations. Prior to being placed in the drycleaning machine, heavily stained garments are usually pre-cleaned or pre-spotted with cleaning chemicals. The types of chemicals used depend on the type of stain and the type of fabric being cleaned. After they are drycleaned, garments that are still stained or soiled are spot cleaned using the same chemicals as in pre-cleaning. There are three types of pre-cleaning/spotting agents: wet-side agents, dry-side agents and bleaches.

Wet-side Spotting Agents

Wet-side pre-cleaning/spotting agents are used to clean water soluble stains from clothing. Wet-side agents can be subdivided into three different classes: neutral, alkaline, and acidic.

Neutral Wet-Side Agents – Neutral spotting agents include water and neutral synthetic detergents (which contain surfactants). These agents are used to remove water-soluble stains, food, beverages and water-soluble dyes.

Alkaline Wet-Side Agents – Alkaline spotting agents include lye, ammonia, potassium hydroxide, sodium hydroxide and so-called protein formula home detergents. Protein formula detergents contain digester enzymes - Amylase, Cellulase, Lipase and Protease. Digesters can be used to remove: starch, cellulose, fats and oils, and protein stains.

Acidic Wet-Side Agents – Acid agents include acetic acid, hydrofluoric acid, oxalic acid, glycolic acid and sulfuric acid. Tannin or plant-based stains can be removed with wet-side spotting agents also known as tannin formula agents.

Dry-Side Spotting Agents

Dry-side pre-cleaning/spotting agents are used to remove oily-type stains, stains including fats, waxes, grease, cosmetics, paints and plastics. The primary constituents of dry-side agents are non-aqueous solvents and alcohols and include, or have included: perchloroethylene, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, methylene chloride, amyl acetate, acetone, ethanol, methanol, isopropyl alcohol and petroleum solvents. In general, from a contamination and regulatory standpoint, dry-side spotting agents include some of the most toxic chemicals used in drycleaning operations.

Bleaches

Bleaches are used in stain removal when other spotting techniques have failed to remove a stain. This process is known as “spot bleaching”. Bleaches are also used in conventional laundry operations which are conducted at most drycleaning plants. Bleaches can be classified as either oxidizing or reducing.

Oxidizing Bleaches	Reducing Bleaches
Sodium Perborate	Sodium Bisulfite
Hydrogen Peroxide	Sodium Hydrosulfite
Sodium Percarbonate	Titanium Sulfate
Sodium Hypochlorite	Oxalic Acid

GARMENT TREATMENT CHEMICALS

A number of different chemicals are used to treat garments after they are drycleaned. The functions of these chemicals include waterproofing, flame retardants, refurbishing, deodorizing, stain repellents and pest control.

Waterproofing

Waterproofing of garments by the clothing manufacturer is a relatively recent development. Historically, much of garment waterproofing was performed by drycleaners. In the past, the water proofing agent was usually a wax-based product and the predominant carrying agent for waterproofing agents has been nonaqueous solvents – perchloroethylene and petroleum solvents. Several methods have been used to apply the waterproofing agent, including immersion in the waterproofing agent in a dip tank; spraying the waterproofing agent on the garments in a tank; applying the waterproofing agent in the form of an aerosol spray; and in some cases applying the waterproofing agent in an auxiliary tank in a drycleaning machine (Rising, 1997).

Flame Retardants

Flame retardants are normally applied to garments by garment or textile manufacturers. Flame retardants can be depleted through repeated conventional laundering and drycleaning of garments. In the past, some drycleaners have treated or re-treated garments with flame retardants. Some of the chemicals used in flame retardants include: decabromodiphenyl oxide (DBDPO), organo-phosphates, phosphate salts and phosphated esters. Dry-side application of flame retardants used drycleaning solvent as the carrying agent. The flame retardant chemicals were applied by immersion or dipping in a tank or by spraying the garment with the flame retardant (IFI, 1995).

Fabric Conditioner

Chemicals are applied to refurbish garments after drycleaning. Typically, these garments can include suedes, leathers, silks, wools and vinyls. These chemicals are usually applied by spraying the garment (using a spray bottle or aerosol spray). Plasticizers such as di-N-butyl phthalate and di-2-ethylhexyl adipate are used to re-condition vinyl garments.

Stain Repellents

Stain repellents are generally applied by the garment manufacturer, but some drycleaners do apply stain repellents. Historically, these products have been silicone based and the carrying agent has been 1,1,1-trichloroethane (no longer used) or petroleum naphtha (IFI, 1994). Stain and water repellent chemicals used in drycleaning today use non-aqueous solvents as carrying agents (PCE, TCE, methylene chloride and petroleum solvents). A common constituent of many of these repellents is aluminum alcoholates. Most stain repellents can be applied as an aerosol spray.

CHEMICALS USED IN SOLVENT & EQUIPMENT MAINTENANCE

Solvent Maintenance & Treatment

From the early part of the twentieth century until the early 1950s, both alkalis and sulfuric acid were used to clarify spent petroleum drycleaning solvent. The most common alkali used was caustic soda (sodium hydroxide) in an 8-10% solution. The solvent was bubbled through or agitated with the caustic soda solution to help remove soap-fatty acid type detergents. Sulfuric acid was mixed and agitated with the spent solvent and the solids were then allowed to settle out (Martin, 1958).

Distillation of PCE solvent at high temperatures (> 300° F.) can result in the formation of hydrochloric acid in the distillation unit. Several chemicals have been used to neutralize acidic solvent/still bottoms in the distillation unit. These chemicals include sodium carbonate (soda ash), calcium carbonate and Alkanon, an alkali-aluminum silicate. The neutralization process consists of introducing an aqueous solution of the buffering compound into the distillation unit distilling the solvent.

Anti-foaming agents (commonly fluorosilicates) are sometimes added to the distillation unit to prevent contaminants in the spent solvents (pigments, fatty acids, filter powder, detergents water repellents and retexturing agents) from causing excessive foaming during the distillation process.

Detergents are sometimes added to the system to clean the drum and button trap of the drycleaning machine.

Filter Maintenance

Trisodium Phosphate was once used to clean tubular (regenerative) filters – used in powder filtration systems. It is doubtful that any of these tubular filters are still being utilized in drycleaning operations.

Detergent Maintenance

In charged systems, where anionic detergents are used, it is important to maintain a constant detergent concentration. Test kits are utilized to titrate solvent/detergent mixtures to measure the amount of detergent in the system. Chemicals used in these test kits can include: 1,2-dichloroethane, methylene chloride, and chloroform.

Boiler Maintenance

The use of untreated water in a boiler can cause scale buildup and corrosion. Treating the boiler water with chemicals - known as boiler feed water treatment - will increase the life of the boiler and reduce maintenance costs. Scale is formed from calcium and magnesium salts that are carried in solution in the water used in the boiler. Treatment of the boiler water by raising the pH with the addition of alkaline salts – such as sodium or potassium hydroxide – will prohibit most of the calcium and magnesium salts from precipitating and causing scale buildup in the boiler. Sodium sulfite is a constituent of some boiler feed water treatments. This constituent acts as an oxygen scavenger. The presence of oxygen in boiler water will lead to corrosion of the boiler (Faig, 1990). A chelating agent, sodium hexametaphosphate is sometimes added to boiler water to inhibit hard water salts from precipitating to form scale. Hydrochloric acid is sometimes utilized in acid boils to remove scale form the boiler.

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REFERENCES

Albergo, Nick. 1997. Letter from Nick Albergo, H.S.A. Environmental, to William J. Linn, FDEP.

Allsbrooks, Chris. November 2000. Use of Bleaches in Stain Removal. Silver Spring: International Fabricare Institute Industry Focus No. 2.

Andrasik, Maria J., M. Scalco. November 1989. Bleaches. Silver Spring: International Fabricare Institute Special Reporter, Vol. 17, No.4.

California Air Resources Board (CARB). October 2005. California Dry Cleaning Industry Technical Assessment Report (Draft). Stationary Sources Division, Emissions Assessment Branch.

California Air Resources Board (CARB). March 2008. Dry Cleaning Alternative Solvents: Health and Environmental Impacts. Sacramento: California Air Resources Board Fact Sheet.

California Environmental Protection Agency. January 2007. News Release. Sacramento: California Air Resources Board.

Calleja, Jay. January 2000. Stain Removal Chemicals: From A (Amyl Acetate) to Z (Zuds).

Chemical Week, 1953. Tri, Per and Carbon Tet. 72, 56.

Chemical Engineering News. 1963. New Dry-Cleaning system Under Field Test. Chemical Engineering New. November, 41, 28.

Chevron Phillips Chemical Company LP. 2003. EcoSolv® Drycleaning Fluid MSDS. The Woodlands: Chevron Phillips Chemical Company LP.

Childers, Everett. February 2008. The Fine Art of Efficient Finishing. American Drycleaner.

Doherty, Richard E. 2000. A History of the Production and use of Carbon Tetrachloride, Tetrachloroethylene, Trichloroethylene and 1,1,1-Trichlroethane in the United States: part 1 – Historical Background; Carbon Tetrachloride and Tetrachloroethylene. Environmental Forensics, Volume p. 69-81.

Dembovsky, Len. 1991. Preventing Drycleaning Machine Corrosion by Solvent Maintenance. Caringbah: The Australian National Drycleaner. October 1991, pp 6-8.

Eastern Research Group. 2005. Control and Alternative Technologies Memorandum. Morrisville: Memorandum, Eastern Research Group to U.S. E.P.A.

Enviro tech International, Inc. 2007. DrySolv Material Safety Data Sheet. Melrose Park: Enviro Tech International, Inc.

European Chemicals Bureau. 2005. European Union Risk Assessment Report. Tetrachloroethylene. Italy: European Communities.

Eisenhauer, Paul. 1985. Use of Sizing in Drycleaning. Silver Spring: International Fabricare Institute Bulletin Reprint – Practical Operating Tips No. 199.

Enviro Tech International, Inc. 2006. Dry-Solv™ Material Safety Data Sheet. Melrose Park: Enviro Tech International, Inc.

Faig, Ken. November, 1988. Boiler Feed Water Treatment. Silver Spring: International Fabricare Institute Bulletin Reprint – Technical Operating Information No. 605.

Faig, Ken. November, 1990. Maintaining Your Boiler. Silver Spring: International Fabricare Institute Bulletin Reprint – Special Reporter, Vol. 18, No. 4.

Hayday, William. 2007. E-mail from William Hayday, Rynex Holdings, Ltd. To William J. Linn, Florida Department of Environmental Protection.

HSIA. Perchloroethylene White Paper. 2008. Washington D.C.: Halogenated Solvents Industry Alliance, Inc.

International Fabricare Institute Education Department. Detergents. Silver Spring: International Fabricare Institute Bulletin Reprint, Technical Operating Information No. 603.

International Fabricare Institute Education Department. Dryside and Wetside Spotting and Prespotting. Silver Spring: International Fabricare Institute Bulletin Reprint – Technical Operating Information No. 625.

International Fabricare Institute. 1995. Flame Retardant Finishes. Silver Spring: International Fabricare Institute Bulletin – Technical Operating Information No. 658.

International Fabricare Institute. November 1994. Stain and Soil Repellents on Upholstery Fabrics: Do They Protect or Harm? Silver Spring: International Fabricare Institute Industry Focus, No. 6.

Jackson, Richard E. V. Dwarakanath. Fall 1999. Chlorinated Degreasing Solvents: Physical-Chemical Properties Affecting Aquifer Contamination and Remediation. Groundwater Monitoring Review. Dublin: National Groundwater Association, p. 102 – 109.

.
Johnson, Albert E. 1971. Drycleaning. Watford: Merrow.

Kamra, Mohammed. September, 1992. Water. Silver Spring: International Fabricare Institute Industry Focus, Vol. 16 No. 4.

Kirk-Othmer. 1965. Encyclopedia of Chemical Technology. New York: John Wiley & Sons Inc., Volume 7.

Knight, Don B. 1969. Perchloroethylene Corrosion. Presentation at International Fabricare Institute Technical Conference, November 1969.

Leder, A. 1999. C2 Chlorinated Solvents. Chemical Industries Newsletter. January 1999.

Leppin, Betty. March 1992. Corrosion in Drycleaning Machines. International Fabricare Institute. Silver Spring: Focus on Drycleaning, Volume 16, No. 1.

Liotta, Frank J. 2007, E-mail form Frank J. Liotta, Lyondell Chemical to William j. Linn, Florida Department of Environmental Protection.

Martin, Albert R., G. P. Fulton. 1958. Drycleaning Technology and Theory. New York: Textile Book Publishers, Inc.

Maxwell, Tim. 2007. E-mail form Tim Maxwell, GreenEarth Cleaning to William J. Linn, Florida Department of Environmental Protection.

Michelsen, Edna M. 1957. Remembering the Years 1907 – 1957. Silver Spring: National Institute of Drycleaning.

Mohr, Thomas K. G. 2001. Solvent Stabilizers White Paper (prepublication copy). San Jose: Underground Storage Tank Program – Water Supply Division, Santa Clara Water District.

Phillips, Lorraine. February 1992. What Is Pre-spotting? Silver Spring: International Fabricare Institute Bulletin Reprint – Technical Operating Information No. 637.

PPG Industries, Inc. 1999. Perchlor Type 236 Material Safety Data Sheet. Pittsburg: PPG Industries, Inc.

Rising, Jane, Schwartz, S. 1997. Water/Stain Repellents. Silver Spring: International Fabricare Institute Bulletin – Technical Operating Information No. 666.

Roccon, Ray. 2007. E-mail form Ray Roccon, National Sales Manager, Drycleaning Technologies to William J. Linn, Florida Department of Environmental Protection.

Rynex. 2001. Rynex Fact Sheet. Woodbury: Rynex Holdings, Ltd.

Schreiner, James. 2001. Petroleum Solvent – What Am I buying? Lyons: National Coalition of Petroleum/Hydrocarbon Dry Cleaners. April Newsletter.

Sciences International, Inc. 1995. Toxicological Profile for Stoddard Solvent. Washington D.C.: U.S. Department of Health and Human Services Public Health Service, Agency for Toxic Substances and Disease Registry.

Spotting Procedures. Concord Custom Cleaners.

Tech Chem. 2008. Tech Kleen for Dry Cleaning Material Safety Data Sheet. Hilton Head: Tech Chem.

United States Department of Commerce. 1986. County Business Patterns for the United States. Washington D.C.: Bureau of Census.

United States Environmental Protection Agency. August 1989. Locating and Estimating Air Emissions from Sources of Perchloroethylene and Trichloroethylene. Triangle Park: Office of Air Quality.

United States Environmental Protection Agency. July 27, 2006. National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities: Final Rule Part II. Washington D.C.: U.S. E.P.A. Federal Register, 40 CFR Part 63.

United States Patent & Trademark Office. August, 2001. United States Patent 6,273,919 – William A. Hayday.

Van Den Berg, J.H. December 1984. Corrosion Problems with the Cleaning Machine. Delft: Institute for Cleaning Techniques.

Van Den Berg, J.H. October 1985. Neutralizing of Acid PERC. Delft: Institute for Cleaning Technologies.

Wentz, Manfred. Keith R. Beck & V. Monfalcone III. 2001. Colorfastness of fabrics Cleaned in Liquid Carbon Dioxide. Research Triangle Park: American Association of Textile Chemists and Colorists, Vol. 1, No. 5.

Western States Drycleaners and Launderers Association. National Clothesline's Spotters Complete Guide.

EXHIBIT G

STATE COMPENSATION INSURANCE FUND

Safety Meeting Topics (Bilingual)

Dry Cleaner Safety

Dry cleaners use chemicals, heat, and steam to clean and press clothing and other fabrics. While helping their customers look spotless, dry cleaners need to be aware of their workplace hazards.

The use of chemicals is the primary hazard in a dry cleaner. Almost all dry cleaning is done with perchlorethylene (PERC), a solvent. Inhaling PERC can lead to serious health effects such as liver and kidney damage, dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. PERC is also a suspected carcinogen.

To avoid overexposure, use PERC in closed-loop dry cleaning equipment that controls the vapors. Check equipment for leaks and fix them promptly. Keep the lids tightly closed on fresh and waste solvent containers. Maintain good ventilation in areas where PERC is used.

Dry cleaners often use “secret-recipe” stain removers and spot cleaning solutions. These recipes may contain highly concentrated PERC and other unknown chemicals. You have the right to know what chemicals are in the spot cleaner you use and their potential hazards. To avoid dermatitis, a skin-irritation caused by chemical exposure, wear gloves and avoid skin contact with PERC and spot cleaning chemicals.

Fire is another hazard in dry cleaning. PERC has low flammability, but Stoddard solvent, an older dry cleaning solution and sometime spot-cleaning solvent, is very flammable. Store solutions and waste in properly closed containers. Check dry cleaning equipment for leaks and repair them immediately. Keep heating elements clear of clothing and lint so heat does not build up and cause a fire.

Dry cleaners suffer ergonomic injuries at a high rate if they do not use safe work practices. The high volume and fast pace of work can lead to fatigue. Take micro breaks every 20-30 minutes. Moving heavy clothing and fabrics requires the use of proper lifting techniques. Folding, pressing, and bagging clothing are repetitive motions. Rotate tasks throughout your day to give your different muscles a break. Try to keep your work at waist level to avoid awkward postures such as reaching and bending.

Watch for pinch and caught/crush injuries when using overhead conveyor systems. Make sure that you and your clothing are clear of the conveyor before activating it. Watch for pinch points on presses and folding machines. Keep an eye on your hands and your mind on your work when you are doing your job.

Dry cleaners are often hot, humid environments, so wear light layers of clothing and drink fluids throughout the day. Watch presses for hot surfaces and steam that can cause burn hazards. Label equipment hot surfaces with warning signs. Water and chemicals can cause spills in the workplace, so clean them up immediately to reduce the chance of a slip, trip, or fall.

Supervisor's Signature: ______________________ Date: ______________________

Location: ____

Meeting Attended By:

EXHIBIT 4

California Regional Water Quality Control Board
San Francisco Bay Region

September 11, 2013, 9:00 a.m.

Elihu M. Harris Building
First Floor Auditorium
1515 Clay Street
Oakland, CA 94612

Reported by: Tahsha Sanbrailo

Index

PROCEEDINGS

SEPTEMBER 11, 2013 9:00 A.M.

ITEM 7. <u>Site Cleanup Requirements</u>

Moonlite Associates, LLC, and United Artists Theatre Circuit, Inc., for the property located at 2640 El Camino Real, Santa Clara, Santa Clara County - Adoption of Site Cleanup Requirements

MR. WOLFE: Item 7 is Consideration of Site Cleanup Requirements for the Moonlite cleaner site in Santa Clara. This is an item that we are separating staff functions on, so I am head of the Advisory Team for the Board on this, Dyan is head of the Cleanup Team for this, and we have two parties in addition to the Cleanup Team. So I would say let's now allow the opportunity for all the parties to have a seat up here at the table, so we can do some musical chairs. I think we need to provide enough space so that the two parties can have space up here at the table.

On this item, the Advisory Team has allowed each of the three parties up to 30 minutes to make a presentation, cross examine witnesses, etc. So with that, while the parties are getting settled, I'll ask Dyan as head of the clean-up team to initiate their clean-up team's presentation.

MS. WHYTE: Thank you. For the record, I'll just introduce the staff that I have here. Stephen Hill, he's the Division Chief in our Toxics Cleanup Division; John Wolfenden is the Senior in his unit; Yuri Won will be helping us out here as the Cleanup's counsel, and Nathan King will be giving the presentation. So for now, I'll turn it over to Nathan.

MR. MCGRATH: Nathan, for the record, you are an Engineering Geologist. Is that correct?

MR. KING: Yes, I am.

MR. MCGRATH: Thank you.

MS. WHYTE: And a Registered Geologist.

VICE CHAIR YOUNG: It means he gets all the hard questions from now on?

MR. MCGRATH: He gets some of them.

MR. KING: Good morning, Vice Chair Young and Board members. My name is Nathan King. I'm an Engineering Geologist here in the Toxics Cleanup Division at the Board and member of the Cleanup Team. And I took the oath.

This morning, I'm presenting the Tentative Order for the adoption of site cleanup requirements for the property at 2640 El Camino Real in Santa Clara. In my presentation, I will go over the background of dry cleaner spills, the site history and investigation results, the Tentative Order and our basis for naming United Artists Theatre Circuit, or UATC. I will summarize UATC's objections to being named and will follow this with our response why UATC should be named. I will then finish the presentation with our conclusions.

It will be helpful to have some background on dry cleaner spills before getting into the specifics of this case. We provided a status report to the Board in 2011 on the challenges posed by dry cleaner spills. The key points we discussed are as follows: Most dry cleaning operations since the 1960's have used a chlorinated solvent called Tetrachloroethene or PCE. This is a suspected carcinogen that can cause liver and kidney damage. PCE spills and releases were common at least in the 1960's through the 1980's. PCE is a significant threat to our drinking water. It is the most commonly detected contaminant in drinking water.

The next slide shows the various ways PCE spills can occur. Both the equipment and the operations have improved over time and spills are now smaller, much less common. In California and elsewhere, there has been a push in recent years to phase out PCE used by dry cleaners.

Common causes of spills from dry cleaners are described in detail in the 2007 dry cleaner study prepared by the Santa Clara Valley Water District, which relied heavily on a landmark Florida dry cleaner study. The district study is comprehensive and gives us a good idea of how spills occur at dry cleaners. During typical use and maintenance of the dry cleaning machines, PCE was spilled onto the floor. It seeped through cracks and seams, and it was released to the subsurface. Dirty filters saturated with solvent were commonly taken outside to dry. Wastewater with solvent was disposed of down the sewer where it could leak out of joints and seams. The most common way spills occurred is from around the machines, which is the first bullet.

Now I will discuss site location and site history. The site is located within the Moonlight Shopping Center on El Camino Real in the City of Santa Clara. Notice the San Jose Airport and

Highways 101 and 880 for reference. It falls within the Santa Clara Valley Groundwater Basin, the most heavily used basin in our region. We have focused much of our site cleanup efforts in the basin due to its importance.

There are three public supply wells within a half mile radius of the site, as shown on the map by the blue triangles.

MR. MCGRATH: Excuse me, would those be up-gradient, at least in terms of the slope of the stream? Can you go back and show with the pointer where the stream direction is?

MR. KING: The stream is located -- you can see the red symbol for the site --

MR. MCGRATH: Right.

MR. KING: -- the site is immediately to the west of the stream, so the stream is right to the right of that red indicator. The deep wells would then be cross-gradient and up-gradient, and the flow would be towards the north. The regional gradient is toward the north, towards the Bay.

MR. MCGRATH: And is that stream completely channelized at this point?

MR. KING: No, it is not. The sides of the streams are reinforced, I believe the term is gabions, and the bottom of the stream is open.

MS. WHYTE: We're going to talk a little bit more about the hydro-geology of the stream in some slides coming up, too, as well.

MR. MCGRATH: Okay, good.

MR. KING: Any other questions? Site history: there have been two property owners since the property was developed in the 1960's. UATC developed the shopping center in the early 1960's, owned the shopping center until 1975, and was Master Lessor until 1978. Moonlight Associates has owned the shopping center since 1977. The Moonlight Cleaners Dry Cleaning business operated at the site for 35 years from 1962 until 1997.

The PCE concentrations at this site are very significant and warrant aggressive oversight by our agency. High concentrations of PCE have been detected in the indoor air, in soil gas, in groundwater, and in the adjacent Saratoga Creek. To put these in perspective, this table shows maximum concentrations compared to our environmental screening levels.

The concentrations of PCE in the indoor era of the shopping center were extremely high, one of the worst we have seen. And we have required mitigation measures to assure the safety of the current tenants. Moonlight Associates has installed a solar vapor extraction system to begin to clean up the site, but additional site cleanup is needed to protect human health and restore groundwater quality.

This slide shows the extremely high concentrations of PCE in soil gas. To get you oriented on the slide, the location of the dry cleaner is surrounded by the colored circles which represent the soil gas contamination. And I don't know if you can see this, there is a sewer lateral that extends to this sewer line that is owned by the City; the sewer lateral is a facility. The sewer line extends down to Bowe Avenue and runs parallel to Saratoga Creek where it hooks up to the main running down El Camino Real. Again, note the location of Saratoga Creek.

MR. MCGRATH: Excuse me, you've got isopleths here of concentration.

MR. KING: That's correct.

MR. MCGRATH: Are there adequate numbers of soil vapor samples to be able to map the isopleths with a lot of accuracy? Or is there a fair amount of inference going on here?

MR. KING: There's a high degree of accuracy. There are many soil gas samples that have been collected not only laterally, but vertically.

MR. MCGRATH: All right. Rough number?

MR. KING: Greater than 50. PCE was detected at up to five million micrograms per cubic meter in soil gas, more than 2,000 times our soil gas screening level for PCE. The highest concentrations were detected immediately beneath the former Moonlight Cleaners facility. The concentrations dissipate with distance from the former dry cleaner, indicating that the release occurred from the facility. Note that the high concentrations of PCE and soil gas are not found in the vicinity of the City of Santa Clara Sewer located in the back alleyway and along Bowe Avenue. We'll discuss this more later.

This slide shows the high PCE concentrations in groundwater. PCE was detected at over 1,000 micrograms per liter. This is more than 200 times our groundwater screening level for PCE. The highest concentrations are located immediately down-gradient to the facility, the area shown in red. The groundwater plume extends approximately 300 feet further to the northeast.

MR. MCGRATH: And again, the number of samples to draw these isopleths?

MR. KING: I would say approximately about the same number. It's spread over a greater area. There have been several investigation stages. There currently are several monitoring wells that have been in place based on the results of the groundwater investigation.

MR. MCGRATH: Are the samples necessarily differentiated by depth?

MR. KING: Yes, they are. There has been many samples collected vertically, as well as laterally.

Now, I will briefly discuss the Tentative Order. We need a Cleanup Order in order to assure that the site gets cleaned up. We circulated the Tentative Order in late June for a 30-day comment period, the Tentative Order named UATC and Moonlight Associates as Dischargers. It set cleanup levels for groundwater, soil, soil gas, and indoor air, and it set various tasks to make sure those cleanup levels are met in a reasonable time. The key issue in this case is whether to name ATC as the Discharger in the Cleanup Order.

The next few slides explain our rationale for naming ATC.

What are the criteria for naming a past owner or Lessor of the Discharger? The State Water Board's precedential orders lay out three criteria that must be met before we can name a past owner or Lessor as the Discharger. They must have owned or leased the property during the time the discharge occurred. They must have had knowledge of the activities on their property which resulted in the discharge. And they must have had the legal ability to prevent that discharge. I'll go through each one in turn in the next several slides.

There is substantial evidence that a PCE release occurred during UATC's tenure. This slide lists the evidence we used to reach that conclusion. There are high concentrations of PCE in the subsurface and indoor air. There is a history of PCE being used at the site beginning in 1962. Dry cleaning operations in the 1960's tended to have PCE releases, and that's documented in the Santa Clara Valley Water District Dry Cleaner study. And the specific dry cleaning equipment used during UATC's tenure was prone to leaks and spills. I'll explain that in the next slide.

This slide shows some of the older dry cleaning equipment used during UATC's tenure. Each of these machines had ways PCE could cause a release. These older machines are the types of machines that the Santa Clara Valley Water District Dry Cleaner Study claims caused so many releases. Old 1961 dry cleaning equipment from this site was likely still being used in 1975.

Moonlight Cleaner's operation was not a closed system; for example, wet PCE laden clothes were manually transferred from the dry cleaning machine into the reclaimer for drying. Such transfer inevitably led to PCE dripping on the floor. Also, the Reclaimer's purpose was to recover as much PCE for reuse, but then never recovered 100 percent of that PCE. The remaining PCE mixture either went into a bucket, or into a drain, in addition, the still cooked and the leftover PCE mixture from the dry cleaning process. The PCE mixture routinely boiled over and was released in to the environment, either onto the floor or drain. The still produced wet PCE laden muck waste that would drip while being disposed of. And the vapor mat model 800 took PCE out of the air, generating more PCE contaminated waste.

This slide shows how PCE migrated to the subsurface. PCE most likely spilled onto the concrete floor due to the sloppy nature of the dry cleaning equipment and processes. PCE slowly seeped into the concrete floor, or through cracks, or perforations in the floor, then into the soil beneath the slab. PCE could have been bound up for years in the soil beneath the slab.

Now I'll move onto the issue of whether UATC had knowledge of the activities that resulted in the discharge. We conclude that it knew, or should have known. In 1961, the State Fire Marshall Permit put UATC on notice that a dangerous solvent, PCE, will be used on their property, and noted the need to control toxic vapors generated during operation of the dry cleaner and it notified UATC that they were still required to follow a local ordinance rules, regulations and restrictions. UATC should have known that the solvent required careful handling and that the use of solvent had risks not inherent in other businesses. In the same timeframe, UATC received a Building Permit and a Certificate of Occupancy for the dry cleaner. This shows that UATC was actively involved in the establishment of the dry cleaner.

The 1975 City Ordinance prohibited the discharge of any PCE to the sanitary sewer and prohibited the discharge of PCE in sufficient quantity to create a hazard for humans, animals, or fish in any waters receiving effluent from the sewer.

Now, I'll move on to the issue of whether UATC had the legal ability to prevent the discharge. We conclude that it did. UATC was the owner of the site and landlord to Moonlight Cleaners. UATC had leases with its tenants. UATC exercised ultimate control over the site and had the legal ability to prevent the discharge of PCE.

In conclusion, there are substantial evidence for all three of their criteria for naming a past owner as a Discharger; therefore, we named UATC as a Discharger in the Tentative Order.

In response to the Tentative Order, we received minor comments from the Advisory Team, all of which were incorporated. Moonlight Associates, the current owner, generally supports the Tentative Order, some of its comments were incorporated. UATC strongly objects to being named.

We have prepared a detailed Response to Comments, which is in your agenda package. I will focus now on UATC's comments and our responses.

UATC has raised four major issues about being named, shown on this slide. Does site data support a PCE release during UATC's tenure? Did UATC have the required knowledge to be held liable? Did UATC's 2001 bankruptcy shield it? Would naming UATC conflict with past precedent? In addition, it is argued for naming the City of Santa Clara to the Cleanup Order on the theory that PCE leaked from its downstream sanitary sewer.

Regarding the first bullet, UATC has offered three arguments for why it thinks PCE was not discharged during its tenure between 1962 and 1978. Next slides go through each argument. UATCs first argument is based on its own modeling of hypothetical PCE leakage from the sewer. It includes that such leakage would only take six years to reach groundwater, which indicates a release after UATC's tenure. We disagree and conclude that the modeling is misleading. The model does not incorporate the primary release mechanism of discharge from the dry cleaning equipment to the floor of the dry cleaner. Therefore, the model is not representative of this situation.

UATC's second argument is that the lack of a Northwest trending groundwater plume rules out a discharge during its tenure. Specifically, it argues that percolation of water from Saratoga Creek in the 1960's and 1970's would have influenced the direction of groundwater flow beneath the site, producing a northwest trending plume. We disagree. We conclude that a northwest plume is implausible for two reasons: first, the site data show that PCE was released at the dry cleaner building most likely in numerous small releases that seeps through the concrete floor cracks and migrated downward through soils beneath the floor, a process that would have taken several years.

Second, groundwater was much deeper during UATC's tenure, and therefore the creek could not have had influenced the direction of groundwater flow in the northwest. This point is illustrated by the next several slides.

For most of UATC's period of ownership, there was no shallow groundwater and the creek was completely disconnected from deep groundwater. Saratoga Creek was an intermittent creek during UATC's tenure, only flowing during the wet months of the year, and most likely did not produce enough water to recharge the dried up shallow groundwater zone.

This slide and the next three slides shows the estimated depths to groundwater during UATC's tenure and more recently. The upside down triangle shows groundwater elevations based on the data from the three deep production wells in the vicinity. Here is the situation in 1962 when dry cleaning operations began. You can see that the creek was about 200 feet above the groundwater, too far above it to cause groundwater flow to shift to the northwest.

Here is the situation in 1970, midway through UATC's tenure. The creek was about 120 feet above groundwater, still too far above it to cause groundwater flow to shift to the northwest. The groundwater is rising because, in the late 1960's, the Santa Clara Valley Water District began to recharge the Santa Clara Groundwater Basin.

Here is the situation in 1978 at the end of UATC's tenure. The creek was about 80 feet above the groundwater, but even if the PCE release extended to 40 feet deep as it does now, the groundwater was still far below the contamination zone, and PCE was not yet migrating in groundwater.

MR. MCGRATH: I have a question here. You've indicated that the depth to groundwater on these three are graphics which are extremely important, were taken from the three water supply wells which are within half a mile, if I recall.

MR. KING: That's correct.

MR. MCGRATH: But they reflect not localized draw down cones from those wells, but the regional groundwater overdraft and the beginning of recharge efforts. Is that correct? So these aren't localized phenomenon that would be due to the three well; rather, they are regional trends? Is that correct? Or is it impossible to know?

MR. KING: I don't really understand your question.

MR. MCGRATH: Okay. Groundwater dropped rather famously in the Santa Clara Valley because of overdraft, and their land subsided, as well. So you can have regional phenomenon where the entire groundwater basin is over-drafted, and that's reflected in --

MR. KING: That's correct.

MR. MCGRATH: -- in well data you get anywhere. You can also get drawdown cones from individual wells which would have a regional effect, or a small aerial effect.

MR. KING: That's correct.

MR. MCGRATH: And I'm assuming that the wells reflect the overall large scale groundwater depths, not localized impacts of a drawdown cone from the three wells, that they were too small to have such a far afield effect. Is that correct?

MR. HILL: Mr. McGrath, can I respond quickly? The three wells that we're using to put this data on the slides, they do reflect the basin-wide effect of groundwater levels coming up, so in that sense they're consistent with the basin-wide rise of groundwater, but because they are so close to the site, we feel that they are relevant to the site.

MR. KING: If I may add one more thing, Mr. McGrath, these elevations are -- the numbers that were used to calculate these elevations are static level numbers; in other words, when the wells were not pumping.

MR. MCGRATH: Ah. So the mechanism that I'm worried about, or wanted to be clear on the record, it is possible that strong pumping can create localized drawdown cones that could reverse groundwater flow, and so I think it's really important to be very clear here that these are not localized drawdown cones which then could help support the argument that groundwater could have flowed to the west. But indeed -- in other words, if you've got higher groundwater underneath the Moonlight Shopping Center than you do, and the drawdown cones are localized, then you can create an artificial gradient back towards those wells.

MR. KING: That's correct.

MR. MCGRATH: And that doesn't appear to be the case here because, as you said, it reflects regional trends and it reflects times where there are actually static measurements, so it's not during pumping.

MR. KING: Yes. There are three things

that we are relying on, this information is only one line of evidence, and the other two lines of evidence are the depth of water encountered during one of the wells that was drilled during first encountered water in 1962 was 225 feet below ground surface.

MR. MCGRATH: Okay, thank you. That's excellent. I think -- there's plenty of data to support this particular phenomenon.

MS. AJAMI: Just a quick question. So these wells are monitoring wells, or they're active wells that are being used?

MR. KING: These are deep production wells.

MS. AJAMI: Deep production wells, and have been active since 1960's. Has anybody been monitoring that well?

MR. KING: Yes. The three wells on that figure, on that first figure, all are still active today and they are used to produce drinking water. And they have -- it is our understanding that these wells are active, therefore they are not shutdown, which would mean that the concentrations, if any detectable at all, are so low, it's most likely that these are producing safe water to drink.

MS. AJAMI: Okay, so they have been monitoring though?

MR. KING: Yes. I think I'll repeat this slide to make sure we're on track again. Here's the situation in 1978 at the end of UATC's tenure. The creek was about 80 feet above the groundwater, but even if their PCE release extended 40 feet deep as it does now, the groundwater was still far below the contamination zone, and PCE was not yet migrating in groundwater.

VICE CHAIR YOUNG: So just to repeat, the 40 foot depth of the PCE release that's shown on this slide is actually current conditions?

MR. KING: That's correct.

VICE CHAIR YOUNG: Thank you.

MR. KING: And last --

MR. REISCH: Just a question, I'm sorry. The product well data that Mr. King is referring to, I understand, is not data that is in the record, or that's been shared. We've tried to request it from the people who have it and they're in the process of providing it, it was just referenced in this material that was submitted last week. So I guess my question is whether it's appropriate to be discussing that at this juncture?

VICE CHAIR YOUNG: We need your name and who you're representing.

MR. REISCH: Oh, I'm sorry. Scott Reisch, representing UATC, I'm with Hogan Lovells. I'm so sorry. So it was just a question in terms of how the procedure works. Is that now in the record because it's being mentioned here? Or how does that work?

MR. KING: I can respond if you would like. May I respond to that? The well data that was provided is confidential information, it was provided to me by Santa Clara Valley Water District, and I had to sign a disclosure not to make this information public. And the idea is that information could be used in a harmful way. So the exact location of the wells and the information from those wells has to remain somewhat private. The process, if someone would like to see that information, they have to go through the process of signing a form and the requirements are that this information will not be made public, so I will have to keep that information confidential. In other words, I cannot present this -- yes, they can get it themselves, but they have to sign the form.

MS. WON: So the actual -- this is Yuri Won -- so the actual data is not in the record, but Nathan's interpretation of the data after having seen the confidential interpretation is in the record.

MR. REISCH: And just to clarify, when we identified this issue, you know, this was referenced for the first time in the Board's response, the packet that went out Wednesday evening, we have filed that request and submitted the nondisclosure form, we haven't received the data yet, so I guess I'll just put that on the record. I guess it's a little odd to me that we have confidential data that one party has at this late data, and we've been doing this for a couple years, that all parties don't have. So I guess we're concerned about that. But I'll let him continue with his presentation. I just want to note that objection for the record.

MS. WON: Obviously --

VICE CHAIR YOUNG: We'll get further clarification from Ms. Won.

MS. WON: -- if I may once more, sorry.

VICE CHAIR YOUNG: Yes.

MS. WON: Obviously, since the data is confidential, we cannot rely -- it's not in the record, but as I said, again, Nathan has reviewed the confidential data and his interpretation and his understanding is reflected in the record, and it's before you, and it's before the parties.

VICE CHAIR YOUNG: Right, and could you maybe be more specific about where it is in the record so that we could look at particular pages of the staff report?

MS. WON: It's not in the agenda package, but Nathan's -- he reviewed the data and, like I said, the data itself is not in the record, but his interpretation of the data is in the record, and unfortunately it has not been produced in the agenda packet. You're basically relying on Nathan's interpretation of this information.
Also, I'm hearing that it's also in the Response to Comments.

MS. WHYTE: Just again for your benefit is why confidentiality arises in these types of situations is to protect the exact location of the well, which is why Nathan has depicted it as a fairly large triangle so one could not from the map depict it, go out to the individual well, and perhaps cause some harm to that well. So that is essentially why we're in the --

VICE CHAIR YOUNG: Just to clarify, in the Response to Comments in our packet, our staff's -- your team's professional interpretation of that data is in our packet, it's in the Response to Comments?

MS. WHYTE: Yes, and it really pertains simply to the fact that there are production wells nearby within a half mile radius and this is the general depth to groundwater that was observed in those wells over time.

VICE CHAIR YOUNG: In relationship to the probable depth of the plume?

MS. WHYTE: Yes, exactly.

VICE CHAIR YOUNG: Thank you. Your objection is on the record --

MR. REISCH: I don't want to interrupt the Board member.

MS. ABE-KOGA: So I guess I'm a little confused, though. If we understand the information is confidential, you've been able to obtain it, you've done an analysis as a result, but if the party, the other party has requested information, but hasn't received it, and I think this is their argument, is they haven't had a chance to analyze it. Is that correct?

MR. REISCH: Right, we haven't received it yet. We only learned it existed -- and I don't know if his interpretation is right or wrong, I just -- we just can't assess it at this point, and I don't want to --

MS. ABE-KOGA: I guess if they don't have the information to assess or respond to your analysis, I'm not sure where we are with that.

MS. AJAMI: Can I also ask another question? I'm assuming this was within that Responses to the Comments when you provided them to the party, but unfortunately I can't really remember what was the date on that, but I'm wondering how long they have time to review it and maybe make an action to go get the data. Do you know how long they have time? I just want to make sure --

MS. WON: Well, if I may, this data is available, just because we did the leg work doesn't mean that they couldn't have done the leg work earlier, as well.

MS. AJAMI: That's what I'm asking, like

when did we provide a response to the comments? I can't remember exactly.

MR. MCGRATH: Can I follow-up on Yuri's comment? So the confidentiality rules are intended to protect the integrity of the wells, not to make the actual underlying data unavailable to professionals who sign confidentiality. So let me finish the question. So if in due diligence of soil engineering reports and groundwater flow reports, an engineering geologist under the employ of anybody comes to Santa Clara County Water District and signs the confidentiality, they can obtain the evidence? Is that correct?

MS. WON: That's my understanding. And, Nathan, if you want to elaborate on that, please do so.

MR. KING: Yes, the process is to get that information, but the standard of practice in an investigation such as this is to do a well search and to obtain that information.

MR. MCGRATH: I was going to go there next. I would say that, when I first looked at this material, I mean, I've never looked at groundwater depths in Santa Clara in a lot of detail, but kind of everybody that is in a technical field knows about 15 to 30 feet of land substance, it's a level of surface change that's rather remarkable in the extent of groundwater pumping. So anybody approaching this would know that there had been periods of extreme groundwater overdraft, and so there is perhaps a due diligence question, as well as a equal opportunity through the record question here. So I would suggest that should someone have proceeded from their knowledge of the groundwater basin, they would have poked around at some wells, I certainly would have.

VICE CHAIR YOUNG: It seems to me that we have clarified who had access to what, when, who could have had access to what, when, and I would recommend that, unless there's strenuous objection, that we take all of this information under advisement and continue with the other lines of evidence that the staff wants to present. We have your objections.

MS. GUALCO: Vice Chair?

VICE CHAIR YOUNG: We'll need a name and affiliation.

MS. GUALCO: Lori Gualco, Attorney for Moonlight Associates, LLC. I have been sworn to testify here today. I would just like to clarify that this information is in the record, it was placed in the record by my consultants and there are numerous reports on file which are available by Geo Tracker and have also been served directly on United Artists, also, as Mr. McGrath pointed out, they could have obtained this information at any time by going to the appropriate agencies and regulators to obtain it. So thank you.

VICE CHAIR YOUNG: And just to clarify, when you say "this information," you mean information on the depth to groundwater --

MS. GUALCO: Yes.

VICE CHAIR YOUNG: -- and perhaps the critical depth of the plume. Thank you.

MS. GUALCO: That's correct. Thank you.

MR. KING: I will continue with this slide. And lastly, there's the situation in the mid-1990's toward the end of the dry cleaner operations. Groundwater reached the PCE contamination, creating groundwater pollution and causing it to migrate away from the site. We have shallow water groundwater monitoring data for this period from a nearby gas station site and it shows shallow groundwater flowing to the northeast, starting in the mid-1990's and continuing to the present. This matches up well with the groundwater PCE plume I showed you earlier.

UATC's third argument is that groundwater levels were deeper during UATC's tenure. If a discharge occurred during its tenure, there should be a deep groundwater plume; since it doesn't exist, the discharge must have happened after 1978. This is incorrect. Groundwater contamination is detected at about 40-feet below ground surface. This is above a relatively thick clay layer that would likely slow down any further down with migration of PCE until groundwater came up and contacted the contaminated soil.

So with respect to the first major issue, we conclude that PCE was discharged during UATC's tenure between 1962 and 1978.

The next major issue is whether UATC had knowledge of the activities which caused the discharge. UATC argues that it had to have very specific knowledge of the PCE discharge and contamination in order to be liable. But it is applying the wrong knowledge standard. The State Water Board's precedential orders have required current landowners to know about contamination in order to be liable. For past landowners, precedential orders require the owner to have knowledge of the activities that caused the discharge. This is based on the idea that, so long as a landowner is aware, or should be aware of what is happening on his or her property, and has the power to regulate it, he or she bears the cost of cleanup. Here, from the Fire Marshal Permit, UATC knew, or should have known, that a dangerous and toxic chemical was being used on site and required careful containment and handling.

UATC focuses on the fact that the permit did not mention groundwater pollution. We think it is unreasonable to conclude based on this that it was okay for a dangerous and toxic chemical like PCE to be released into waters of the State. Moreover, UATC should have known from the 1975 City Ordinance that PCE even in trace amounts posed risks to sewers and receiving waters.

The next major issue is whether UATC's 2001 bankruptcy shields it from liability at the site. UATC argues that it does. We disagree. UATC emerged from bankruptcy in 2001; the Board found out about the site and its contamination in 2009, yet UATC argues that its environmental liability was discharged by the Bankruptcy Court. We disagree for two reasons: 1) a cleanup obligation with dual objectives of removing accumulated waste and stopping ongoing pollution is not a claim that is dischargeable in bankruptcy; 2) even if it were a claim, it never arose in time to be discharged because the Board found out about the site eight years after bankruptcy.

UATC claims there is no site-specific technical evidence of a discharge during UATC's tenure, such as a fate and transport study, or eye witness testimony, and that this is a deviation from past precedent. We disagree that a fate and transport study or eye witness evidence is required under past precedents. Under State Water Board precedents and State Water Board Resolution 9249, we may use any evidence, whether direct or circumstantial, including chemical use, hydro-geologic information, industry-wide operational practices, that have historically led to discharges and physical evidence.

Here, we are relying on both industry-wide practices and site-specific evidence, as described earlier in my presentation. Thus, we are being consistent with past precedence and Resolution 9249.

The last major issue is whether the City of Santa Clara should be named in this order. UATC argues that the City should be named based on its review of the sewer video and the pattern of PCE in groundwater near the site. We disagree. The soil gas concentrations are three orders of magnitude greater at the facility than near the City sewer line. This pattern of PCE contamination in soil gas and in groundwater do not indicate that the release occurred from the City sewer line, but indicates that the release occurred from the facility. The pattern of contamination may indicate a possible secondary release mechanism from the building's sewer lateral, but not from the City sewer line.

In conclusion, this site presents a threat to human health and the environment due to the significant PCE release from past dry cleaning operations. Therefore, it is important that this PCE contamination is cleaned up and the Board's adoption of a Site Cleanup Order will help make that happen. One of the key issues in this matter, we conclude there is sufficient evidence to name UATC as a Discharger.

You have a Revised Tentative Order in your package. It reflects minor changes in Response to Comments. We recommend adoption of the Revised Tentative Order. This concludes the staff presentation. I'd be happy to answer any more questions.

VICE CHAIR YOUNG: And we have a Supplemental sheet that clarifies changes in some of the dates on the tasks of Item C?

MS. WHYTE: That's correct, yes, just some clerical errors on that.

VICE CHAIR YOUNG: Jim.

MR. MCGRATH: I appreciate the clarification on the hydro-geologic questions; I think all of my questions in that arena had been answered. But I want to be educated a little bit here on the mechanisms of flow and the mechanisms of dissolving in PCE. PCE would move through the soil in two different ways, it would move by gravity and I am assuming here that, as a DNAPLE, that PCE would move very slow because it would have a very high viscosity, but it would move more rapidly when in a dissolved phase. But I'm not well educated to how that occurs. So since that's part of the argument that's been used, is this must have been in a dissolved phase, and would therefore flow more rapidly, and that was modeled, without a gradient, without groundwater, I mean, you've got a paved site, so you've got no direct rainfall creating a gradient, then the force bringing the PCE down would just be gravity. Would any leakage that remained under the slab that had not come from a nocuous solution be moving very very slowly? I mean, what's the nature -- and would it remain as a heavy dense fluid rather than a dissolved phase fluid until such time as it intersected the groundwater? Take me through that process of a DNAPLE becoming a liquid phase a little bit here.

MR. KING: Our conceptual model is that the releases occurred above slab from the operation and use of the machines. As the PCE moved through the subsurface, it would sorb onto the finer grain soil clays. It may not have had enough volume to reach to great depths at the time where groundwater was very deep, and our model is that it was held up above that; in other words, it did not continue through time, through the years, but there wasn't a large enough release to reach groundwater. At that point, it would be sorbed to the finer grain particles, and it would volatilize and would cause a concentrated soil gas plume. That's what we see today and that's what the site indicates.

MR. MCGRATH: A soil gas volatilization is very high.

MR. KING: Yes.

MR. MCGRATH: Now, I would also assume that DNAPLE will volatilize much more greatly than the dissolved phase? And it does represent -- one other point. It doesn't appear -- you clarified that a lot of sampling has been taken, both to establish the soil gas levels and to establish the plume, and it certainly meets a high degree of confidence in terms of statistical confidence. The consultant for the theatre company had a model that they used, theoretical values to model flow through and reach certain conclusions that this occurred afterwards. I read fairly carefully, it's my understanding from what I read that there was no soil sampling, so no one has actually sampled the soil, looked at whether or not it was fill, and tried to figure out what actual soil transmissivity (*sic*) were. Is that correct?

MR. KING: It's my understanding that there has not been soil sampling beneath the slab itself. The consultant that did the work is here today and, if I'm wrong, please correct me.

MR. MCGRATH: So additional technical work could be done to measure actual -- the nature of the soil, look at how much the site might have been filled, I mean, it's fairly close to the creek and I would assume that there was some fill when they developed as a shopping center, and begin to look at the actual pattern of resistance to flow rather than a theoretic pattern. And none of that -- just a statement -- none of that is precluded by whatever action we take today. Thank you.

VICE CHAIR YOUNG: Yes.

MS. ABE-KOGA: So I guess my questions have to do more with the process -- and this is all new to me -- but in terms of I guess like permitting and -- so going back, I understand you have to get permits to operate, the operator of the business would do that. But then, is the owner of the property also -- I guess my question is how involved are they in the process of getting a small business up and running on their site, other than a lease, are they involved with the Building Permitting and so forth, which I don't think they are, to my knowledge, from the work I do at the City. So the question is really about knowledge of what -- and I understand, you know, there's the knowledge of the dry cleaning operation, but how does the land owner know what's going on in the business? Is there like an inspection that's done every so many years by the City to have been able to detect that these machines -- and I guess the question is like were these machines always faulty? Or what was their percentage of faultiness? Who would have known that this was happening and there was spillage going on that shouldn't have been going on? And when should they have known that, that it could have been prevented sooner than later?

MS. WON: If I may, I mean, that is the key question. We don't know. I mean, this was the 1960's, we don't know exactly what happened, but if you look in terms of the build-out of the Moonlight Shopping Center and this dry cleaner, but if you look at the Building Permit that is in your packet, the application is by United Artists and it is signed by -- it's Contractor and Agent, so it was involved in getting the permit for this facility.

MS. ABE-KOGA: Okay, I understand that, but then I guess it's more about in terms of the operations, you know, the dry cleaning operator doing their business, using these machines, they would have known if spillage happened or not, but how would the owner of the property have known that?

MS. AUSTIN: If I may, Board member, to clarify what our State Board has said about the level of knowledge.

VICE CHAIR YOUNG: State your name.

MS. AUSTIN: Pardon me, Tamarin Austin, and I'm Counsel with the Advisory Team. And I'm losing my voice again. One of our State Board Orders provides some guidance for us so that we don't have to delve into the issues of exactly how much knowledge is known by the landowner or the Lessor, and this is the John Stewart (ph) Order, State Board Order No. 8615. And the State Board says the actual knowledge of the contamination need not be shown where it is reasonable for a person to be aware of the dangers generally inherent in the activity. And there's a footnote in this order, as well, that talks about the legislative intent of our Code is to provide strict liability in this section, so getting away from the knowledge requirement, if that makes sense.

MS. ABE-KOGA: Okay, this is probably going to go to, then, the other question about the City's responsibility, then, and I'm trying to understand the process there. I know, depending on what kind of zoning it is, you would have to renew your permits, but would the City have -- they would have known, 1) that there was a dry cleaning operation, but what is their responsibility then to see if the operations were happening correctly or not correctly?

MS. AUSTIN: So you're talking about the City. In this particular case, the City is not being named as the Discharger, so that analysis is not before us. If you're asking about the question of the sewer operator or owner being the municipality, that's a different analysis. I just want to make sure I'm answering the right question.

MS. ABE-KOGA: I guess by Code, if you're saying there's knowledge of an operation that's going on, that could cause potential damage or danger, then wouldn't there be some responsibility?

MS. AUSTIN: Meaning knowledge by the landowner?

MS. ABE-KOGA: Right.

MS. AUSTIN: Right.

MS. ABE-KOGA: Well, and that would extend out to the City, too, wouldn't it?

MS. AUSTIN: So in this particular case, again, we don't have the City before us as a potential Discharger. You could --

MS. ABE-KOGA: For --

MS. AUSTIN: -- analysis, but the question before us is whether or not the landowner, then, had the requisite knowledge of an activity occurring at this site that is known to have a hazardous chemical involved.

MS. ABE=KOGA: Okay, so the pure fact that it was a dry cleaning business and you're saying that there was knowledge, or there should have been knowledge, that the potential danger was going to occur?

MS. AUSTIN: So luckily for us, the State

Board has evaluated this, too, there's another Order, it's the matter of Harold and Joyce Logsdon, and this is State Board Order 846. And this is actually a case that was involving a wood treating facility where there's chemicals being used, and so there's some interesting language on this concerning the use of hazardous waste and they basically say that, given the hazardous nature of the waste, the discharges are presumed dangerous. So you're sort of making that leap -- in other words, they are basically imputing knowledge to if you know that the chemical is being used, you kind of also know that bad things could happen -- I'm paraphrasing, quite obviously.

MS. ABE-KOGA: So then, flipping that, the only way to have stopped this or to prevent the responsibility based on Code would be to just have not allowed that operation.

MS. AUSTIN: So the analysis that is in quite a few Board Orders, State Board Orders, and this pertains to former landowners, former Lessors, also current landowners and Lessors, they go through the analysis of did your lease have control over the site? In other words, could you say what types of activities are permitted or not permitted on the site? Is there a right to inspect the site? Do you have a right of entry? And many leases also have the provision that you are required to not create a nuisance and you are required to abide by State, Federal and local laws. And so based upon those criteria, many State Board Orders then find that Lessors or landowners had control of the site, had the ability to enter the site to investigate to see what was going on, and ultimately had the right to control the activities that were going on there, a kind of precedent that is referred to in the packet that you have today.

MS. ABE-KOGA: So --

MS. WON: And if I may, sorry, on that point there is a Master Lease between United Artists in 1975 when they sold the property and then --

MS. ABE-KOGA: Released it back.

MS. WON: Yeah, leased it back, so it was a sale leaseback situation, and under that Master Lease it calls for United Artists to comply with all laws and also to cause compliance with all laws, including its tenants, such as dry cleaner operators. So we do have that requisite control over what goes on at the property.

MS. ABE-KOGA: So then, in terms of when this was detected, was it 2009 that --

MS. WON: We found out about it in 2009, correct.

MS. ABE-KOGA: So how was that triggered, like what caused -- did we go in to inspect for some reason or --

MS. WON: There are thousands of properties -- I mean sites. I am sure Nathan can answer how we found out about this site.

MR. KING: This site came to us voluntarily -- they came to us, the current landowner, and provided us with this information that requested that we were the regulatory agency and based on the contamination that they presented to us from the site, we accepted it into our Cost Recovery Program.

MS. ABE-KOGA: So no knowledge, really, until then?

MR. KING: We had no knowledge until the current landowner came to us with the results of the site investigations that were conducted.

MR. HILL: And this is Stephen Hill, if I can add on to that. Most of the cases that come in the front door these days are because somebody comes to us, they need a loan, they want to sell the property and a lender or buyer says, "We don't want it until you show us that everything is okay." So if they're aware of a problem, they want to have some oversight.

VICE CHAIR YOUNG: The -- to newer Board members, can you just say a sentence about the Cost Recovery Program?

MR. HILL: Okay, sure. In an effort to reduce our use of General Funds, the Water Board has set up what's called a Cost Recovery Program, so if someone wants oversight from us, or if we're requiring cleanup, we enter into a Cost Recovery Agreement and then our oversight costs are reimbursed by the Discharger.

MS. ABE-KOGA: Okay, so --

VICE CHAIR YOUNG: It's the Regional Board recovering costs, not some kind of cleanup money.

MS. ABE-KOGA: So the trigger is just if someone is trying to sell their land and they need to get through the environmental cleanup, clearance, and whatnot, then they'll come and --

MR. HILL: That's correct.

MS. ABE-KOGA: Okay. So we don't have some kind of mechanism to, you know, on some kind of schedule be checking in to see if any of the things are being done correctly. Okay, thanks.

VICE CHAIR YOUNG: Newsha.

MS. AJAMI: I guess actually Margaret asked a couple of my questions, but one thing that I have been trying to figure out is how long these wells have been monitored because Santa Clara uses a lot of groundwater to meet their water supply, and I'm assuming they have monitored -- because I see a lot of like back and forth on when the contamination, you know, and the water and that kind of goes back with the fact of how long this has been monitored, and was this specific contaminant has been on the list of things that they have been monitoring for. I wonder maybe that will clarify some of these issues in the sense of, you know, obviously modeling is a way to do it, but I assume they have some monitoring on these wells.

MR. HILL: Should I answer that question?

MR. KING: Go ahead, Steve.

MR. HILL: If you know.

MR. KING: This is Nathan King with the

Toxics Division, Cleanup staff. The assumption that we're making is that they are collecting -- I don't have the monitoring data from those wells, the deep wells, that's the short answer. Because those wells are still producing and water is being used from those wells, I'm assuming that any concentrations, if it was even detected in those wells, are below the drinking water standards. If that was not the case and there were concentrations of any chemical above the drinking water standard in that well, I'm fairly certain they would take that well off line, so to speak, they would not use that well for drinking water purposes. You also have to remember that these deep production wells are very deep and they will just from that fact alone, the screened intervals where they're pulling water from, they will dilute any low concentrations of contamination that enters into the well.

MS. AJAMI: So, in a way, the answer is under the monitoring system that they had, this was not at a level that will be detected, at least for those wells that are around that area?

MR. KING: That's the assumption. The wells are still active and I know that the oldest well was put in in 1955.

MS. AJAMI: Okay.

MR. WOLFE: And let me, on behalf of the Advisory Team -- Bruce Wolfe for the record -- having headed up the Board's Well Investigation Program, I'm quite familiar with this, that in any municipal well that supplies more than 200 connections, they're required by the Department of Public Health to regularly monitor. And based on our involvement with the Santa Clara Valley Water District, there were some wells in South San Jose that detected levels of organic chemicals at such high levels that those wells had to be closed; however, there were additional wells that had hits, not high enough that they were in excess of a level that would require them to be closed, but there were various wells within Santa Clara Valley Water District's system that had hits, and these wells never showed any hits during the time I headed that program in the '80s.

MS. AJAMI: So I assume that somehow this was, I mean, again, I think we talked about this, but through some sort of like problem, this showed up on someone's radar.

MR. WOLFE: And the Moonlight party may

touch on this, but from the findings in the Tentative Order, it says that PCE was first detected in 2004, and so they may during their presentation elaborate on that.

MS. AJAMI: Elaborate on that, okay.

VICE CHAIR YOUNG: All right, we have representatives from Moonlight and from the United Artists. I may massacre this because it's very interesting handwriting -- we have Scott Reisch who is with Hogan Lovells?

MR. REISCH: Right.

VICE CHAIR YOUNG: Okay. And we have Carey Peabody who is Vice President of -- I'm sorry -- Erler and Kalinowski. I don't think you had these cards -- speaking to our Recorder -- when we last checked, so we're going to give you two the opportunity to present and I understand that we've allotted 30 minutes?

MR. WOLFE: Correct.

VICE CHAIR YOUNG: And at that point, we'll do -- after your presentation and the associated questions, we'll do a time check and figure out when and where we should have a break.

MR. WOLFE: And do recognize, we also have parties from Moonlight Associates.

VICE CHAIR YOUNG: Yes, absolutely. We have two representatives from Moonlight Associates who also will be allotted 30 minutes.

MR. WOLFE: Okay.

VICE CHAIR YOUNG: So just to give everybody a little heads up on where we're going with the timing. But let's -- you've got a timer, okay. And when you start, if you could state your name and the affiliation and swearing the oath, yes. Thank you.

MR. REISCH: My name is Scott Reisch. I'm an attorney with Hogan Lovells and I'm representing United Artists Theatre Circuit, and I have taken the oath. With me is Carey Peabody. Do you want to say that you've taken the oath and introduce yourself real quick?

MS. PEABODY: I'm with Erler and Kalinowski and I've also taken the oath.

MR. REISCH: And we're going to respond to a lot of what you've just heard. I want to say at the outset that there isn't any disagreement that there is an issue here that needs to be remediated. The issue is whether or not the theatre operator should be named as a discharger.

And I thought it would be useful to get

the statute right up on the board so everyone can see. This isn't a statute that makes a prior landowner liable simply for being a prior landowner, it says that the Board may issue an order to a party that has caused or permitted the discharge. And similar to what you saw in Nathan King's slide, there's been some discussion in the law as to what it means to permit a discharge, there's no allegation here that the theatre operator caused anything. So we're talking about what does it mean to permit a discharge, most of (indiscernible) are very similar to what you saw from Nathan, except number 2, but we're going to talk first -- I'll let Carey talk about the ownership possession during discharge issue and then I'll come back and talk about this disputed standard, about what the knowledge standard really is, and then talk about the legal liability, ability to prevent the discharging, and touch on the bankruptcy. So, Carey, why don't you take over and walk them through the technical piece. Thank you.

MS. PEABODY: Thank you. So obviously the key issue here is the timing of the release that we've been hearing about this morning and what we want to show is that there was a change in groundwater flow direction at the site that allows us to determine that the PCE release happened well after 1978. The staff in its package that was provided to us last week presents several counter-arguments and we would like to go through those and show that those arguments really are not supported by the data. There's sort of an inconsistent local groundwater flow theory that's presented, and they also talk about this idea of -- we call it the sort of suspended PCE theory, in other words, that the PCE was released and it was somehow bound up in sediments and didn't sort of make itself revealed in a groundwater plume until decades after the release. And then finally, we want to address the staff's conclusion that sewer leaks were not a primary source of contamination at the site.

So just quickly again, the site as you can see is located very close to Saratoga Creek and therefore the Creek would provide a strong influence on groundwater conditions at the site. Fundamentally, as you know, groundwater elevations and flow directions can change over time and, when groundwater elevations at the site are below

Saratoga Creek, you get flow to the northwest, generally to the northwest. And then, when groundwater elevations at the site are above Saratoga Creek, you get flow from the groundwater table towards the creek, and you get a northeasterly -- you would get a northeasterly plume had there been a release at that time.

So what I'm going to show you is that groundwater flow shifted from generally northwesterly to northeasterly in around 1993. The site has a northeasterly plume, not a northwesterly plume, so the contamination must have reached groundwater after 1993. And as was mentioned earlier, we did calculations to evaluate if there had been a release of PCE in wastewater, how long would it take to get to groundwater, and we used site specific parameters, you know, reasonable assumptions, and we concluded that it would take on the order of six years for contaminated water to reach the groundwater table.

So just to put a picture to what I've just been saying, on the left side is the pre-1993 sort of schematic where the Saratoga Creek is full and groundwater is a losing condition, groundwater is flowing in a northwesterly trajectory past the site, so if there had been a release at that time, you'd see a plume that would have generally a northwesterly trajectory.

Conversely, on the right-hand side, the conditions post-1993, it's just the opposite, the basin at this point has been completely recharged, and we would expect based on the groundwater flow direction to the northeast that we would see a plume with a northeasterly trajectory.

And what do we currently have? On the right-hand side, it looks a little dim from here, but you can see an outline of the current plumes. There's actually two plumes that we have been able to identify when you look a little more closely at the data than what was presented earlier.

So when we look at the information that has been provided in the various correspondence, basically there's general agreement that there was a shift from northwest to northeast in the early 1990's. West, the consultant for Moonlight, in its 2011 Site Investigation Report, points out that groundwater varied from toward the northwest when surface water exfiltrated from Saratoga Creek, and then as the groundwater elevations rose, the groundwater flow shifted to the northeast.

MR. MCGRATH: I need to ask a question at this point. Are you assuming that with flow in the creek and an alluvium that flow would disperse and would disperse by gravity --

MS. PEABODY: There's a connection --

MR. MCGRATH: -- to the west and to the north? Or is there a line of evidence in terms of the soil geology that you want to present, as well? Is this just an assumption that, with some level of water in the creek, it's going to diffuse, as well as go down?

MS. PEABODY: Well, there is, yeah, connection between the creek, the bottom of the creek, and the surrounding groundwater table. And we see this -- we actually see data -- evidence for this from data for a Shell station that I think Nathan referenced earlier briefly.

MR. MCGRATH: Well, there's reference to a Shell station on the other side of the creek --

MS. PEABODY: That's right.

MR. MCGRATH: But I'm asking you, is there groundwater monitoring data that you have depth to groundwater? Or is this an assumption that, with some water in the creek, some of this can infiltrate?

MS. PEABODY: Well, we have elevation data for the creek, we have elevation data for the surrounding wells, and we can see a gradient that shows that it is connected. So --

MR. MCGRATH: These are different wells than the three that were sited?

MS. PEABODY: Yes. As Nathan said, the three wells that he's talking about, I think he said they are deep production wells that are very deep, so we're really talking about kind of apples and oranges. The wells that had been installed at the site, at maximum, go down about 50 feet, and these deep production wells that Nathan referred to, again, we haven't gotten the information yet from Santa Clara Valley Water District, but I believe they are hundreds of feet deep.

MR. MCGRATH: Can you point out the location of the water surface wells that you're relying on here?

MS. PEABODY: Can I show you in a minute on a slide?

MR. MCGRATH: Okay, yeah. I'm just trying to focus the testimony.

VICE CHAIR YOUNG: I'm sorry, I need to

also ask a question and I think it's similar to what Jim just asked. You're assuming that the flow in the creek, and at this point I think there was something in our packet, but I don't actually remember, how much flow goes through this creek and whether it's a perineum stream or not. But you're saying the flow in the creek actually would have picked up and moved any plume, had it existed at the time because --

MS. PEABODY: No --

VICE CHAIR YOUNG: -- groundwater flow, as far as the data we have, is kind of irrelevant because the plume would not have intersected groundwater yet, so it's only the -- the deep groundwater, it's only the groundwater that is seeping out of the creek, and so we need to kind of know what the geometry of that and what the amount of seepage from the creek would be. Am I --

MS. PEABODY: Well, this is --

VICE CHAIR YOUNG: -- characterizing this understandably?

MS. PEABODY: -- our understanding of the post-1993 condition and sort of the condition in the late '70s and '80s, not the early '60s when the groundwater table was extraordinarily low. And again, to rely on data from deep production wells and to argue that the data from those deep wells are representative of the groundwater elevations much shallower in this aquifer, I would question whether that is defendable to do that -- particularly inasmuch as there's an aquitard that separates this shallow groundwater from these deep production wells.

VICE CHAIR YOUNG: And what is the elevation of the aquitard? Do you know?

MS. PEABODYP: I believe it's 100 feet or so below ground surface. And it's minimally 20 feet thick and greater.

VICE CHAIR YOUNG: All right, thank you.

MS. PEABODY: So again, West has written that there was this shift at the site from northwest to northeast, and even the Board last week in its package indicates that there was a shift in the early '90s. They claim it was a northerly regional gradient that shifted to northeast near the creek as is seen today. So, you know, we can quibble a little bit about whether it shifted from north to northeast, or northwest to northeast, but generally speaking, you know, everybody seems to agree that there was a shift. And when we look at this plume, and you can see here I've gotten more detail than what was shown to you earlier, there's really sort of two parts to it. There's this main plume, and then a subsidiary plume that happens to be underneath sewers. And when we look to the north, we don't see any significant concentrations of PCE in groundwater, even to the north or to the northwest. In fact, the concentrations are on orders of magnitude lower than what's in this northeast trending plume. So from this, we conclude that what you see is what you get, it was a post-1993 time period at which the contaminants hit the groundwater table, it was flowing to the northeast, since everybody agrees.

Now, the Board has said, wait, hold on, you know, there's data from this Chevron station over here that says it's a lot more complicated than that. There's been a lot of changes in groundwater flow direction over time. So we took a look at that, and this is -- my paraphrase was basically of this comment that came out of their staff report: "There's uncertainty regarding the groundwater flow direction." And this was, again, a new theory that was just presented for the first time last week. And we look at the data from the Chevron station, we see that the conclusions are based on one clearly anomalous data point, and also relying on the interpretation of the Chevron consultant. So the Board points to this particular table that, as you can see, shows groundwater flow directions for the Chevron site, which they basically are inferring would be representative of the area around the Moonlight site. And you can see in 1990 and half of '91, there seem to be pretty consistent southwestern gradient, and then it started flipping around after that.

So looking at that, you know, you think, wow, maybe it really is more complicated than a shift from north northwest to northeast. So we plotted the data, the underlying data, rather than just relying on the interpretation of Chevron's consultant, and what we saw is that there's one well, in particular, C1, that seems to be very anomalous in its behavior, it's sort of stuck at 50 feet above mean sea level for a couple of years, and it's only after two and a half years that it seems to get sort of picked up with the rising groundwater elevation in that area. Now, I just want to point out that, for the first year and a half, there were only three wells at the site, C1, C2, and C3.

So here is their piezometric surface map, this is a groundwater elevation map from 1991, and you can see that the consultant has concluded that there is a westward groundwater flow direction. And this is the information that you saw tabulated in that earlier table. Well, when you really look closely at the data, you see that, in fact, you could calculate gradients going off in all sorts of directions because this C1 location is five feet higher than all these other surrounding wells and, in fact, over here at Kieley Blvd. you would predict a flow going back the other way. So clearly, to say that this data represents a westward flow direction just, you know, doesn't make sense.

Again, in the early days there were only three wells, C1, C2, and C3, so based on those you would predict a southwest groundwater flow direction, but clearly once these additional wells were installed, it became clear that that southwestward gradient was not real. And the

Board uses that early '90s southwestern gradient in its argument to basically defend the city sewer potential release mechanism, and I'll get back to that shortly.

So clearly, this is just a suggestion from a manual of field hydrology to look carefully at bulls eyes, you know, unusual data, to make sure that it's real.

So here, in its' conclusion, this part, Well C1, those groundwater elevations are again like five feet higher than the surrounding wells forming a mound, and for almost three years they were stuck at around 50 feet above mean sea level, clearly anomalous, clearly relying on data from only Well C1, C2 and C3, and concluding that there is a southwest gradient in the early 1990's is an error.

There is a suggestion in the Chevron report that these different flow directions were caused by deep production wells, but there's no evidence for that presented in that report. And then if you take away the C1 data point and calculate gradients, what we found is that they generally trend north or northwest. But bottom line is that there's no evidence for a local southwest gradient at the former Chevron station, much less the Moonlight site. So the data from Chevron don't demonstrate that it's more complicated than essentially a north northwest to northeast shift --

MS. AJAMI: Can I ask you a question?

MS. PEABODY: Sure.

MS. AJAMI: So the groundwater contamination came when the groundwater met the soil contamination, right? The groundwater contamination was caused by the soil contamination first, right? The soil was contaminated and eventually leached to groundwater?

MS. PEABODY: It could be that way, there are a couple of mechanisms, and I talk about those in a minute if --

MS. AJAMI: My question is, you know, the groundwater level was so low during the period that soil contamination was happening that it might not have had enough chance to get to that point, right? So I'm wondering like, you know, maybe I'm not getting some of this, but I'm trying to wonder, okay, your point well taken, it's a north, you know, west plume, but if the groundwater is not really getting the contamination, it doesn't matter which direction it's going because contamination is not going with groundwater anyway. When you start hitting the contamination, that is when we really care which direction groundwater is going, and I guess based on what you have just presented, that's about the time that the groundwater gradient started being north --

MS. PEABODY: The data that we've relied on indicates that, by the late 70's, the groundwater table was in fact much shallower than what the Board has presented. The Board is relying on, again, data for wells that are in a completely different aquifer --

MR. MCGRATH: We're looking for that data, what you've got up there is data only from 1993 and '94 when we all know that it's 13 years after the year in question, and we all know the groundwater was rising because of recharge. So where's this mysterious data from 1976 through 1990? That's the data I'm looking for.

MS. PEABODY: Well, the pre-1993 data is described in our report that was provided to the Board I think about six months ago --

MS. AJAMI: And that's data from?

MS. PEABODY: And that's data from a Shell station. It's on the opposite side of the creek, but about the same distance as Moonlight is from the creek, and that data clearly shows that there was a shift in groundwater flow. The groundwater was not ultra deep and we see the shift over there, and that allows us to conclude that the same thing happened on our side of the creek.

MS. AJAMI: But the one that you are just showing, the shift happened around the same time, the '93-'94, right?

MS. PEABODY: Right, so we see it on both sides of the creek.

MS. AJAMI: So do you have the groundwater level from that Shell station that we can look at?

MS. PEABODY: It's in our report. I don't have it as part of this presentation, you know, we only have a limited amount of time and we're trying to respond to the new theories that were just raised last week.

VICE CHAIR YOUNG: All right, let's move on with the presentation. Margaret is -- she's on and offing the timer as we go through questions, so….

MS. PEABODY: Okay. So finally, the argument has been raised that PCE could have been bound up for years to decades in the soil immediately beneath the concrete slab and above any sewer lines. So, when we look at the data for groundwater, we see that it's relatively low concentrations when compared to the one percent maximum solubility in water of this particular DNAPLE PCE. Our conclusion from that is that it's most likely a wastewater -- PCE dissolved in water release. And what we, as I said earlier, we did calculations using site-specific data, reasonable assumptions, and concluded that it would take six years to reach groundwater, which at that groundwater elevation was about 50 feet below ground surface. And we believe that that's consistent with the groundwater elevation in the late '70s.

Alternatively, free product DNAPLE could have been released, it hasn't been detected at the site, but let's say it had been released, DNAPLE is not a very viscous material. This DNAPLE has an extremely low viscosity and would move, in fact, faster than water going down under gravity.

It can move faster than the dissolved PCE case. Furthermore, as I think it was raised earlier, you know, pure phase solvent that gets discharged to the ground immediately starts to volatilize.

So here are some of the observations that have been made over the years based on a lot of different studies --

VICE CHAIR YOUNG: May I interrupt with a question going back to your model calculation that it would take six years, you say, that dissolved PCE would take six years to reach groundwater at 50 feet below the surface, so the dissolved PCE is coming in the liquid that's being spilled with the PCE? Is that your assumption?

MS. PEABODY: Yes. Our conceptual model for that particular calculation is that there was wastewater in a sewer, that wastewater contained PCE, and it was discharged from the sewer line, and then made its way vertically down to the groundwater table.

VICE CHAIR YOUNG: All right, so to derive your six year figure, you were assuming quite a quantity of water because you were assuming that it was coming from sewer leakage, not just from the amount of water or the amount of liquid that might have accompanied the PCE as it went through a concrete slab. Correct?

MS. PEABODY: Right, that was not the concrete slab scenario, that's right.

VICE CHAIR YOUNG: All right. Thank you.

MS. PEABODY: So just getting back to this slide, there are studies by Paulson and Cooper that show that small DNAPLE releases on the order of only a few gallons have the potential to penetrate to depths of many feet below ground surface within hours or days. In addition, some DNAPLE will volatilize and, again, the modeling studies and field studies have shown that contaminated vapors diffuse tens of yards or more from a DNAPLE source in the in (indiscernible) within a period of weeks to months. So these are rapid processes and so it's hard to imagine that PCE could have been bound up for decades and not be revealed either through DNAPLE migration or volatilization of a plume, which itself can then contaminate groundwater.

So finally, the staff has concluded that sewer leaks were not a primary source of contamination at the site, and they make an argument in this most recent package that you can explain this secondary plume down to the south, which is underneath sewer lines, by saying, well, there could have been -- you remember that southwest gradient I spent quite a bit of time talking about over here that turned out to be not real, well, that southwest gradient could have somehow pulled some contamination off from the main plume and then, when the groundwater shift occurred, it shifted this contamination back to the northeast, and that's why you see this contamination here underneath the sewers. And our view is that a much simpler explanation for why there are these elevated concentrations under the sewers is that the sewers themselves leaked.

MR. MCGRATH: What's the direction of the flow of the sewer line?

MS. PEABODY: It goes -- yeah.

MR. MCGRATH: So an alternative explanation could well have been DNAPLE that intersected a leak in the sewer line or direct discharge to the sewer line, the fact of one doesn't belie the fact of the other. So let me make my reasoning clear on the record, there's evidence in the exhibit that shows a secondary plume of fairly high concentration, along with the sewer line, it does appear to be -- it's clearly down gradient from the dry cleaner, so it's not precluded that that could have been a discharge into the sewer line that then came out at another mechanism; in other words, the presence of a second plume doesn't belie the origin of the first plume, they could be separate mechanisms, which was made very clear in the staff recommendation, and I think is very clear here. It's interesting information and I think evidence of exfiltration from the sewer line, but a sloppy operation didn't cause (ph) the spill into the sewer line, I guess it depended on how diluted it got before it got out of the sewer line.

MS. PEABODY: Well, I think the distinction, though, is that I think what the Board is saying is that there might have been some releases out of a sewer lateral that would have been controlled by the property owner, as distinct from a City sewer line, which is what we're looking at here.

MR. MCGRATH: But if that sewer line is down-gradient from the dry cleaner, so a discharge from the dry cleaner into their sewer line because of a cross connection because they used the sewer line to dispose of some materials, would have gone in that direction. And if there was a hole in the sewer line, if it was pretty tight up to that point, that would be your source, correct? Am I missing something here?

MR. REISCH: Well, and there is actually a picture of the sewer line. I think you're saying that the sewer could have leaked and that's what we're saying. I think the Board staff's position is that it was only the lateral that leaked, the sewer itself was not a primary source, so to the extent you're saying that you think the sewer might have leaked, that's what we're saying too. And that's a video taken of the sewer line.

MR. MCGRATH: But the question is where the contaminants got into the sewer line up-gradient.

VICE CHAIR YOUNG: If I understand Jim's reasoning and, Jim, I'm just checking on this, that you're saying even if it did leak out of the sewer, the original source could well have been the dry cleaners, and so it really doesn't matter.

MR. MCGRATH: I can't imagine it being any other source because you've got diffusion over time with any kind of flow phenomenon; you look for the closest source if you've got something as high as this plume. It can't come from far afield, it had to come from near field.

MR. REISCH: Just to be clear, that's what we're saying, too. We're not saying it wasn't the dry cleaner, we're saying the dry cleaner wastewater leaked just below where you see that second plume.

VICE CHAIR YOUNG: All right, I just want to make you aware that we're not subtracting -- our question time is not subtracting from your time, but your time is still waning.

MR. REISCH: Oh, okay. How much time? Ten minutes, okay. Well, I'll pick up. I'm going to go back to the legal issues; I think Carey has hit the technical issues. And the first one is this knowledge question, and the key -- you heard -- I think the staff argued two different points, one is that the theatre operator had actual knowledge of the activity and also that there was constructive knowledge. And I'll get to this very important distinction between knowledge of the activity versus knowledge of the discharge, which is really fundamental.

But in terms of the permit that they rely on in the Wastewater Regulation, you know, if you look at both of them, and I encourage you to do so, neither of them talks about groundwater contamination. The Fire Marshal was concerned about fires, you know, obviously, and there is discussion of vapors and things like that, but there's nothing about that Fire Marshal Permit that would put anybody on notice that there was a risk of groundwater contamination. And similarly, the fact that there was a wastewater regulation, and you kind of have to work your way through it to see that it prohibits the discharge of chlorinated solvents the way it was described, but once you do that, if you do that you still have a wastewater regulation that's telling you what can go to a POTW, presumably for the protection of the POTW. I don't think that puts you on any notice that there was a risk of groundwater contamination. And it certainly didn't in this case.

The other issue that they claim is, well, maybe there wasn't actual knowledge, maybe it was constructive knowledge, and here I think you have to cast yourself back to the '60s because what you knew or should have known depends upon the timeframe, and we heard earlier today that there were things that we know are of concern today that we didn't know about yesterday. We heard about thermometers may be our concern and things like that. Well, what was the constructive knowledge of a theatre operator in the 1960's, what did they know or should they have known about a dry cleaner? Well, when you look at just the public record, you see that the Board's first case against a dry cleaner was in the late '80s, there's maybe a mention that the dry cleaners became known as sources of contamination in the mid-'80s, you know, for the first time, so when it became a commonly known hazard it would presumably be after that. But it was not well known in the '60s that dry cleaners were at risk of groundwater contamination, and certainly if it wasn't well known to the regulators, it wasn't well known to the theatre operator.

Somebody asked before, I think one of the Board members asked about, well, what should the landlord have done? And you look at the cases and you see what they say is you're constructive knowledge depends upon what would have been a reasonable investigation at the time period.

There's even a case that talks about what kind of investigation you do of gas stations and things like that, and they say it really depends upon the time. So in the '60s and '70s, what would a reasonable investigation have been? Well, I can tell you that people were not doing subsurface investigations of dry cleaners in the '60s and '70s, and if the landlord had reason, and I don't think they did, but if they had had reason to conduct a physical inspection, they might have seen colorless PCE? No, I don't think so. They wouldn't have seen cracks, subsurface cracks in the concrete. They wouldn't have seen leaking sewers through an inspection. So when you look at constructive knowledge, those are the things that you have to look at, and again, based on the timeframe we're talking about, that's not what a reasonable inspection would have been, and that's not the kind of knowledge that a theatre operator would have had. And here's really the key. You heard reference to the Stuart case and the Logsdon case, and I want to talk about both of them and actually look at what they actually say.

Stuart Petroleum is about a company that is a gas station, an oil company, Stuart Petroleum that leases property, subleases property through a gas station operator, and what the Board actually said was that Stuart Petroleum was liable because problems of leaking underground tanks have become common knowledge, particularly in the oil industry. So that's what the Board relied on. Someone in the same industry, and what was common knowledge, was this problem of leaking tanks. They didn't say a Lessor is liable just for a leak in the gas station, which is what is at issue here, you know, that the theatre operator is liable just because it leased to a dry cleaner. They looked further and they said, oh, no, we think there's constructive knowledge here because at this time in the mid-'80s, we know that leaking underground storage tanks were our problem, so it's knowledge of the condition, the risk of groundwater contamination, not just knowledge of a gas station or a dry cleaner. And I think the Logsdon case, I'm going to find it for you, says something very similar and I'm going to read it to you, the issues thus become whether Petitioners as landlords had one actual knowledge of the dangerous condition, and an opportunity to obviate it. And guess what? In that case the landlord was in the same business as the tenant, wood treatment, his agent had received notice from the Regional Water Quality Board of contamination issues. So to cite these cases and say, well, you know, they're precedent for this, they're not. They're precedent for the opposite, which is that you have to have actual knowledge or constructive knowledge of the condition, and it's not enough just to say someone leased the property to a dry cleaner, and therefore they're liable. I think this is probably the fundamental -- on the law, at least, we'll get to the bankruptcy issue -- the fundamental dispute between the parties on the legal side.

We also site a couple cases or pieces that are along the same lines. These are a resolution shots (ph) case is a case that interpreted 13304 of the Water Code and the Nuisance law (ph) in the same way, and they said the Defendant must be aware of the specific dangerous condition, be able to do something about it before a liability will attach. The City of Stockton is the Nuisance case from the Ninth Circuit, you have to know or should know of the artificial condition and the nuisance. Again, not enough to know that there was a commercial activity there, you have to know of the risk of the nuisance.

We can mention on the third issue about control, you know, we don't have a copy of a lease here, this is years ago, we don't know that a lease even existed. If you look actually at the Hanson (ph) lease that was referenced earlier, it doesn't say that a lease existed, it said that the Tenant was going to provide copies of any leases to the landlord. Does that mean there was a lease or there wasn't a lease? I think it means they gave them what they had, I don't think we know. And we certainly don't know these things, that United Artists had the authority to enter the premises, terminate the lease, and remediate the contamination, which are what the Board's precedents say. And in both the cases we've talked about, particularly Logsdon, they look at the actual terms of the lease to decide this, we don't have that information here.

You heard reference to the bankruptcy, I'm not going to spend a lot of time on that because it's in our papers, but United Artists went through a bankruptcy in 2001. It's interesting for me to see that the Board is saying, well, under the legal theory they think applies, they say, well, you know, the Board couldn't have contemplated a claim back in 2001, we didn't know anything about the site. At the same time, they're saying, but you should have been on notice in 1961, or 1962 from this Fire Marshal Permit, you should have known that there was a contamination issue, but we didn't know, you know, decades later. I think that's a fundamental inconsistency.

So to wrap up, if my time allows my last slide, I think so, you know, what Carey presented is I think a data driven analysis about what actually happened at this site. You know, we can talk about studies, we can talk about what dry cleaners usually did, the question here is not whether this dry cleaner leaked, but when did it leak, and to the Board questions that we received, I want to make sure people understood the question. You know, there's no dispute that groundwater shifted. The question is, when did the PCE hit the groundwater? And I think one of the Board members was trying to say that. And I think what Carey was telling you was, no matter which form this release took, it if was a DNAPLE or a wastewater, it would not -- it would have hit quickly, a DNAPLE doesn't sit there suspended for decades waiting for groundwater flow to change. And so there's no evidence of that. Again, I talked about the (indiscernible) thing and I won't go through that. I do want to spend a moment on this expansion of landlord liability. You know, the precedent here I think is very important. You're looking at holding a landlord liable just for being a landlord and just for leasing to a dry cleaner, when we have cases that say it's not illegal to rent to a gas station, but now it's going to be a problem to lease to a dry cleaner and I think other activities. I think you're basically saying, you know, if there was a commercial use of the property, or industrial use, or an agricultural use, you know, the landlord could be liable because they're going to be charged with knowing about that. You know, we heard about thermometers earlier, I think now landlords have to say, oh, well, I guess doctors always use thermometers. You know, if it turns out that a thermometer is broken, that was swept into the drain, which I've seen has been an issue, you know, we figure that out four years later, we're going to go back and hold the landlord for the doctor's office responsible four years later? I think that's a very important issue here.

Last point, the case against my client, I think, is really unnecessary. What the Board is really doing is deploying its resources to help Moonlight Associates pay for this, which they're capable of doing on their own, and this is not a party that deserves your help. They leased the property to a dry cleaner during the modern environmental era, you know, during the '90s, they didn't do any testing until 2004, and this whole voluntary thing, I'm sorry, there's a statute that required them to report that contamination in 2004 that they didn't abide by, and they told you about it five years later. So they're not quite what was presented here. And they've never really been asked to tell us everything they knew about the site. They haven't been asked to provide a site history report, they weren't asked why they did the testing in 2004. They haven't been asked whether they knew about releases before that. We don't have any of that information because they haven't been asked by the staff.

And then, finally, we do think that Santa Clara should be here from what we saw earlier, there's an obvious release, you know, you've got this big hot spot right underneath the sewer, somehow this idea that the sewer lateral can leak, but the sewer itself a few feet away didn't, you know, I don't think that's really believable. So that's my presentation. I'm happy to take any questions that Board members have.

VICE CHAIR YOUNG: Right. Do we have additional questions at this point?

MS. AJAMI: I just want to make a comment. You know, I understand some of the legal issues you present. Modeling is modeling, you know, there are so many assumption that go to your modeling that we really don't know what they are, like the fact of how much you're talking about the PCE dissolved which, you know, there's no evidence that there was wastewater leakage there. My point is, you know, the argument that there was leakage and then it took the PCE and took it to the groundwater, and all the other assumption that are in your model, we don't have access to, we don't know what they are, and that can very much impact what results comes out of your model, and the same as Board's model --

MR. REISCH: I don't think they run a model, but can I address that point because I think you mentioned it earlier, and I don't know that we answered it fully, and I think it's a really important point. First of all, in terms of our model, you know, we provided all those calculations to the Board. We haven't heard boo that any of our assumptions were wrong. Their point is not -- I think their point is, hey, it would have just hung up there, and what Carey has told you is that's not the way DNAPLE works. So there's two theories, right, there's the DNAPLE theory and there's the wastewater theory. It just doesn't really matter which one you pick because you get the same answer. If it was a DNAPLE, if it spilled on the surface which is a product kind of thing, it wouldn't stay there forever. If it made it through concrete, it's going to go down to the groundwater or it's going to vaporize and then that's going to go down to the groundwater. If it was a wastewater, we did the model, they haven't criticized any aspect of the calculations. And if it's going to take six years for a wastewater, we know that a DNAPLE moves faster. So I think you can get there if you're following everything I just said, that the model is valid, it hasn't been criticized, and when you look at a DNAPLE and compare it, you know the DNAPLE is going to be faster. So it doesn't matter which of the mechanisms, we have looked at both mechanisms, and either way we're not going to have this magic DNAPLE that sits up there and waits for 20 years, that's not the way DNAPLE works.

VICE CHAIR YOUNG: Thank you for your presentation.

MR. REISCH: Thank you. Thank you very much.

MS. PEABODY: Thank you.

VICE CHAIR YOUNG: The next thing we will be moving on to is a presentation from Moonlight Associates, and I wonder if it's your recommendation that we go ahead and do that, or that we take a break for everyone to have lunch first?

MR. WOLFE: Lunches have arrived, so it depends on the level of angst in your stomach, but on one hand, if we do have lunch, that seems to be an appropriate time to do our Closed Session; on the other hand, that would sort of break up the flow. You've just gotten two of three presentations, and it may be appropriate to hear the third presentation and resolve that.

VICE CHAIR YOUNG: Well, our humming bird -- are they okay? Go ahead?

MR. MCGRATH: For another 45 minutes? I have to take at least five.

MR. WOLFE: I think maybe the old men in the crowd may need to take a little break here.

VICE CHAIR YOUNG: Let's take a five-minute break and then we'll try to come back so that we can hear everyone sort of all at once.

(Break at 12:42 p.m.)

(Reconvene at 12:52 p.m.)

VICE CHAIR YOUNG: We are now going to hear from Moonlight representatives, Lori Gualco and Peter Krasnoff.

MS. GUALCO: Good afternoon, Madam Chair -- or Vice Chair -- and members of the Board. My name is Lori Gualco. I am the attorney for Moonlight Associates, LLC and I will be presenting today along with Peter Krasnoff of West Environmental, who is an Environmental Consultant, who has been working with Moonlight Associates during -- not starting in 2009, but shortly thereafter. And I will say that Moonlight Associates, LLC is a part of the voluntary cleanup program, they have been working out at the site since 2009, conducting a number of investigations, and they have also installed the system which is addressing the soil vapor at the site, to make certain that the occupants are in a safe environment out there. It is our hope that our presentation will answer questions that have been raised thus far by the Board and will provide you with factual information regarding the site, and the legal basis for naming United Artists in this Order, as well as the environmental information and data that has been developed at the site, and through extensive and thorough reviews of documents regarding groundwater, soil, etc.

I'm going to start with our first slide, which I noted Mr. King also used in his slide presentation. I think we both liked it because whatever happened to Baby Jane is up on the marquis, and that is still a cool classic, I will say, and this is a photo from the 1960's, and I still like that movie and I still love those two actresses.

So UATC should be named as a Discharger, that's why we are here today. The RWQCB Order is not barred by the UATC bankruptcy, they entered bankruptcy in approximately 2000, and a Bankruptcy Confirmation Order was entered in January of 2001. UATC as the owner and Master Lessor permitted the discharge of PCE. The only documentation we have of the leases, unfortunately, is the Master Lease. Now, UATC has made a representation that they destroyed documentation regarding their site, it was their company policy in 2006, so that's one reason we don't have those leases. But if we examine the Master Lease, it provided UATC control over subleases and those subleases included the dry cleaning tenants.

Now, having been a lawyer for 33 years, I can tell you that if you review the Master Lease, there is a very good chance that the leases that were in place during that time period in the '70s and before that in the 1960's included terms that were in the Master Lease because that's what people tend to do, use lawyers, large corporate entities use lawyers.

There was a reference to simply the theatre out at the site; in fact, UATC owned and operated the shopping center, there was a theatre there, and Mr. King, I was surprised to see this, he found something I didn't, I like that, but he also found that United Artists owned and operated the shopping center, and I believe it was Millbrae, California that also had a theatre, and also had a dry cleaning operation at that Millbrae location, so kudos to you on finding that.

UATC had knowledge of the dry cleaning activities through various written documents that we were able to obtain from the State Fire Marshal, and the County of Santa Clara Building Records. We know that Moonlight Cleaners operated at the site during the UATC tenure of 1961 to 1978. How do we know that? We know because there are recorded documents with the Santa Clara County Recorder's Office which have been submitted to the Regional Board, clearly showing that dry cleaners were operating during the entire time period that UATC was associated with the property either as an owner or as a Master Lessor. And I would add that the Master Lessor status of UATC after it sold the property in 1975 essentially mirrored the ownership status. They were responsible for the tenants, they were responsible for supervising them, collecting rents, etc.

And that brings up another important point that United Artists, or UATC, was in the stream of commerce with this property. When you operate a shopping center, you derive rents from operating that shopping center, and that's exactly why people do own real property, they hope to make income off of it, so they were in the stream of commerce doing this, and they then let the premises to various tenants, including the dry cleaner.

The issuance of an order to a former landowner, UATC, is consistent with SWRCB precedent for naming dischargers at sites. The order is not barred by bankruptcy. The UATC bankruptcy was filed in Delaware in the year 2000. Third Circuit law applies in Delaware, this is just standard law. The case of In Re Torwico Electronics, Inc. cited at 8 Fd 3rd 146 Third Circuit 1993, which precedes the filing of the bankruptcy, controls and is directly on point in this matter. That case found that a regulatory agency order does not constitute a claim and is therefore not barred. And a claim is a very important item in a bankruptcy because bankruptcy law essentially says that if you have the opportunity to make a claim, you should have made a claim and then the bankruptcy is resolved and those claims are discharged, and then it's essentially over. But what Torwico said was very very important. When a regulatory or governmental agency issues an order, that does not constitute a claim, and so therefore it is not barred by current or prior bankruptcy proceedings. In this particular case in Torwico, there were ongoing Chapter 11 bankruptcy proceedings and the government issued an order, did not make a claim in the bankruptcy, and the Court found that it was not barred.

There are some similarities here. Torwico was a former Lessee of the contaminated property in New Jersey. The New Jersey Department of Environmental Protection and Energy issued an order to clean up the property. The Court decided that the order did not constitute a claim because Torwico was ordered to clean up a hazardous waste site, which posed an ongoing hazard similar to what is occurring at our site, the former Moonlight Cleaner site. And because this cleanup obligation was not a claim, it was not subject to discharge in the bankruptcy.

So just to sum up, the RWQC has issued a Tentative Order to UATC for the investigation, cleanup and abatement of PCE contamination at the Moonlight site. The 2001 Bankruptcy Confirmation Order does not bar the issuance of the Order by the RWQCB to UATC.

Now, the next section I'm going to discuss is UATC as Owner and Master Lessor permitted the discharge of PCE. As I've discussed, UATC was the owner of the site from 1952 through 1975. It then became the Master Lessor at the site from 1975 through the end of 1978. And UATC as Owner and Master Lessor had lease agreements with the dry cleaner operators. In the Master Lease, it specifically references subleases in Sections 4.02, 18.01, 22.01, 23.05, and 23.06. Let's look at the Master Lease here. In section 4.02, it contains a direct reference to subleases with tenants, those tenants would include Moonlight Cleaners, as we know from the recorded documentation on file with the Santa Clara County Recorder's Office. In Section 18.01, and I quote it here, it says, "UATC…" -- and it's as the Master Lessor -- "…shall at its own cost and expense promptly comply with or cause compliance with all requirements of all statutes, laws, ordinances, orders, rules, regulations, and/or requirements of the Federal, State, County, and Municipal Authorities." And that's a direct quote. UATC had an obligation to cause compliance by the subtenants. These subtenants included Moonlight Cleaners and they had an obligation to cause compliance with nuisance law, it would have been included in the various areas outlined above.

In terms of knowledge of activities, I would refer you to what is Appendix F in the Board packet, and Appendix F contains some very important written documentation regarding knowledge of activities. The first one is the Application for the Building Permit, and this Application for Building Permit was issued to the Owner, recited as United California Theatre, and then an Agent of the Owner, the Contractor, signed that document. And underneath the signature line, it specifically says "Contractor, Agent." And this Building Permit is in the amount of $1,000.00. Now, there's been some talk, "It's only $1,000, what's $1,000?" Let's take ourselves back to 1961. A thousand dollars in 1961 was a lot of money. I didn't go online, I should have asked my son who is majoring in Economics in college, "Please figure this out for me, honey; what was $1,000 in 1961?" But I didn't do it. But I know that it was an awful lot of money because I'll bet you people were making like $6,000 or $7,000 or $8,000 or $10,000 back in 1961. And this was the owner of the property who takes out the Building Permit and it specifically is for Moonlight Cleaners at Moonlight Shopping Center.

The second piece of documentation that is important is the Certificate of Occupancy, and that Certificate of Occupancy once again is issued to United California Theatres, Inc., not Moonlight Cleaners, but the owner of the property. And they're talking about that it's ready for the occupancy.

And the third document in the Appendix F is the State Fire Marshal document. Now, this would have been a public record document, and this document is very important in terms of establishing what sort of activities were going to be associated with the dry cleaning equipment out there. And if you read this permit, it covers the installation of four specific pieces of equipment that only use PCE. The first one is the Hoffman Master Jet Cleaning Unit, which used PCE, the next is the Hoyt SF130 Reclaimer, which reclaimed PCE, sort of acted like kind of a dryer type system, but reclaimed it because you have to remember that PCE was expensive for dry cleaners, and so they were going to use that PCE again, so this equipment was trying to reclaim it. Unfortunately, it didn't reclaim all of it.

The next piece is the Precombo (ph) Filter Still Cooker which boiled the PCE, and the last piece is the Vapor Mat model 800 which captured the PCE vapors. What's important about this slide is, is that if you look at a recorded document in 1975 which was a security interest given by Mr. Reid (ph), who was the current dry cleaner, and the security interest was given to the Bank of America. It lists the same exact equipment that we are seeing here 14 years later and, in fact, they added equipment to it, so there is even additional dry cleaning equipment as of 1975 being used out of the site, and that shows continuous operation of that equipment at the dry cleaning site.

Now, I'd like to just take two moments

because I know our time is short, on the second page of the State Fire Marshal Permit, there is much language in here that shows the hazardous nature of PCE. I can tell you that the five and dime that was probably out there at that time didn't have anything like this. It says in number one that everything needs to take place in equipment approved for that purpose by the State Fire Marshal. Number two says it has to be a ventilated enclosure and that you have to be careful in the event a toxic concentration of vapor develops, they are calling that out because it was something to be very concerned about, and that doesn't just mean a fire hazard, that means it's a toxic concentration of vapor, and they want to protect people from that. Number three talks about automatically exhaust vapors to the ventilation duct provided. Number four talks about exhaust ducts that have to be on the exterior to the building. Well, of course, the owner has control over the exterior of any of the building there. Number five talks about if muck is removed, you have to have an approved breathing mask, well, that's pretty important in terms of what they were dealing with out there, obviously hazardous. And number six talks about there must be approved piping. And number seven says that there has to be a fan on and the dampers of the vapor mat must be open before the units can be put into operation. So this is a highly regulated activity that was going on out there.

I've been over most of this just now, and the one thing that I would just say is that this type of activity was heavily regulated, the State Fire Marshal was involved, and the owner of the property had a heavily regulated activity which was ongoing on the property that it owned and was a Lessor on.

I'm just going to catch up with my notes here if you'll just give me a moment. Moonlight Cleaners operated from 1961 to 1978, there was a Certificate for Limited Partnership for Moonlight Cleaners Dry Cleaning Plant which was recorded on October 11, 1961 for the Schroeders (ph) and Mr. Bettencourt (ph). There was a Certificate of Occupancy, as we know, that was recorded in 1962. And we have provided the Regional Board and also United Artists with copies of various documents that we found with the County Recorder's Office.

UATC permitted the discharge. The State

Water Resources Control Board has consistently taken the position that a landowner who has knowledge, or should have known of the activity taking place, and has the ability to control the activity, has permitted the discharge within the meaning of Water Code Section 13304, and that is also found in the Water Quality Order 8912 In Re San Diego Unified Port District. In that Port District case, there's a footnote that also refers to various Orders which are 89-1, 87-5, 87-6, 86-16, and 84-6, as well as the Atwater Memorandum that's dated May 8th of '87.

The staff cited the John Stuart case, which was discussed by the United Artists attorney, and in that case it asks the question, did Petitioner have the legal power to stop contamination? The answer in that decision was yes, because the lease provided Petitioner would comply with all statutes, laws, etc. That's identical to what we found in the Master Lease. The Order also said that the Petitioner had legal interests in the property and derived income from it, for example, economic benefit, and that the contractual position of Petitioner as Lessor and Sublessor of the service station gave him enough legal control over the property to hold him responsible for what took place.

UATC permitted or threatened to permit discharge of waste as the owner of Moonlight Shopping Center and as the Master Lessor. Water Code Section 13304 authorizes an Order against any person who has caused or permitted, causes or permits, or threatens to cause or permit any waste to be discharged into the Waters of the State and creates or threatens to create a condition of pollution or nuisance. In the Logsdon case, the question was asked, or Petitioner stated that they were not legally responsible for the acts of their Tenant, of which they had no knowledge, and that the Board answered in that Order and said a landlord knows, or is chargeable with the knowledge that waste was being discharged or placed where it could be discharged on the property, and knowledge of an agent is imputed to its principle by operation of law, even in situations where the knowledge was not, in fact, communicated. If the nature of the waste is hazardous, such discharge can be presumed hazardous, and that is in the In Re Logsdon Order No. WQ846, and it also cites Civil Code Sections

2330, 2332 and 2338. And we referred back in our case to the State Fire Marshal Permit, the Building Permit, and the Certificate of Occupancy.

UATC is properly named as a discharger under the Torwico case, it's not barred, the Master Lease demonstrates that UATC as the Owner and Master Lessor permitted the discharge of PCE because the Master Lease dictates that UATC caused compliance under all laws. Moonlight Cleaners operated there from '61 to '78. The State Fire Marshal Permit lists PCE using equipment at Moonlight and the hazards associated with that use, and the issuance of the Order to UATC as former Landowner is consistent with SWRCB precedent for naming dischargers at sites under Water Code Section 13304 and Water Quality Orders.

If you have any questions, I'd be happy to answer them, otherwise I'm going to turn it over to Mr. Krasnoff.

MR. KRASNOFF: Good afternoon, Vice Chair Young, members of the Board. My name is Peter Krasnoff. I'm with West Environmental and I have taken the oath. I'm here as a consultant to Moonlight Associates. I'm going to focus on a similar series of technical topics covered by

Nathan King earlier today and covered in the staff report.

Looking at the timing of the releases, and I think that some of the questions that got asked earlier today will hopefully be addressed through this presentation, there are multiple lines of evidence that there were releases during the 1960's and 1970's. We know that Moonlight, as Ms. Gualco explained, was a tenant from 1961 through the United Artists Theatre Circuit, or UATC's control of the property through 1978.

The equipment that was used, the dry cleaning equipment, used PCE. And I'll go through some additional support on that. There was a fair amount of discussion about the depth to groundwater and its relationship to the contamination, and there were lower groundwater elevations in the 1960's and '70s, and what we find, and that's consistent with an earlier release, is there's actually higher PCE concentrations at depth and, as the groundwater elevations rose in the Santa Clara Valley Basin, the concentrations actually got pulled up with the rising groundwater, which is very consistent with the line of evidence of an earlier release.

There's also been a discussion by the UATC consultant about the length of plume and the travel time. A review of the data shows that that line of evidence also shows that it was a pre-1978 release, and I'll discuss the groundwater flow direction and how that is also consistent with a pre-1978 release.

So the particular dry cleaning equipment used and released PCE, and we've discussed the 1961 Fire Department records, some of the particular equipment, the Hoffman Master Jet, the Hoyt SF130 Reclaimer, which is basically a dryer. I'll talk a little bit about the Precombo Filter Still because it plays a particular role in being a source of contamination, and the Vapor Model 800, which is further indication, if you will, that there were PCE vapors being released to the atmosphere, and those PCE vapors will permeate the concrete, we know this. We know that a lot of what we do in addressing dry cleaner sites now is we're trying to address the vapors that are coming up from soil gas. Well, that same phenomena works from inside the dry cleaner, down. And so you open up the bottle of ammonia in the room, the vapors go out, and the PCE, it's heavy, it sinks through the concrete as a vapor, contaminates soil, sort of like coming back into a hotel room after someone has smoked a cigarette, you know they were in there. There will continue to be releases years after the PCE dry cleaner operated.

We have documentation through 1975 confirming that this same equipment, now some 14 years older, and that's significant because this equipment does corrode, it does deteriorate, they used rubber hoses with PCE on this dry cleaning equipment, and that's important because these hoses, rubber hoses, are not compatible with PCE. And I've been involved in a number of dry cleaner matters over the years, and read enough depositions and talked to enough dry cleaner operators, and they're all going to tell you, "Yeah, the hoses dried out and cracked and we had releases." So we know that if you had a piece of dry cleaning equipment there for 14 years, and it was in contact with PCE, there were releases of PCE.

This is a copy of the 1975 document showing Moonlight Cleaners and the list of the same equipment being there 14 years later. So I'll back up a little bit on this dry clean process because that's sort of at the heart of the matter here. It is similar to the home washer dryer process, and particularly during this time period. We have a washing machine, and some of the dry cleaning equipment actually looked just like this, and then they had something called a Reclaimer. And that's basically a dryer. And as Nathan King explained earlier, when they were finished washing the clothes in the PCE, and the reason they used PCE is fairly obvious, it needed to be "a dry process" because you don't want to put your wool suit in hot water, it doesn't come out, you know, the same size you put it in. So it's very important that we're dealing with a special chemical here, PCE. And by the way, a very good dry cleaning chemical other than the environmental issues we're dealing with.

When this equipment was transferred, there would be saturated clothes containing up to five to seven percent PCE in the clothes, themselves, pounds and pounds of PCE. They actually had these things called "Transfer Tables" that had little drains in them and, you know, things would drain onto the floor from the table, so that was very common in a dry cleaner.

There were also other sources of releases of waste during the dry cleaning operation during the 1960's and '70s. We know that there was separator water, so we've talked a little bit about the sewers. We've talked about the sludge and the vapors and the spills and leaks. I'm going to spend a second on the boil-overs because these are a particularly problematic issue with dry cleaners that had these stills.

PCE and water are very unique in that they form a unique chemical combination referred to as an azeotrope. And what that means is PCE, which has a boiling point of 121 degrees centigrade, and water which has a boiling point of 100 degrees centigrade, when they get to a certain combination, I think it's about three or four percent mixture, the boiling point actually drops to 88 degrees, so you've got this dry cleaner operator trying to boil off his PCE to reclaim it, and it gets to this magic point where you hit this azeotrope and I'm sure a lot of these dry cleaners studied that in their Chemistry class, and we're all prepared for this, they got this relatively explosive sort of thing called a boiler-over, they're so common, there's names for them, and

I've talked to dry cleaners and these things didn't occur once a year, they occurred once a month, they happened because any time you got into this distillation process, there was this chance you're going to run across that magic azeotrope concentration. And so we know that there were releases. Every dry cleaner site that I've looked at, talked to operators, we know that they had these boiler-overs.

So this is actually from the dry cleaner manual for SF 130, so we know a fair amount about this type of equipment, how it's operated, we've reviewed the manuals, and once again, it's unambiguous, this is for use with Perchloroethylene. So we know that this dry cleaning operation during the tenure when UATC controlled the property had PCE, used it, and there were releases.

So I'll talk about the vertical distribution of PCE because this once again -- and there's been a fair amount of talk about the relative elevations of groundwater. The PCE, looking at this vertical distribution as a line of evidence that there were releases during United Artists Theatre Circuit, the groundwater elevations were lower in the 60's and 70's, and we'll take a look at some of the information on that. PCE migrated down to this clay layer. Nathan King earlier today talked about this relatively impermeable layer, and I think there were some questions asked by members of the Board about when the PCE would go down there and get hung up. Yeah, there's a fairly thick material very much like that aquitard that Ms. Peabody was talking about. We know that the groundwater elevations rose, and what we see is higher PCE concentrations at depth and lower in the shallower.

VICE CHAIR YOUNG: I'm going to give you a time check, which is that you have very little time left. So if you could move through to your strongest arguments, we'll give you a couple of extra minutes.

MR. KRASNOFF: I will move through to strongest arguments, so let me just hit the highlights. The Santa Clara Sub Basin, we do have groundwater elevation information, this information is available online and it's been part of the record, so I know there was a fair amount of question about that. This shows the vertical distribution and the higher concentrations at depth --

MR. MCGRATH: Before you leave that, because I would ask this question anyway, it says -- I want to know where this cross section is and it says historical water levels, '71, '73, '76 -- the next one -- so this shows deeper --

MR. KRASNOFF: Yes.

MR. MCGRATH: And it also shows -- I can see now your bore holes -- where is that cross section trending?

MR. KRASNOFF: This is right in front of the dry cleaner, so that's the building right there, this is trending in the northeast.

MR. MCGRATH: So it trends to the north.

MR. KRASNOFF: Yeah, northeast, and I'll show you with the Rose diagrams that will address the groundwater flow direction here in a second. So I'll spend a second on the length of the plume, there were a fair amount of calculations talking about when the release occurred based upon the length of plume, it's actually quite a bit longer, this is what was included in the EKI, Erler Kalinowski document. But there were data that were not included in their plume length, there's actually PCE that's migrated off into this residential neighborhood. You double the length of the plume and you increase the amount of time the PCE has been in the environment. So that's a very important point.

Groundwater flow direction. I'm not going to spend a lot of time on the losing and gaining because I think we've talked about that, other than to say it's very limited in extent. These are the diagrams you've seen, these are actually the Rose diagrams based upon the groundwater elevation data that exists and, yes, there is flow to the northeast when there is a losing stream condition up until '95; yes, there is flow to the southwest. But these diagrams are actually plots of the data and the frequency of the events and the direction. So there was no flow to the northwest as hypothetically presented by UAT's consultant; same thing when we are gaining stream, it doesn't reverse the way they showed the arrow, we have the data from the Shell station, these plots are taken from the data included in the technical report presented by UATC, and it doesn't reverse the way it says it does. And I believe that was also covered in the staff report.

So we talked about the discharge on UATC control of the site. We've talked about the multiple lines of evidence. I only have one other thing to comment on because the schedule has been addressed. We were requesting a clarification in the Order because it includes both cleanup goals, specified cleanup goals, and there's a task that says that we should recommend final cleanup goals, we were just hoping, should Nathan King not be our staff person down the road, that there be some clarifying language indicating there that the current goals are interim cleanup goals. And that, I believe, covers the highlights. If you have any questions, please let me know.

MR. MCGRATH: Would you go back to that cross section that I was so enamored with because I want to be very clear on what the data says in the period prior to 1990 as to the depth of groundwater. So what is the depth to groundwater shown here? You've got data points for the concentrations. What was the depth to groundwater?

MR. KRASNOFF: That's about close to 50 and 70 feet, somewhere in that range, 80 feet.

MR. MCGRATH: So it was 70 feet still to groundwater --

MR. KRASNOFF: During the time period UATC was there. That's based upon the same well. I know UATC's consultant doesn't necessarily agree that that nearby well that we used this plot for is representative of shallow groundwater, but if I follow along the same theories that UATC's consultant has, that there was shallow groundwater, that that well isn't representative, well, then you've got to look at this data and say the PCE, in any case, would have migrated down to this clay layer.

MR. MCGRATH: But it looks like there's seven wells represented here.

MR. KRASNOFF: Some of those are grab groundwater samples, some of those are monitoring wells.

MR. MCGRATH: Okay.

MR. KRASNOFF: We do have groundwater elevation data from that nearby Chevron and Shell, but this is really just focusing on the chemical distribution.

MR. MCGRATH: So in terms of the stratigraphy, some of these would have casing records and soil samples, and some of them would not?

MR. KRASNOFF: We have, I think, very few soil samples from the borings, but we have a lot of PID readings. We do have some soil samples. We have lots of Litho logy. We have mapped the vertical stratigraphy in detail at the site.

MR. MCGRATH: Thank you.

VICE CHAIR YOUNG: Any other questions at this time? All right, is it the Board's preference to meet in closed session with our Advisory Team? Or not? Yes?

MR. MCGRATH: I would like to meet with the Advisory Team and not with the remainder of the staff.

VICE CHAIR YOUNG: That's how it would go.

MR. MCGRATH: That's how we roll.

MR. WOLFE: That would call a closed session.

MR. REISCH: Can I ask just a procedural question?

VICE CHAIR YOUNG: Yes.

MR. REISCH: Scott Reisch for UATC. Will you be coming back out of closed session to talk to us?

VICE CHAIR YOUNG: Yes, we will.

MR. REISCH: Okay, thank you.

VICE CHAIR YOUNG: And we will be meeting with our advisors who are Bruce Wolfe and his team, as well as Tamarin Austin who is the State Board attorney, asking them questions in closed session to clarify whatever we need clarified. Then I think we'll bring everyone back, make a decision on this item, and at that point we'll figure out what order we do the rest of our business in. So hang around outside. And we'll call you back.

MR. WOLFE: And just to try to provide opportunities for anybody to seek lunch or not, how long, do you have some sense on how long we may --

MR. MCGRATH: We have another Executive Session matter, don't we?

VICE CHAIR YOUNG: Yeah, we could lump the two together in order to get everyone --

MR. MCGRATH: Let's give them a half hour for lunch at least.

VICE CHAIR YOUNG: -- enough time to go out and get some lunch, or we could come back and

--

MR. WOLFE: Okay, but I just want to also be prepared to have -- if that's the case -- our second closed session cued up. So I'm trying to look around to see who is our party -- yes, Lila is there, I see.

VICE CHAIR YOUNG: Bruce, we'll do it in whatever order you like.

MR. WOLFE: Okay, well, I would agree with the Board that right now it would be appropriate to go into closed session to discuss the Moonlight matter, some of the team is saying as we clear the room, is that enough chance to grab a sandwich?

MR. MCGRATH: Yes. I'll make sure of that.

MR. WOLFE: Okay. So for everyone in the room, that implies that the closed session will be the Board and the Advisory Team of myself, Tamarin and Alex. And so if the Board wants to consume its lunch at the same time, and then go into the second closed session, we can do that.

(Off the record for closed session at 1:29 p.m.)

(Reconvene from closed session at 2:23 p.m.)

VICE CHAIR YOUNG: All right, we are

reconvening now. We still have our quorum. We would like to -- even though everyone used up his or her time, we would like to provide the opportunity for each of the parties to use, if you wish, up to five minutes to ask questions of either the other parties or the staff.

MR. WOLFE: And/or to make a closing statement.

VICE CHAIR YOUNG: Thank you -- and/or to make a closing statement. We hope you don't use all five minutes. Is there a recommended order that we should --

MR. WOLFE: That's certainly up to you, but probably reasonable to do the same order that we did in the initial presentation.

VICE CHAIR YOUNG: Okay, let's offer the opportunity to the staff first to ask any questions that you want and/or make a closing statement.

MS. WHYTE: I think for the record, we'd like to make some closing statements here and maybe possibly clarify some issues that were presented before you.

To begin with, I guess, and based on our experience on overseeing many different types of sites over the years, we never have all the data that we really need, and here is another example even though there have been a number of investigations so far. So we need to go forward with the data that we do have in hand, and that's what we have presented and have put forward in terms of our ideas about the scenario, and in terms of the PCE migration out there.

And notably there are a number of different scenarios that can be presented, but we tried to move forward with what we felt was simplest and most straightforward and commonly accepted, both within the literature and things like the Santa Clara Dry Cleaner Study that's out there, and what's generally assumed to be groundwater conditions historically over time within the Santa Clara Valley Basin, so we don't believe we're putting forward any new evidence, but really working with information that we all have a general working knowledge about.

And we think that that information is sufficient to show that there was a discharge that took place in the early period at the site when UATC did indeed have ownership. And we base that not only on the fact that there was a dry cleaner facility there during that period of time, but there was specific equipment that was used during that period of time which is known to cause leaks. In addition, again, we have evidence that that is indeed what was used at that period of time, and it's also common knowledge that the dry cleaner equipment that was used early on in the '60s was more prone to leakage than the equipment that was used much later on, and that's mainly because, as was discussed, it was an open system where there was a lot of transfer back and forth, and a lot of potential for spillage that was inherent within that equipment.

You've heard some discussions about changes in groundwater gradients, and there's a lot of different ways to kind of parse it out, but basically we believe that that is not particularly relevant in this situation because of the depth to groundwater being far enough below the release site that it didn't make that much of a difference here. So the basic information that we're working from is the high indoor air concentrations directly beneath the facility, which is driving our decision making.

You also saw a map that was illustrating a potential second plume out there related to the sewer system; we do not believe that there is sufficient information to point directly to the City's operation of that sewer system and/or that sewer pipe being a discharge point. You saw different maps that had different contours drawn in terms of that, but there's clearly a lack of information about that area, and there's a number of other plausible scenarios that need to be investigated in relation to that. Certainly, transport can take place through the conduits around the sewer lines, the gravel packed trenches in which the sewer lines are in, there could be other plumes that are nearby, there's lots of questions that come up in relation to that area in addition to just simple migration of the shallow groundwater where you've heard debate about how uncertain that may be in terms of the direction. So the bottom line for us is that there's clear evidence underneath the facility of a release of the constituents that were used there, and that is the basis of our recommendation.

You also heard sort of a geochemical argument that was presented in terms of DNAPLE out there and whether it was or was not present.

Again, we think the fact that, and again, consistent with the Santa Clara Valley Dry Cleaners Study Report, we don't need the presence of DNAPLE to illustrate the fact that there was indeed a release that took place a long time ago, again, we have those high air concentrations, volatilization of DNAPLE can lead to high indoor air concentrations, so we do not agree with the geochemical argument that was put forward, as well indicating that there was a more recent release than what we're seeing.

And I think actually since I'm almost out of time, I think I will conclude with that unless you have any specific questions for us.

VICE CHAIR YOUNG: No questions. All right. We're going to United Artists, the option to go next.

MR. REISCH: Can you hear me now? Scott Reisch for United Artists. Just one thing I wanted to start with, which is this objection we raised before, I want to just repeat, about the production well data. Question: Response D12 in the Board materials says, "According to this data and SEVDWD production well data, only deep groundwater beneath the regional aquitard existed beneath the site until groundwater was recharged (ph). So it appears that the Board is relying on SEVDWD production well data. We have an email from SEVWD yesterday saying they'll be providing the well log shortly; unfortunately, section 13752 of the Water Code does not have provisions that allow the release of production information.

It seems that we still don't have everything that the Board has, and will never get what has been relied on here, and we object to that.

In terms of other arguments, I think if you, as I do, pay attention to what has gone unanswered, as well as what was answered, you know, we heard just now again that this equipment was commonly known -- commonly known, commonly known today. Okay? If that's when it's commonly known, it was not commonly known in the '60s, and this question of knowledge of the discharge versus knowledge of the dry cleaner, I think you heard a lot that goes to the question of whether UATC knew there was a dry cleaner at the site. That's not the question. The question is whether we knew or should have known of the risk of dry cleaning contamination hitting the groundwater, that's --

the statute doesn't say that we're liable for causing or permitting a dry cleaner. It says for causing or permitting a nuisance, a discharge to groundwater that causes a nuisance. And the UATC did not know, or have reason to know of that. And I think that's very clear from the Board's prior authority, and a big deal in terms of the precedent that you're being asked to set here. I'm going to let Carey respond on the groundwater issue.

MS. PEABODY: Well, as we said earlier, I think there isn't a disagreement that there was a shift in groundwater gradient. I think all parties have indicated that. Earlier there have been some figures that were presented by Moonlight's consultant that indicated that groundwater elevations were much shallower than what you've been told today, and the data that were provided today were new, and apparently at least not yet available to us.

I want to point out that the groundwater elevation information that they're talking about are from groundwater production wells that are half a mile from this site, and they are very deep, they're in a deep part of this aquifer. And they are not -- I guess a question would be, is it possible for them to support the notion that the data for these deep wells at half a mile away are representative of conditions at the site, which is 400 feet from Saratoga Creek, so it's a very different hydraulic regime.

So I think the question of the elevation of the groundwater table is key to our argument regarding whether you would have seen a plume and, based on what West had earlier displayed in a cross section, you know, the groundwater table was shallow enough such that a release from the ground surface would have gone down, and as the groundwater table came up, it would have generated a plume.

MS. WON: Through the Chair. I'm sorry, I know we've already gone, but with your indulgence, may I just add one point to what Dyan said?

VICE CHAIR YOUNG: Since you're the staff, yes.

MS. WON: Thank you. I just wanted to clarify for the record because Mr. Reisch thinks that the cleanup staff wants to name UATC merely because it permitted a dry cleaner onsite, and that is not the case; we are saying that they are liable as a discharger because they had knowledge that PCE was being used onsite and that it was a hazardous material that required careful handling and containment. So it's not just because they allowed operation of a dry cleaner.

VICE CHAIR YOUNG: Would you like to respond to that?

MR. REISCH: Well, I think that is what you're saying, though, because the statute and the case law is that you have to have knowledge of the condition, and knowing that a dry cleaner used dry cleaning chemicals is the same thing as saying you knew that there was a dry cleaner, and it's going to be the same thing, as I said, for doctors' offices that use Mercury thermometers, and for agricultural companies that use pesticides, you're taking this, your reading out of the case law and the statute, something that is very important, which is that it has to be knowledge of the condition, not knowledge that somebody used chemicals or that it was a dry cleaner. Thank you.

VICE CHAIR YOUNG: All right, would you like to take the opportunity to make a closing statement or ask questions?

MS. GUALCO: I'd just like to make a short closing statement just on the subject matter that's been touched upon by Mr. Reisch and Ms. Won. And I would just --

VICE CHAIR YOUNG: And again, you're -- just --

MS. GUALCO: Oh, I'm sorry, Lori Gualco, attorney for Moonlight Associates, LLC.

VICE CHAIR YOUNG: This is being recorded and some people who are listening to the recording won't recognize everyone's voices, so I'm sorry.

MS. GUALCO: I apologize. I know on Court Call, we always have to announce ourselves because otherwise no one knows who is speaking. And I would just refer the Board back to our Slide 11 In Re San Diego Unified Court District, where it said that the State Water Resources Control Board has consistently taken the position that a landowner who has knowledge, or should have known of the activity taking place, and has the ability to control the activity, has permitted the discharge within the meaning of Water Code Section 13304. That same reasoning is in the Stuart case, which was cited by Regional Board staff, that because a lease provided Petitioner complied with all statutes and laws, that the Petitioner had the legal interest in the property and they had the ability to contractually control that property through the lease. And at this point, I'm going to turn it over to Peter Krasnoff to respond to just a couple of the technical issues. Thank you.

MR. KRASNOFF: Hi. Peter Krasnoff with West Environmental. I just wanted to address two of the technical issues raised by UATC's consultant. There is disagreement on the shift in groundwater flow direction. I think we showed that when you plot up the data using appropriate science, there is not the shifting groundwater flow direction that's been represented.

The second technical issue I wanted to address is the use of the nearby water production wells. The elevation data which has been available online and we've studied for a while, correlates very well with the rise in groundwater elevations that we actually see at the site, whether it's at the Chevron site or the Shell site, or at our site over the years. So they are hydraulically connected. It is really good science. The actual rate of rise of groundwater elevations at the Chevron station, which is in the corner of the shopping center, mirrors -- you can overlay the two graphs of groundwater elevation rise, they overlay perfectly. So they're definitely hydraulically connected, they are lower at the site, but not by much. So they are very useful data. So, thank you.

VICE CHAIR YOUNG: All right. With that, may be have a staff recommendation?

MR. WOLFE: Before a recommendation, I do have a question for the Cleanup Team. Moonlight Associates in their comments pointed out that, while the Order spells out cleanup goals, that Task 7 says "recommend final remedial actions in cleanup levels," and I would ask for clarification of Cleanup Team's intention on that. Should there be an interim cleanup goal identified? Or is 7E where it says "recommend final remedial actions and cleanup levels," should that simply read "recommended final remedial actions?"

MR. HILL: This is Stephen Hill with the Cleanup staff of the Water Board. And we don't see a very large distinction here. We need some cleanup levels now because it will help guide the discharger's work to finish the tasks necessary to clean up the site. We have given them the option of coming up with site-specific cleanup levels as a part of their cleanup plan, or they may decide that they're quite happy with these screening level-based cleanup levels that are in the Tentative Order before you today. So we think that the Order is structured in such a way that they have the choice, and it's clear that if they do propose additional or site-specific cleanup levels, and we consider those and think they're reasonable, then we'll bring this Order back and amend it, and those will be the new cleanup laws.

MR. WOLFE: So --

VICE CHAIR YOUNG: In short, you do not think that there needs to be any word change?

MR. HILL: That's correct. We think the order as structured addresses that concern.

MR. WOLFE: Okay. Based on that, I think our recommendation is that the Revised Tentative Order -- that the Board adopt the Revised Tentative Order with the revisions to the due dates as included in the Supplemental that has been given to you, that essentially clarifies where 2013 should be stated as 2014. And that is essentially based on at least the perspective that

I see that the parties have not brought up any question that PCE was used and spilled at this site, and while that's frequently at issue, really the Water Board's role, then, is if PCE was spilled to see that it's cleaned up and that beneficial uses are protected. And so Cleanup Team has recommended use of the 13304 Order to do that, to push the cleanup. The Order names dischargers, but does not assign any level of responsibility to the discharge itself. And that is consistent with the approach we have historically taken at this Board. So as I say, with that I would recommend adoption of the Revised Tentative Order with the date changes that are supplied in the Supplemental.

MR. MCGRATH: I would so move.

VICE CHAIR YOUNG: Is there a second?

MS. AJAMI: I second that.

VICE CHAIR YOUNG: Yes, we are going to have discussion now. Jim.

MR. MCGRATH: When I first heard and read the lengthy material from UATC, I thought it was a not unreasonable proposition that, as a brand new development, sewer lines would be tight, the concrete would not have settled, dry cleaning equipment would be new, and it may well be possible that it did not leak for a period of time. The question then becomes when. So I've listened very carefully and, as you know, asked a number of questions. I support the staff recommendation and I'm going to tell you what I think is the compelling information that leads me to the conclusion that, undoubtedly, a discharge occurred during the period time where UATC was the owner of the land. And hopefully energy will be spent on cleaning it up, rather than figuring out how much an allocation because that's a little bit of angels dancing on a pinhead.

But here is what I find to be the compelling information: First, the West cross section in Figure 2.3 shows groundwaters plus or minus 40 feet lower in the 1970's, so until groundwater had advanced to the point where it intersected with whatever material -- whether it was DNAPLE or aqueous phase in the groundwater, the staff's theoretical proposal that material was sifting through the groundwater, moving its way through clay, is an entirely reasonable proposition and fits the facts; second, and I think the most compelling, is there's a much larger plume and it's shown in the West drawing figure 3.1, and it's a substantially greater extent than the more limited area shown in the corresponding Erler and Kalinowski -- I hope I pronounced that right -- diagram.

Moonlight presented analytical information estimating that groundwater plume as 750 feet in length and using a assumption on movement through soil, calculated that it would take 46 years for the plume to reach that length. Now, I'm not going to say that I am compelled that 18.6 or 18. whatever is a perfect estimate, but it could be off by 50 percent, but I am convinced that the length of time to create that plume is substantially greater than just somehow magically after 1978, and I think that's the most compelling.

A couple more points. I find the theoretical reverse of flow, particularly the arguments about the well on the other side of the creek, unpersuasive; its' the nature of deposition of water bearing alluvium in time of rapid sea level rise around San Francisco Bay that the alluvium would slope towards the creek, so on the other side of the creek, it would slope toward the creek, or to the east. And without a compelling lithography that makes a distinction and shows exactly how the flow is, I find it not only easy to distinguish that, but necessary to distinguish that.

I disagree with the argument made by counsel for UATC on due process on the questions of groundwater. We don't need to know precisely the depth to groundwater. We don't need to know precisely the relevance of perch water versus other water. They didn't provide information in the period between 1978 and 1990, yet the consultants for Moonlight did, which indicated groundwater was well below. Minor reversals of groundwater during this period of time of rapid rise are of no consequence in the larger question of was there a discharge during the period of time, and should they have known? Perhaps I am among the Board members in knowing that, when you rent land for profit to an activity known to be dangerous on a fire safety perspective, on an air quality perspective, on a worker safety perspective, it is not unreasonable to ensure those risks and perhaps even water quality; I do find that constructive knowledge, at least in the way I look at those things. The Clean Water Act passed in 1972, there was tenure on the property until at least 1975, and there was hot debate about the air quality impacts and the volatility. So I find these to be hazardous substances. I was well aware of them as hazardous substances at the time. So for those reasons, I find the discharge occurred, there was constructive knowledge, and certainly the equipment probably leaked more as time went on and I leave it to the parties to work that out, finding someone to be a responsible party does not allocate the relative level of responsibility. It just simply tries to get the necessary studies done so that work can be done.

VICE CHAIR YOUNG: Margaret, did you want to make any comments?

MS. ABE-KOGA: This is definitely a very challenging item and in terms of -- because I go back to the criteria for naming a responsible party and, well, I'm using the slide that was given, the three items here, own/lease the property at the time of discharge, I think, and the science, and I admit I don't have a lot of background in this, but from what has been shown and discussed, I think there is a lot of evidence that shows that there was potential for -- or was potential for discharge at the time that UATC owned the property. I guess I really was stuck on this issue of -- it's number two, knowledge of activities which resulted in discharge, this issue of, you know, because you allow a dry cleaner to operate on your property, is that knowledge, you know, is that enough knowledge to be responsible and whatnot? But from what our legal counsel has advised us, the State Water Code states that and, you know, I really struggled with this and I guess I've learned that there actually was a change in the State Water Code to where it was before this issue of knowing that something dangerous had occurred, to just knowing that such an activity could occur. And that's where I really struggled with this issue, but it seems like it's pretty clear and, you know, I'm going to say I don't necessarily agree with water -- the Code because I think I look at other possibilities in terms of property ownership and what kind of liabilities that lead to, but if that's what the Code says, that's what the Code says. So given that, and item 3, I think, there is legal ability to prevent it. So it was a tough one for me, but I will have to say, because it's in the Code, I will go ahead and support the motion. Yeah, it's unfortunate I don't necessarily agree with it, but I have to go with it.

VICE CHAIR YOUNG: Newsha.

MS. AJAMI: I think I also struggled with it a little bit. I think the science -- personally, I feel the science does reflect that there was a release, there was a discharge, and I think there's enough evidence to support that. I also was struggling with this whole point of knowledge and how that works, and being a scientist, not a lawyer, it obviously is not my best suit to comment about it, but you know, based on the conversations we had, and I think I do also support where we are going with this because, you know, the knowledge was apparently there, you know, there was a permit that does specifically state that there's a hazardous material being used in this operation, and there's evidence supporting that. So for me, as well, it was definitely a challenging decision because in one hand I do feel the science is there and it supports what has been happening, and on the other hand, I've been trying to understand how does the naming really work and proceed, like how we can proceed with this case, so I do also feel that we are on the right track. Thank you.

VICE CHAIR YOUNG: All right. Well, as you can all see, this Board is not in the habit of just rubber stamping anything that comes before it. We've given very careful consideration to all of the testimony that was presented today and, for those of you who don't appear here very often, you should know that the Board members also read these sometimes six-inch thick packets, all for our ninety-one (ph) dollars a month. And we appreciate you all coming and making presentations to us today, they were informative and enlightening.

Like the other members of the Board here, I looked very carefully at the three requirements for us to agree that we should name UATC as part of this Order, and as far as the first one which was addressed in almost all of the technical evidence, I considered it very carefully, looking at the nature of the activity, the equipment that was used, the chemicals that were used with that equipment, the historic hydrology of the site, and the monitoring results that we have, and I would conclude that the weight of evidence would indicate that the PCE discharge did occur before 1978, that there was a discharge during the time when UATC was either owned or was in control of the site. That's my conclusion from the evidence that was presented today.

I also feel that the evidence meets the State Board standard that UATC had the legal ability to be able to prevent the discharge. Like my colleagues, I was struggling with the explanation that we got from our legal team, both the Prosecution Team and our Advisory Team, about what the standard is for the middle criterion, which is having knowledge of the activities that result in the discharge, and therefore permitting the waste to be discharged.

As I understand the legal advice that has been given us today and looking at the precedential cases, this case meets the standard that the State Board and the case law has set forward, so that they did permit the discharge according to the definitions that we are being provided with today. And I recognize there is some legal discussion back and forth. I'm relying on the advice, which I have to, of our counsel, Ms. Austin, and so I am also going to support the staff recommendation.

With that, I think we should have a roll call vote, please.

MS. TSAO: Board member McGrath - Yes; Board member Ajami - Aye; Board member Abe-Koga - Aye; Vice Chair Young - Aye.

VICE CHAIR YOUNG: All right, so ordered. Thank you again for coming and spending your time.

MR. REISCH: Will we be able to get a copy of the transcript from today's proceeding? And when will that be available? Oh, okay, thank, you. And how about the copies of the presentations that were made today? Will that also be made available?

MS. WHYTE: Yes. Those will be part of the record, and then what was spoken will be included in the transcript, yes.

MR. REISCH: Okay, and will there be a written Order issued? Or does our 30 days run from today? Will you issue the final order? Or is that what just happened?

MR. WOLFE: It's 30 days from signed order, and the order will be signed within the next couple days, but about 30 days from now.

MR. REISCH: All right. Thank you so much. And thank you all for your time today.

EXHIBIT 5

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

San Francisco Bay Regional Water Quality Control Board

June 25, 2013
File No. 43S1090 (NMK)

Moonlite Associates, LLC
c/o SClay Management
Attn: Mr. Bill Mehrens
1111 Bayhill Drive, Suite 450
San Bruno, CA 94066
Bill_Mehrens@sclay.com

United Artists Theatre Circuit, Inc.
c/o Hogan Lovells US LLP
Attn: Scott Reisch
One Tabor Center, Suite 1500
1200 Seventeenth Street
Denver, CO 90202
Scott.reisch@hoganlovells.com

SUBJECT: Transmittal of Tentative Order – Site Cleanup Requirements for Moonlite Associates, LLC, and United Artist Theater Circuit, Inc., for the Property Located at 2640 El Camino Real, Santa Clara, Santa Clara County

Dear Mr. Mehrens and Mr. Reisch:

Attached is a Tentative Order (Site Cleanup Requirements) for the subject Site. The Tentative Order names United Artists Theatre Circuit, Inc., and Moonlite Associates, LLC, as dischargers and requires the investigation and cleanup of tetrachloroethene contamination at the Site.

This matter will be considered by the Regional Water Board during its regular meeting on September 11, 2013. The meeting will start at 9:00 am and will be held in the first floor auditorium of the Elihu Harris Building, 1515 Clay Street, Oakland, California. Any written comments by you or interested persons must be submitted to the Regional Water Board offices by July 25, 2013. Comments submitted after this date will not be considered by the Regional Water Board.

Pursuant to section 2050(c) of Title 23 of the California Code of Regulations, any party that challenges the Regional Water Board's action on this matter through a petition to the State Water Board under Water Code section 13320 will be limited to raising only those substantive issues or objections that were raised before the Regional Water Board at the public hearing or in timely submitted written correspondence delivered to the Regional Water Board (see above).

Water Code section 13304 allows the Regional Water Board to recover its reasonable expenses for overseeing the investigation and cleanup of illegal discharges, contaminated properties, and other releases adversely affecting or threatening to adversely affect the state's waters. The Site involved in this matter falls into the category for which the Regional Water Board may recover oversight costs.

If you have any questions, please contact Nathan King of my staff at (510) 622-3966 [nking@waterboards.ca.gov].

Sincerely,

Stephen Hill
for

Digitally signed by Stephen Hill
Date: 2013.06.25 10:53:43 -07'00'

Dyan C. Whyte
Assistant Executive Officer

Attachment: Tentative Order

cc w/attachment:

Mr. George Cook
Santa Clara Valley Water District
gcook@valleywater.org

Ms. Julia Hill
City Attorney's Office
City of Santa Clara, California
jhill@santaclaraca.gov

Mr. David Parker
Santa Clara City Fire Department
Hazardous Materials Division
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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

TENTATIVE ORDER

ADOPTION of SITE CLEANUP REQUIREMENTS for:

MOONLITE ASSOCIATES, LLC, AND
UNITED ARTIST THEATER CIRCUIT, INC.

For the property located at:

2640 El CAMINO REAL
SANTA CLARA, SANTA CLARA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region (hereinafter Regional Water Board), finds that:

1. **Site Location:** The Site is a located at 2640 El Camino Real in Santa Clara (Figure 1). The Site is a 3,000 square foot tenant space located in the 14.34 acre Moonlite Shopping Center (Figure 2). The Moonlite Shopping Center is bounded to the west by Kiely Boulevard, to the east by Bowe Avenue and Saratoga Creek, to the north by El Camino Real, and to the south by an alley. Saratoga Creek is located immediately east of Bowe Avenue. El Camino Real is a large boulevard flanked by residential neighborhoods located one block to the north and south.

   The Site is presently occupied by Cosmo's Gifts, a retail store. Within the Moonlite Shopping Center there are several large tenant spaces and twenty-five additional smaller tenant spaces.

2. **Site History**: Moonlite Cleaners, a dry cleaning business that used the dry cleaning chemical tetrachloroethene (PCE), operated at the Site for 35 years, from 1962 to 1997. In 1961, the State Fire Marshal issued a permit for establishment of the Moonlite Cleaners dry cleaning facility, and permitted the installation and use of dry cleaning equipment using PCE.

   United California Theaters, Inc., (now United Artist Theater Circuit, Inc. [UATC]) developed the shopping center in 1960. UATC owned the shopping center, including the Site, from 1961 to 1975, and then continued as the master lessor until 1978. UATC owned and controlled the shopping center where the dry cleaner operated for 16 years, from 1962 to 1978. On September 5, 2000, UATC and affiliated entities filed for chapter

11 bankruptcy in the United States Bankruptcy Court for the District of Delaware. The court confirmed UATC's plan of reorganization.

Moonlite Associates, LLC, (Moonlite Associates), the current property owner, has owned the shopping center, including the Site, since 1977. As such, Moonlite Associates owned the shopping center where the dry cleaner operated as a tenant for 20 years (1977 to 1997).

Moonlite Cleaners used PCE in conducting its dry cleaning operations. These operations resulted in PCE discharges to soil and groundwater beneath the Site. There is substantial evidence that PCE discharges occurred during UATC's ownership and control of the Site from 1962 and 1978, and Moonlite Associates' ownership and control of the site from 1977 to 1997. The evidence that PCE discharges occurred during UATC's ownership includes the physical evidence of PCE at the Site and downgradient from it, the history of solvent usage beginning in 1961, common industry-wide operational practices, and the inefficiencies of older dry cleaning equipment from the 1960s. The June 24, 2013, Staff Report more fully discusses PCE discharges that occurred during UATC's ownership. Similarly, the physical evidence of PCE at the Site and downgradient from it, the history of solvent usage, the common industry-wide practices, and the inefficiencies of older dry cleaning equipment, provide evidence that PCE discharges occurred during Moonlite Associates' ownership of the Site when Moonlite Cleaners operated. PCE discharges continue to occur from the Site to off-site areas.

3. **Named Dischargers**: UATC is named as a discharger because it owned the Site during the time of the PCE discharges, had knowledge of the activities that caused the discharge, and had the legal ability to prevent the discharge, as more fully discussed in the June 24, 2013, Staff Report.

Moonlite Associates is named as a discharger because it is the current owner of the property on which there was and continues to be discharge of waste, had and has knowledge of the activities that caused the discharge, and had and has the legal ability to control the discharge.

UATC and Moonlite are hereafter collectively referred to as dischargers.

The previous owners and operators of the Moonlite Cleaners dry cleaning business are not named as discharger because they are deceased.

If additional information is submitted indicating that other parties caused or permitted any waste to be discharged on the Site where it entered or could have entered waters of the state, the Regional Water Board will consider adding those parties' names to this Order.

4. **Regulatory Status**: This Site is currently not subject to Regional Water Board order.

5. **Site Hydrogeology**: The topography of Santa Clara is predominantly flat, sloping gently to the north northeast towards the Guadalupe River and the San Francisco Bay. Locally at the Site, the topography slopes gently to the east, towards the adjacent Saratoga Creek, that flows to the north. The elevation of the Site is approximately 80 feet above mean sea level.

   The headwaters of Saratoga Creek originate is in Santa Cruz Mountains at 3,100 feet, approximately 10 miles to the southwest. Saratoga Creek is the principal drainage for the Saratoga Creek Watershed. Santa Clara Valley Water District uses Saratoga Creek upstream of the Site to recharge groundwater in the reach between the city of Saratoga and Highway 280, approximately. Saratoga Creek currently is a gaining creek adjacent to the Site. Saratoga Creek joins the San Tomas Aquino Creek before joining the Guadalupe Slough, ultimately draining to the San Francisco Bay.

   The sediment beneath the Site consists of ancestral Saratoga Creek stream channel sediment overlying older Late Pleistocene alluvial plain sediment. The ancestral Saratoga Creek sediment is fine to coarse grained channel deposits, with fine grained flood deposits outside the channels. The pattern of fine and coarse grained lenses of sediment observed at the Site represent the deposits of the meandering ancestral Saratoga Creek flowing northward over alluvial plain sediment. These ancestral Saratoga Creek sediment has been encountered from approximately 5 to 50 feet below ground surface during investigations.

   The depth to groundwater in Site monitoring wells is approximately 12 feet below ground surface. The calculated groundwater flow direction at the Site is northeast, with a gradient of approximately 0.005 feet per foot.

6. **Remedial Investigation**: Multiple onsite investigations have occurred since PCE was first detected in 2004. PCE has been detected above the Environmental Screening Levels (ESLs) in soil gas, indoor air and groundwater.

   PCE has been detected in soil gas at concentrations up to 5,700,000 ug/m3 beneath the Site, 2714 times higher than the commercial/industrial ESL of 2,100 ug/m3. The extent of soil gas PCE contamination has not been delineated to the adjacent tenant spaces within the Moonlite Shopping Center, and is not delineated offsite to the east before the residences, to the south before the residences, or downgradient across El Camino Real. Further investigation is warranted to delineate the extent of soil gas contamination.

   PCE has been detected in indoor air at concentrations up to 150 ug/m3 within the Site, 71 times higher than the commercial/industrial ESL of 2.1 ug/m3. Additional indoor air delineation may be needed following completion of soil gas delineation. An engineering control (soil vapor extraction) is presently mitigating vapor intrusion of PCE from beneath the building foundation into the retail shop currently operating at Site.

PCE has been detected in groundwater at concentrations up to 1,280 ug/L downgradient from the Site, 250 times higher than the drinking water ESL, with the downgradient extent delineated to approximately 1,600 feet northeast. Groundwater samples collected from boring B24 located in the residential neighborhood 1,200 feet northeast from the Site, contained concentrations of PCE at 120 ug/L.

PCE has been detected at concentrations up to 1,130 ug/L approximately 40 feet below ground surface (bgs) in monitoring well MW-5A (located 75 feet northeast of the Site). PCE has been detected at concentrations up to 22 ug/L at approximately 55 feet bgs in MW-4A (located about 375 feet northeast of the Site). It appears that the vertical extent of PCE contamination is less than 60 feet bgs at the Site.

Groundwater PCE contamination has been adequately defined by grab groundwater sampling, but is not adequately monitored downgradient of Site monitoring well MW-4. MW-4is the furthest downgradient monitoring well of seven Site monitoring wells, contains the highest concentrations of PCE at 799 ug/L as reported during the December 2012 monitoring event. Additional monitoring wells are warranted to adequately monitor the offsite PCE groundwater plume in the down gradient direction.

PCE has been detected in the adjacent Saratoga Creek at 49 ug/L, less than the ESL of 120 ug/L for protection of aquatic receptors.

No soil samples have been collected at the Site. Soil samples will be needed as part of curtailment activities to determine if concentrations of PCE in soil have been cleaned up to the soil cleanup levels.

7. **Risk Assessment**:

a. **Screening Levels:** A screening level evaluation was carried out to evaluate potential environmental concerns related to identified soil, soil gas, groundwater, surface water and indoor air impacts. The chemical evaluated in the risk assessment is PCE, the primary chemical of concern.

As part of the initial assessment, Site data were compared to ESLs compiled by Water Board staff. The presence of chemicals at concentrations above the screening levels indicates that additional evaluation of potential threats to human health and the environment is warranted. Screening levels for groundwater address the following environmental concerns: 1) drinking water impacts (toxicity and taste and odor), 2) impacts to indoor air, and 3) migration and impacts to aquatic habitats. Screening levels for soil address: 1) direct exposure, 2) leaching to groundwater, and 3) nuisance issues. Screening levels for soil gas address impacts to indoor air. Chemical-specific screening levels for other human health concerns (i.e., indoor-air and direct-exposure) are based on a target excess cancer risk of $1\text{x}10^{-6}$ for carcinogens and a target Hazard Quotient of 1.0 for noncarcinogens. Groundwater screening levels for the protection of aquatic habitats are based on promulgated surface water standards (or equivalent). Soil screening levels for potential leaching concerns are intended to prevent impacts to groundwater above target groundwater goals (e.g., drinking water standards). Soil screening levels for nuisance concerns are intended to address potential odor and other aesthetic issues.

b. **Assessment Results:** The results of the screening level risk assessment are summarized in the table below.

	Result of Screening Assessment*					
Media / Constituent	Human health – direct	Leaching to ground water	Indoor air	Aquatic life	Drinking water	Nuisance
Soil Gas:						
PCE			X			
Groundwater:						
PCE			X	X	X	X
Indoor Air:						
PCE			X			
Soil:						
PCE		X[1]				

* Note: an "X" indicates that ESL for that particular concern was exceeded

X[1] Assumed - no soil data has been collected at the Site

c. **Conclusions:** The dischargers have opted to forego a site-specific risk assessment and instead will address these screening level exceedances using a combination of remediation and risk management.

8. **Adjacent Sites**: A Chevron gasoline facility operated at 2798 El Camino Real on the northwest corner of the Moonlite Shopping Center (Figure 2) until approximately 1984. In 1985, three gasoline underground storage tanks (USTs) and one waste oil UST with associated conveyance pipes and dispenser were removed. Soil samples collected beneath the gasoline and waste oil USTs indicated that unauthorized releases of waste oil and gasoline had occurred. There is no reference to a release of chlorinated solvent, such as PCE, at this site. The County of Santa Clara, Department of Environmental Health, closed this case in 2007.

9. **Interim Remedial Measures**: A soil vapor extraction (SVE) system was installed in February 2010 beneath the Site and has been operating continuously since then. The SVE system consists of five horizontal extraction pipes and eight vertical extraction wells. The purpose of the SVE system is to provide vapor intrusion mitigation to indoor

air and to remove PCE mass. Approximately 293 pounds of PCE have been removed as of December 2012.

In March 2013 Moonlite Associates initiated an in situ pilot study to evaluate the effectiveness and implementability of injecting a slurry of zero-valent iron (ZVI) and an electron donor (e.g., emulsified oil) to remediate contaminated groundwater at the Site.

Further interim remedial measures need to be implemented at this Site to reduce the threat to water quality, public health, and the environment posed by the discharge of waste and to provide a technical basis for selecting and designing final remedial measures.

10. **Remedial Action Plan**: A remedial action plan including a feasibility study will be needed following completion of the pilot study that will determine the effectiveness of the ZVI injections.

11. **Basis for Cleanup Levels**

    a. **General**: State Water Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California," applies to this discharge. This order and its requirements are consistent with Resolution No. 68-16.

    State Water Board Resolution No. 92-49, "Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304," applies to this discharge and requires attainment of background levels of water quality, or the highest level of water quality which is reasonable if background levels of water quality cannot be restored. The cleanup levels established in this order are consistent with the maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses of such water, and will not result in exceedance of applicable water quality objectives. The groundwater cleanup levels in this Order are set at drinking water standards, which are greater than background concentrations. This order and its requirements are consistent with the provisions of Resolution No. 92-49, as amended.

    b. **Beneficial Uses**: The Regional Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) is the Regional Water Board's master water quality control planning document. It designates beneficial uses and water quality objectives for waters of the State, including surface waters and groundwater. It also includes programs of implementation to achieve water quality objectives. The Basin Plan was duly adopted by the Regional Water Board and approved by the State Water Board, Office of Administrative Law and the U.S. EPA, where required.

Regional Water Board Resolution No. 89-39, "Sources of Drinking Water," defines potential sources of drinking water to include all groundwater in the region, with limited exceptions for areas of high TDS, low yield, or naturally-high contaminant levels. Groundwater underlying and adjacent to the site qualifies as a potential source of drinking water.

The Basin Plan designates the following potential beneficial uses of groundwater underlying and adjacent to the Site:

o Municipal and domestic water supply
o Industrial process water supply
o Industrial service water supply
o Agricultural water supply
o Freshwater replenishment to surface waters

The deeper aquifer is used for the above purposes, with shallow groundwater underlying the Site only expected to replenish Saratoga Creek; however, the aquitard separating the shallow groundwater from deeper groundwater in the vicinity of the Site is apparently not competent and/or compromised by deep old production wells in the vicinity. This allows communication between the shallow and deep aquifers; therefore, the shallow groundwater beneath the Site is potentially used for the above purposes.

The existing and potential beneficial uses of Saratoga Creek include:

o Agricultural supply
o Fresh water replenishment to surface water
o Groundwater recharge
o Wildlife habitat
o Cold freshwater and warm freshwater habitat

c. **Basis for Groundwater Cleanup Levels**:
The groundwater cleanup levels for the Site are based on applicable water quality objectives and are the more stringent of EPA and California primary maximum contaminant levels (MCLs). Cleanup to this level will protect beneficial uses of groundwater and will result in acceptable residual risk to humans.

d. **Basis for Soil Cleanup Levels**: The soil cleanup levels for the Site are intended to prevent leaching of contaminants to groundwater and will result in acceptable residual risk to humans.

e. **Basis for Soil Gas Cleanup Levels**: The soil gas cleanup levels for the Site are intended to prevent vapor intrusion into occupied buildings and will result in acceptable residual risk to humans. An attenuation factor of 0.001 was used from soil gas to indoor air.

f. **Basis for Indoor Air Cleanup Levels:** The indoor air cleanup levels for the Site are intended to prevent unhealthy levels of VOCs in indoor air as a result of vapor intrusion.

g. **Basis for Sub-Slab Soil Gas Cleanup Levels:** The sub-slab soil gas cleanup levels for the Site are intended to prevent vapor intrusion into occupied buildings and will result in acceptable residual risk to humans. An attenuation factor of 0.05 was used from sub-slab soil gas to indoor air.

h. The remedial action plan may propose revised cleanup levels for Regional Water Board consideration.

12. **Future Changes to Cleanup Levels**: The goal of this remedial action is to restore the beneficial uses of groundwater underlying and adjacent to the Site. Results from other sites suggest that full restoration of beneficial uses to groundwater as a result of active remediation at this Site may not be possible. If full restoration of beneficial uses is not technologically or economically achievable within a reasonable period of time, then the dischargers may request modification to the cleanup levels or establishment of a containment zone, a limited groundwater pollution zone where water quality objectives are exceeded. Conversely, if new technical information indicates that cleanup levels can be surpassed, the Regional Water Board may decide that further cleanup actions should be taken.

13. **Risk Management**: The following human health risks are acceptable at remediation sites: a cumulative hazard index of 1.0 or less for non-carcinogens and a cumulative excess cancer risk of 10^{-6} to 10^{-4} or less for carcinogens. The screening level evaluation for this Site found contamination-related risks in excess of these acceptable levels. Active remediation will reduce these risks over time. However, risk management measures are needed at this Site during, and possibly after active remediation to assure protection of human health. Risk management measures include engineering controls (such as engineered caps or wellhead treatment) and institutional controls (such as deed restrictions that prohibit certain land uses).

    The following risk management measures are needed at this Site:

    a. A risk management plan to ensure that vapor intrusion mitigation systems (including the current SVE system) operate reliably and protect human health.

    b. A deed restriction that notifies future owners of sub-surface contamination, prohibits the use of shallow groundwater beneath the Site as a source of drinking water until cleanup levels are met, and prohibits sensitive uses of the Site such as residences and daycare centers.

14. **Reuse or Disposal of Extracted Groundwater**: Regional Water Board Resolution No. 88-160 allows discharges of extracted, treated groundwater from site cleanups to surface waters only if it has been demonstrated that neither reclamation nor discharge to the sanitary sewer is technically and economically feasible.

15. **Basis for 13304 Order**: Water Code section 13304 authorizes the Regional Water Board to issue orders requiring a discharger to cleanup and abate waste where the discharger has caused or permitted waste to be discharged or deposited where it is or probably will be discharged into waters of the State and creates or threatens to create a condition of pollution or nuisance.

16. **Cost Recovery**: Pursuant to Water Code section 13304, the dischargers are hereby notified that the Regional Water Board is entitled to, and may seek reimbursement for, all reasonable costs actually incurred by the Regional Water Board to investigate unauthorized discharges of waste and to oversee cleanup of such waste, abatement of the effects thereof, or other remedial action, required by this order.

17. **California Safe Drinking Water Policy:** It is the policy of the State of California that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. This Order promotes that policy by requiring discharges to meet maximum contaminant levels designed to protect human health and ensure that water is safe for domestic use.

18. **CEQA**: This action is an order to enforce the laws and regulations administered by the Regional Water Board. As such, this action is categorically exempt from the provisions of the California Environmental Quality Act (CEQA) pursuant to section 15321 of the Resources Agency Guidelines.

19. **Notification**: The Regional Water Board has notified the dischargers and all interested agencies and persons of its intent under Water Code section 13304 to prescribe site cleanup requirements for the discharge, and has provided them with an opportunity to submit their written comments.

20. **Public Hearing**: The Regional Water Board, at a public meeting, considered all comments pertaining to this discharge.

IT IS HEREBY ORDERED, pursuant to section 13304 of the Water Code, that the dischargers shall clean up and abate the effects described in the above findings as follows:

A. **PROHIBITIONS**

1. The discharge of wastes or hazardous substances in a manner that will degrade water quality or adversely affect beneficial uses of waters of the State is prohibited.

2. Further significant migration of wastes or hazardous substances through subsurface transport to waters of the State is prohibited.

3. Activities associated with the subsurface investigation and cleanup that will cause significant adverse migration of wastes or hazardous substances are prohibited.

B. REMEDIAL ACTION PLAN AND CLEANUP LEVELS

1. **Implement Remedial Action Plan**: The dischargers shall implement the remedial action plan as required by Task 9.

2. **Groundwater Cleanup Levels**: The following groundwater cleanup levels shall be met in all wells identified in the attached Self-Monitoring Program:

Constituent	Level (ug/L)	Basis
Tetrachloroethene (PCE)	5	Drinking water MCL
Trichloroethene (TCE)	5	Drinking water MCL
cis-1,2-Dichloroethene (DCE)	6	Drinking water MCL
trans-1,2-DCE	10	Drinking water MCL

MCL = Maximum contaminant level

3. **Soil Cleanup Levels**: The following soil cleanup levels shall be met in all Site vadose-zone soils.

Constituent	Level (mg/kg)	Basis
PCE	0.70	Leaching to groundwater
TCE	0.46	Leaching to groundwater
cis-1,2-DCE	0.19	Leaching to groundwater
trans-1,2-DCE	0.67	Leaching to groundwater

4. **Soil Gas Cleanup Levels**: The following soil gas cleanup levels shall be met in all Site vadose-zone soils.

Constituent	Commercial or Industrial Level (ug/m^3)	Residential Level (ug/m^3)	Basis
PCE	2,100	210	Vapor intrusion
TCE	3,000	300	Vapor intrusion

5. **Sub-Slab Soil Gas Cleanup Levels**: The following soil gas cleanup levels shall be met in all Site vadose-zone soils that are beneath building foundations.

Constituent	Commercial or Industrial Level (ug/m^3)	Residential Level (ug/m^3)	Basis
PCE	42	8.2	Vapor intrusion
TCE	60	11.8	Vapor intrusion

6. **Indoor Air Cleanup Levels**: The following indoor air cleanup levels shall be met in occupied buildings.

Constituent	Commercial or Industrial Level (ug/m^3)	Residential Level (ug/m^3)	Basis
PCE	2.1	0.41	Inhalation
TCE	3.0	0.59	Inhalation

C. TASKS

1. WORKPLAN FOR ADDITIONAL SOIL GAS INVESTIGATION

COMPLIANCE DATE: September 30, 2013

Submit a workplan acceptable to the Executive Officer to conduct an additional soil gas investigation to delineate the soil gas plume down to or below the appropriate residential or commercial cleanup level for soil gas. The workplan should specify investigation methods and proposed time schedule. Work may be phased to allow the investigation to proceed efficiently, provided that this does not delay compliance.

2. COMPLETION OF SOIL GAS INVESTIGATION

COMPLIANCE DATE: December 31, 2013

Submit a technical report acceptable to the Executive Officer documenting completion of necessary tasks identified in the Task 1 workplan. The technical report shall include recommendations for additional work to delineate soil gas contamination greater than the corresponding cleanup level, as warranted.

3. WORKPLAN FOR ADDITIONAL INDOOR AIR SAMPLING

COMPLIANCE DATE: January 31, 2014

Submit a workplan acceptable to the Executive Officer to conduct additional indoor air sampling following completion of Task 2 to delineate PCE and TCE in indoor air down to or below the corresponding cleanup level in indoor air. The workplan should specify investigation methods and proposed time schedule. Work may be phased to allow the investigation to proceed efficiently, provided that this does not delay compliance.

4. **COMPLETION OF INDOOR AIR SAMPLING**

COMPLIANCE DATE: April 30, 2014

Submit a technical report acceptable to the Executive Officer documenting completion of necessary tasks identified in the Task 3 workplan. The technical report shall include recommendations for additional work to delineate indoor air contamination greater than the corresponding cleanup level, as warranted.

5. **WORKPLAN FOR GROUNDWATER MONITORING WELLS INSTALLATION**

COMPLIANCE DATE: October 31, 2013

Submit a workplan acceptable to the Executive Officer to install additional groundwater monitoring wells downgradient of monitoring well MW-4 to monitor groundwater pollution down to or below the corresponding cleanup level in groundwater. The workplan should specify investigation methods and a proposed time schedule. Work may be phased to allow the investigation to proceed efficiently, provided that this does not delay compliance.

6. **COMPLETION OF GROUNDWATER MONITORING WELLS INSTALLATION**

COMPLIANCE DATE: February 28, 2014

Submit a technical report acceptable to the Executive Officer documenting completion of necessary tasks identified in the Task 5 workplan. The technical report shall include recommendations for additional work to delineate groundwater contamination greater than the corresponding cleanup level, as warranted.

7. **COMPLETION OF ZERO-VALENT IRON PILOT STUDY**

COMPLIANCE DATE: July 31, 2013

Submit a technical report acceptable to the Executive Officer documenting the completion of the tasks identified in the December 3, 2012, Pilot Study Work Plan (Workplan) approved by the Regional Water Board on December 18, 2012. The report should evaluate the effectiveness and implementability of injecting a slurry of zero-valent iron (ZVI) and an electron donor to remediate contaminated groundwater at the Site.

8. **REMEDIAL ACTION PLAN**

COMPLIANCE DATE: April 30, 2014

Submit a technical report acceptable to the Executive Officer containing:

a. Summary of remedial investigation
b. Summary of risk assessment (if applicable)
c. Evaluation of the installed interim remedial actions
d. Feasibility study evaluating alternative final remedial actions
e. Recommended final remedial actions and cleanup levels
f. Proposed risk management plan
g. Implementation tasks and time schedule

The remedial action plan shall include recommended remedial work that has a high probability of eliminating unacceptable threats to human health and restoring beneficial uses of water in a reasonable time. Reasonable time shall be proposed based on the severity of impact to the beneficial use (for current impacts) or the time before the beneficial use will occur (for potential future impacts).

Item d should include projections of cost, effectiveness, benefits, and impact on public health, welfare, and the environment of each alternative action.
Items a through d should be consistent with the guidance provided by Subpart F of the National Oil and Hazardous Substances Pollution Contingency Plan (40 C.F.R. § 300), CERCLA guidance documents with respect to remedial investigations and feasibility studies, Health and Safety Code section 25356.1(c), and State Water Board Resolution No. 92-49 as amended ("Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304").

9. IMPLEMENTATION OF REMEDIAL ACTIONS

COMPLIANCE DATE: December 31, 2014

Submit a technical report acceptable to the Executive Officer documenting completion of necessary tasks identified in the Task 8 workplan. For ongoing actions, such as soil vapor extraction or groundwater extraction, the report shall document system start-up (as opposed to completion) and shall present initial results on system effectiveness (e.g., capture zone or area of influence). Proposals for further system expansion or modification may be included in annual reports (see attached Self-Monitoring Program).

10. PROPOSED DEED RESTRICTION

COMPLIANCE DATE: November 30, 2014

Submit a proposed deed restriction acceptable to the Executive Officer whose goal is to limit on-site occupants' exposure to site contaminants to acceptable levels. The proposed deed restriction shall prohibit the use of shallow groundwater beneath the site as a source of drinking water until cleanup levels are met, and prohibit sensitive uses of the site such as residences and daycare centers. The proposed deed restriction shall incorporate by reference the risk management plan. The proposed deed restriction shall name the Regional Water Board as a beneficiary and shall anticipate that the Regional Water Board will be a signatory.

11. RECORDATION OF DEED RESTRICTION

COMPLIANCE DATE:	60 days after Executive Officer approval of the proposed deed restriction

Submit a technical report acceptable to the Executive Officer documenting that the deed restriction has been duly signed by all parties and has been recorded with the appropriate County Recorder. The report shall include a copy of the recorded deed restriction.

12. RISK MANAGEMENT PLAN IMPLEMENTATION

COMPLIANCE DATE:	August 31, 2015, and every year thereafter

Submit a technical report acceptable to the Executive Officer documenting implementation of the Risk Management Plan over the previous 12-month period ending on June 30. The report should include a detailed comparison of Risk Management Plan elements and implementation actions taken. The report should provide a detailed discussion of any instances of implementation actions falling short of Risk Management Plan requirements, including an assessment of any potential human health or environmental effects resulting from these shortfalls. The report may be combined with a self-monitoring report, provided that the report title clearly indicates its scope. The report may propose changes to the Risk Management Plan, although those changes shall not take effect until approved by the Regional Water Board or the Executive Officer

13. **FIVE-YEAR STATUS REPORT**

COMPLIANCE DATE: July 31, 2019, and every five years thereafter

Submit a technical report acceptable to the Executive Officer evaluating the effectiveness of the approved remedial action plan. The report should include:

a. Summary of effectiveness in controlling contaminant migration and protecting human health and the environment
b. Comparison of contaminant concentration trends with cleanup levels
c. Comparison of anticipated versus actual costs of cleanup activities
d. Performance data (e.g., groundwater volume extracted, chemical mass removed, mass removed per million gallons extracted)
e. Cost effectiveness data (e.g., cost per pound of contaminant removed)
f. Summary of additional investigations (including results) and significant modifications to remediation systems
g. Additional remedial actions proposed to meet cleanup levels (if applicable) including time schedule

If cleanup levels have not been met and are not projected to be met within a reasonable time, the report should assess the technical practicability of meeting cleanup levels and may propose an alternative cleanup strategy.

14. **PROPOSED CURTAILMENT**

COMPLIANCE DATE: 60 days prior to proposed curtailment

Submit a technical report acceptable to the Executive Officer containing a proposal to curtail remediation. Curtailment includes system closure (e.g., well abandonment), system suspension (e.g., cease extraction but wells retained), and significant system modification (e.g., major reduction in extraction rates, closure of individual extraction wells within extraction network). The report should include the rationale for curtailment. Proposals for final closure should demonstrate that cleanup levels have been met, contaminant concentrations are stable, and contaminant migration potential is minimal.

15. **IMPLEMENTATION OF CURTAILMENT**

COMPLIANCE DATE: 60 days after Executive Officer approval of proposed curtailment

Submit a technical report acceptable to the Executive Officer documenting completion of the tasks identified in Task14.

16. **EVALUATION OF NEW HEALTH CRITERIA**

COMPLIANCE DATE:	90 days after evaluation report required by Executive Officer

Submit a technical report acceptable to the Executive Officer evaluating the effect on the approved remedial action plan of revising one or more cleanup levels in response to revision of drinking water standards, maximum contaminant levels, or other health-based criteria.

17. **EVALUATION OF NEW TECHNICAL INFORMATION**

COMPLIANCE DATE:	90 days after evaluation report required by Executive Officer

Submit a technical report acceptable to the Executive Officer evaluating new technical information which bears on the approved remedial action plan and cleanup levels for this site. In the case of a new cleanup technology, the report should evaluate the technology using the same criteria used in the feasibility study. Such technical reports shall not be required unless the Executive Officer determines that the new information is reasonably likely to warrant a revision in the approved remedial action plan or cleanup levels.

18. **Delayed Compliance**: If the dischargers are delayed, interrupted, or prevented from meeting one or more of the completion dates specified for the above tasks, the dischargers shall promptly notify the Executive Officer, and the Regional Water Board may consider revision to this Order.

D. PROVISIONS

1. **No Nuisance**: The storage, handling, treatment, or disposal of polluted soil or groundwater shall not create a nuisance as defined in Water Code section 13050(m).

2. **Good Operation and Maintenance**: The dischargers shall maintain in good working order and operate as efficiently as possible any facility or control system installed to achieve compliance with the requirements of this Order.

3. **Cost Recovery**: The dischargers shall be liable, pursuant to Water Code section 13304, to the Regional Water Board for all reasonable costs actually incurred by the Regional Water Board to investigate unauthorized discharges of waste and to oversee cleanup of such waste, abatement of the effects thereof, or other remedial action, required by this Order. If the site addressed by this Order is enrolled in a State Water Board-managed reimbursement program, reimbursement shall be

made pursuant to this Order and according to the procedures established in that program. Any disputes raised by the dischargers over reimbursement amounts or methods used in that program shall be consistent with the dispute resolution procedures for that program.

4. **Access to Site and Records**: In accordance with Water Code section 13267(c), the dischargers shall permit the Regional Water Board or its authorized representative:

    a. Entry upon premises in which any pollution source exists, or may potentially exist, or in which any required records are kept, which are relevant to this Order.

    b. Access to copy any records required to be kept under the requirements of this Order.

    c. Inspection of any monitoring or remediation facilities installed in response to this Order.

    d. Sampling of any groundwater or soil which is accessible, or may become accessible, as part of any investigation or remedial action program undertaken by the dischargers.

5. **Self-Monitoring Program**: The dischargers shall comply with the Self-Monitoring Program as attached to this Order and as may be amended by the Executive Officer.

6. **Contractor / Consultant Qualifications**: All technical documents shall be signed by and stamped with the seal of a California registered geologist, a California certified engineering geologist, or a California registered civil engineer.

7. **Lab Qualifications**: All samples shall be analyzed by State-certified laboratories or laboratories accepted by the Regional Water Board using approved U.S. EPA methods for the type of analysis to be performed. Quality assurance/quality control (QA/QC) records shall be maintained for Regional Water Board review. This provision does not apply to analyses that can only reasonably be performed on-site (e.g., temperature).

8. **Document Distribution**: An electronic and paper version of all correspondence, technical reports, and other documents pertaining to compliance with this Order shall be provided to the Regional Water Board, and electronic copies shall be provided to the following agencies:

    a. City of Santa Clara, City Attorney’s Office

b. Santa Clara Valley Water District

The Executive Officer may modify this distribution list as needed.

Electronic copies of all correspondence, technical reports, and other documents pertaining to compliance with this Order shall be uploaded to the State Water Board's GeoTracker database within five business days after submittal to the Regional Water Board. Guidance for electronic information submittal is available at:
http://www.waterboards.ca.gov/water_issues/programs/ust/electronic_submittal

9. **Reporting of Changed Owner or Operator**: The dischargers shall file a technical report on any changes in contact information, site occupancy or ownership associated with the property described in this Order.

10. **Reporting of Hazardous Substance Release**: If any hazardous substance is discharged in or on any waters of the State, or discharged or deposited where it is, or probably will be, discharged in or on any waters of the State, the dischargers shall report such discharge to the Regional Water Board by calling (510) 622-2369.

    A written report shall be filed with the Regional Water Board within five working days. The report shall describe: the nature of the hazardous substance, estimated quantity involved, duration of incident, cause of release, estimated size of affected area, nature of effect, corrective actions taken or planned, schedule of corrective actions planned, and persons/agencies notified.

    This reporting is in addition to reporting to the California Emergency Management Agency required pursuant to the Health and Safety Code.

11. **Periodic SCR Review**: The Regional Water Board will review this Order periodically and may revise it when necessary.

I, Bruce H. Wolfe, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on _________________.

____
Bruce H. Wolfe
Executive Officer

==
FAILURE TO COMPLY WITH THE REQUIREMENTS OF THIS ORDER MAY SUBJECT YOU TO ENFORCEMENT ACTION, INCLUDING BUT NOT LIMITED TO: IMPOSITION OF ADMINISTRATIVE CIVIL LIABILITY UNDER WATER CODE SECTIONS 13268 OR 13350, OR REFERRAL TO THE ATTORNEY GENERAL FOR INJUNCTIVE RELIEF OR CIVIL OR CRIMINAL LIABILITY
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Attachments: Site Vicinity Map
Site Map
Self-Monitoring Program
Staff Report

Figure 1: Site Vicinity Map

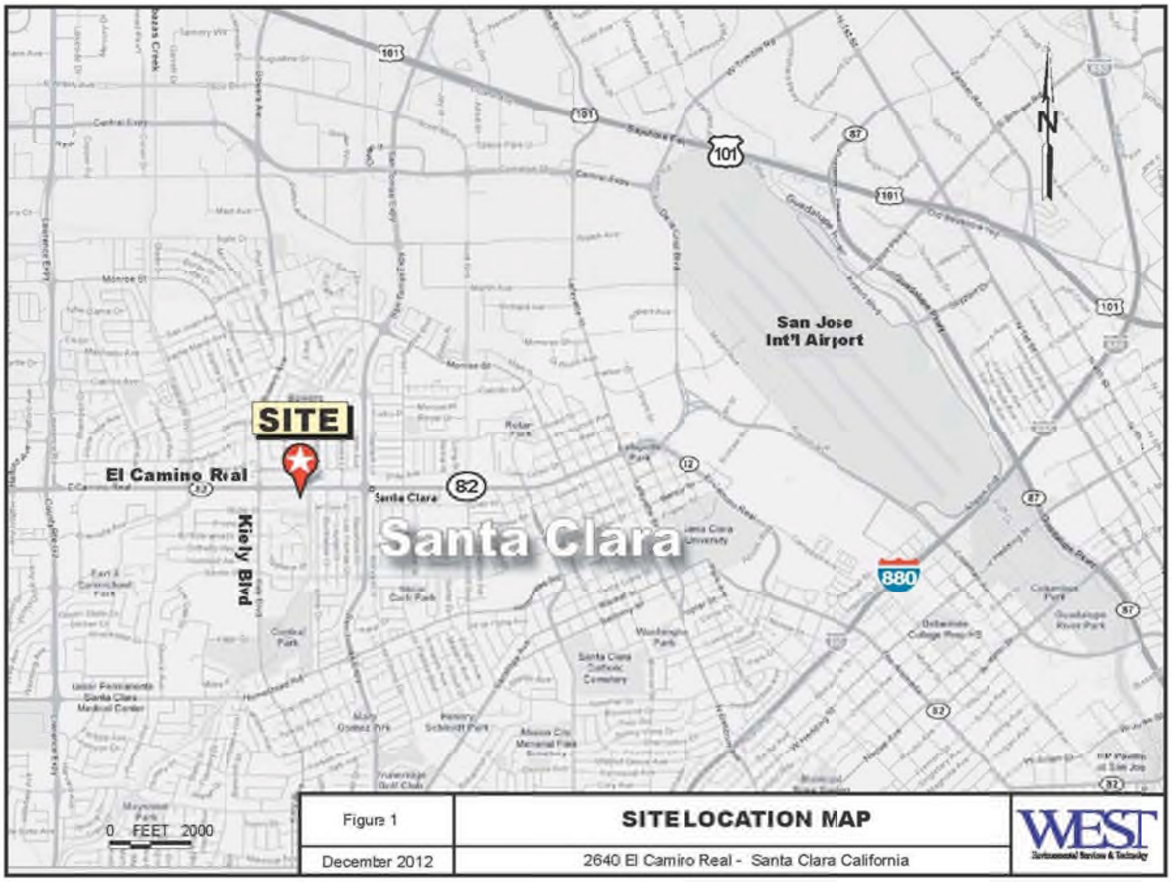
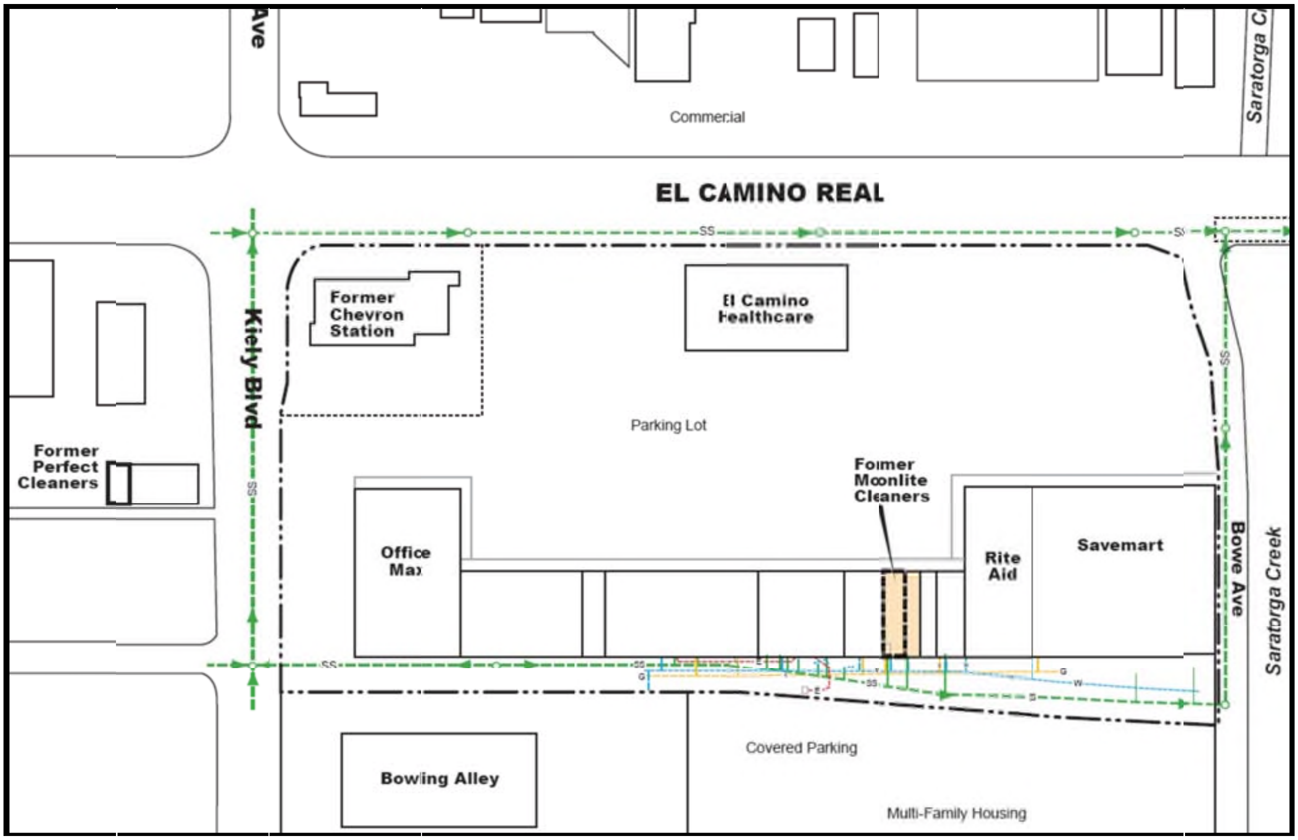


Figure 2: Site Location Map



CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

SELF-MONITORING PROGRAM FOR:

MOONLITE ASSOCIATES, LLC, AND
UNITED ARTIST THEATER CIRCUIT, INC.

for the property located at

2640 El CAMINO REAL
SANTA CLARA, SANTA CLARA COUNTY

1. **Authority and Purpose**: The Regional Water Board requires the technical reports identified in this Self-Monitoring Program pursuant to Water Code sections 13267 and 13304. This Self-Monitoring Program is intended to document compliance with Regional Water Board Order No. *XX-XXX* (site cleanup requirements).

2. **Monitoring**: The dischargers shall measure groundwater elevations quarterly in all monitoring wells, and shall collect and analyze representative samples of groundwater according to the following table:

Well #	Sampling Frequency	Analyses	Well #	Sampling Frequency	Analyses
MW-1	Q	8260B/5030B	MW-5	Q	8260B/5030B
MW-2	Q	8260B/5030B	MW-5A	Q	8260B/5030B
MW-3	Q	8260B/5030B	C1	Q	8260B/5030B
MW-4	Q	8260B/5030B	C2	Q	8260B/5030B
MW-4A	Q	8260B/5030B	C3	Q	8260B/5030B

Key: Q = Quarterly
8260B = EPA Method 8260B or equivalent
5030B = EPA Method 5030B or equivalent
C1, C2, C3 = Saratoga Creek sampling locations

The dischargers shall sample any new monitoring or extraction wells quarterly and analyze groundwater samples for the same constituents as shown in the above table. The dischargers may propose changes in the above table; any proposed changes are subject to Executive Officer approval.

3. **Quarterly Monitoring Reports**: The dischargers shall submit quarterly monitoring reports to the Regional Water Board no later than 30 days following the end of the quarter (e.g., report for first quarter of the year due April 30). The first quarterly monitoring report shall be due on October 30, 2013. The reports shall include:

   a. Transmittal Letter: The transmittal letter shall discuss any violations during the reporting period and actions taken or planned to correct the problem. The letter shall be signed by the dischargers' principal executive officer or his/her duly authorized representative, and shall include a statement by the official, under penalty of perjury, that the report is true and correct to the best of the official's knowledge.

   b. Groundwater and Surface Water Elevations: Groundwater and Surface Water elevation data shall be presented in tabular form, and a groundwater and surface water elevation map should be prepared for each monitored water-bearing zone. Historical groundwater and surface elevations shall be included in the fourth quarterly report each year.

   c. Groundwater and Surface Water Analyses: Groundwater and surface water sampling data shall be presented in tabular form, and an isoconcentration map should be prepared for one or more key contaminants for each monitored water-bearing zone, as appropriate. The report shall indicate the analytical method used, detection limits obtained for each reported constituent, and a summary of QA/QC data. Historical groundwater and surface water sampling results shall be included in the fourth quarterly report each year. The report shall describe any significant increases in contaminant concentrations since the last report, and any measures proposed to address the increases. Supporting data, such as lab data sheets, need not be included (however, see record keeping - below).

   d. Groundwater Extraction: If applicable, the report shall include groundwater extraction results in tabular form, for each extraction well and for the Site as a whole, expressed in gallons per minute and total groundwater volume for the quarter. The report shall also include contaminant removal results, from groundwater extraction wells and from other remediation systems (e.g., soil vapor extraction), expressed in units of chemical mass per day and mass for the quarter. Historical mass removal results shall be included in the fourth quarterly report each year.

   e. Status Report: The quarterly report shall describe relevant work completed during the reporting period (e.g., site investigation, remedial measures) and work planned for the following quarter.

5. **Violation Reports**: If the dischargers violate requirements in the Site Cleanup Requirements, then the dischargers shall notify the Regional Water Board office by telephone as soon as practicable once the dischargers have knowledge of the violation.

Regional Water Board staff may, depending on violation severity, require the dischargers to submit a separate technical report on the violation within five working days of telephone notification.

6. **Other Reports**: The dischargers shall notify the Regional Water Board in writing prior to any Site activities, such as construction or underground tank removal, which have the potential to cause further migration of contaminants or which would provide new opportunities for Site investigation.

7. **Record Keeping**: The dischargers or their agents shall retain data generated for the above reports, including lab results and QA/QC data, for a minimum of six years after origination and shall make them available to the Regional Water Board upon request.

8. **SMP Revisions**: Revisions to the Self-Monitoring Program may be ordered by the Executive Officer, either on his/her own initiative or at the request of the dischargers. Prior to making SMP revisions, the Executive Officer will consider the burden, including costs, of associated self-monitoring reports relative to the benefits to be obtained from these reports.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

June 24, 2013
File No. 43S1090 (NMK)

Cleanup Staff Report

Basis for recommendation to Adopt Site Cleanup Requirements Naming Moonlite Associates, LLC, and United Artist Theater Circuit, Inc., as Dischargers, 2640 El Camino Real, Santa Clara, Santa Clara County

I. Summary

Cleanup Staff (Staff) recommends that the Regional Water Board adopt Site Cleanup Requirements (SCR) naming Moonlite Associates, LLC, (Moonlite Associates) and United Artist Theater Circuit, Inc., (UATC) as dischargers for the former Moonlite Cleaners site (Site). This recommendation is based upon the following:

- A dry cleaner using tetrachloroethene (PCE) operated at the Site for approximately 35 years, from 1962 to 1997.
- The Site is contaminated with PCE, based on indoor air, soil gas, and groundwater monitoring results.
- UATC owned the property from 1961 to 1975, and then continued as the master lessor until 1978.
- Moonlite Associates has owned the property from 1977 to the present.
- Both UATC and Moonlite owned the Site at the time of the PCE discharges, had knowledge of the activities which resulted in the discharges, and had the legal ability to prevent the discharges.

II. Background

The Regional Water Board has provided regulatory oversight for this case since March 2009, at which time Moonlite Associates voluntarily enrolled in our cost recovery program. Moonlite Associates has been conducting the investigation and cleanup, and has now asked the Regional Water Board to name UATC as an additional discharger for the Site in the SCR. UATC objects to being named as a discharger; therefore, this staff report provides the rationale for naming UATC as an additional discharger. Moonlite Associates does not object to being named as a discharger in the SCR.

III. Site Location

The Site is located at 2640 El Camino Real in Santa Clara (Figure 1). The Site is located in the Moonlite Shopping Center (Figure 2). The Moonlite Shopping Center is bounded to the west by Kiely Boulevard, to the east by Bowe Avenue and Saratoga Creek, to the north by El Camino Real, and to the south by an alley. Saratoga Creek is located immediately east of Bowe Avenue. El Camino Real is a large boulevard, primarily used by commercial businesses and as an east to west thoroughfare, and is flanked by residential neighborhoods located one block to the north and south.

The former Moonlite Cleaners Site is an approximately 3,000 square foot tenant space and is presently occupied by Cosmo's Gifts, a retail store. The largest tenant spaces in the Moonlite Shopping Center are occupied by Save Mart Super Market, Rite Aid Drugs, Palo Alto Medical Group, Home Town Buffet, and Office Max. There are twenty-five additional smaller tenant spaces.

IV. Site History

A. History of Owners and Operators

Moonlite Cleaners, a dry cleaning business, operated at the Site for 36 years, from 1961 to 1997.

UATC developed the 14 acre shopping center in 1960. UATC owned the property from 1961 to 1975, and then continued as the master lessor until 1978. UATC owned and, as master lessor, controlled the shopping center where the dry cleaner operated as a tenant for 17 years, from 1961 to 1978. On September 5, 2000, UATC and affiliated entities filed for chapter 11 bankruptcy in the United States Bankruptcy Court for the District of Delaware. The court entered an order confirming a plan of reorganization for UATC on January 25, 2001.

The previous owners and operators of the Moonlite Cleaners dry cleaning business are not named as discharger because they are deceased.

Moonlite Associates has owned the Site from 1977 to the present. Moonlite Associates owned the shopping center where the dry cleaner operated as a tenant for 20 years, from 1977 to 1997.

B. Fire Marshal Permit and Dry Cleaning Equipment Used

On May 11, 1961, the State Fire Marshal issued a permit (Fire Marshal Permit) for establishment of a dry cleaner facility and installation of dry cleaning equipment at the Moonlight Shopping Center. This Fire Marshal Permit, the equipment used, and the discussion below, support that PCE was used at the Site beginning in 1961. The Fire Marshall Permit indicates the following equipment was installed at the Site:

- Hoffman Master Jet Cleaning Unit
- Hoyt SF-130 Reclaimer
- Per Combo Filter-Still Cooker
- Vapor-Mat Model 800

According to an employee of Hoffman/New Yorker, Inc. (personal communication with Richard Grecco, Hoffman New Yorker, February 2013,), a manufacturer and distributer of dry cleaning equipment for over 100 years, the Hoffman Master Jet Cleaning Unit and the Hoyt SF-130 Reclaimer are machines designed to be used only with chlorinated solvent dry cleaning fluids such as PCE, and not with petroleum hydrocarbon-based fluids such as Stoddard solvent. Additionally, according to Tom Mohr (personal communication with George Cook relaying message from Tom Mohr, February 6, 2013), the principal author of the Santa Clara Valley Water District *Study of Potential for Groundwater Contamination from Past Dry Cleaner Operations in Santa Clara County*, the Per Combo Filter-Still Cooker was only used for PCE. A

1979 operation manual for the Hoyt SF-130 Reclaimer also indicates the equipment is for the use of PCE only. The Fire Marshall Permit specifically refers to solvents and contains requirements for its proper handling, such as piping and ventilation.

C. PCE Discharges Occurred During UATC's Ownership and Control
As discussed in Section VI, the evidence indicates that there were substantial discharges of PCE. These discharges of PCE are consistent with common industry-wide operational practices for dry cleaners that operated from the 1960s to the 1990s. The prevalence of dry cleaner discharges is discussed in the 2007 Santa Clara Valley Water District *Study of Potential for Groundwater Contamination from Past Dry Cleaner Operations in Santa Clara County* (Water District Study). Examples of common release mechanisms from dry cleaner operations include:

- PCE spilled onto the floor from dry cleaning equipment maintenance and operation, equipment failure, solvent transfer and storage, or drips from wet clothing with residual PCE;
- PCE spilled onto the floor then seeped through concrete or cracks and reached the soil and groundwater below;
- PCE soaked into concrete and then volatilizing into indoor air;
- Spent PCE dumped onto soil behind building;
- PCE-saturated spent cartridge filters stored behind building;
- Water containing PCE (e.g., from water/solvent separator) discharged to the floor drain with leakage from the sewer lateral to soil and groundwater; and
- PCE in soil and groundwater volatilizing and intruding into indoor air.

The concentrations and distribution of PCE in groundwater, soil gas, and indoor air at the Site (the highest PCE concentrations in soil and groundwater are beneath the Site and downgradient from the Site), indicate that the Moonlite Cleaners' dry cleaning operations were no different than the dry cleaners discussed in the Water District Study that discharged PCE.

In addition, as discussed on pages 43 – 47 and 142 – 148 of the Water District Study, older dry cleaners used more solvent and released a greater percentage of the solvent used due to relative inefficiencies of the older equipment compared to newer equipment. The year during which a dry cleaner began operations is a useful indicator of the potential mount of PCE mass released. In general, the earlier a dry cleaner operated the more likely it is that larger quantities of PCE were released to soil and groundwater due to older equipment and common PCE handling and disposal practiced for that time period. For example, Table 13 on page 47 of the Water District Study shows how typical dry cleaners from the 1960s used much more PCE per pound of clothes cleaned and had a much higher leakage rate than a typical dry cleaner from the 1990s.

Thus, based on the physical evidence at the Site and downgradient from it (see Section VI below), the history of solvent usage at the Site beginning in 1961, the common industry-wide operational practices that led to PCE discharges in the 1960s and 1970s, and the inefficiencies of older dry cleaning equipment from the 1960s, the cleanup staff conclude that there is substantial evidence that PCE discharges occurred during UATC's ownership and control of the Site from 1962 and 1978 and afterwards when Moonlite Associates took ownership.

V. Hydrogeology

The topography of Santa Clara is predominantly flat, sloping gently to the north northeast towards the Guadalupe River and the San Francisco Bay. Locally at the Site, the topography slopes gently to the east, towards the adjacent Saratoga Creek, that flows to the north. The elevation of the Site is approximately 80 feet above mean sea level.

The headwaters of Saratoga Creek originate is in Santa Cruz Mountains at 3,100 feet, approximately 10 miles to the southwest. Saratoga Creek is the principal drainage for the Saratoga Creek Watershed. Santa Clara Valley Water District uses Saratoga Creek upstream of the Site to recharge groundwater in the reach between the city of Saratoga and Highway 280, approximately. Saratoga Creek currently is a gaining creek adjacent to the Site. Saratoga Creek joins the San Tomas Aquino Creek before joining the Guadalupe Slough, ultimately draining to the San Francisco Bay.

The sediment beneath the Site is ancestral Saratoga Creek stream channel sediment overlying older Late Pleistocene alluvial plain sediment. The ancestral Saratoga Creek sediment is fine to coarse grained channel deposits, with fine grained flood deposits outside the channels. The pattern of fine and coarse grained lenses of sediment observed at the Site represent the deposits of the meandering ancestral Saratoga Creek flowing northward over the alluvial plain sediments. These ancestral Saratoga Creek sediment has been encountered from approximately 5 to 50 feet below ground surface during investigations. The ancestral Saratoga Creek sediment was deposited in the same orientation as the present orientation of Saratoga Creek, and the north-trending ancestral stream channels of Saratoga Creek should influence the direction of groundwater flow to the north.

The depth to groundwater in Site monitoring wells is approximately 12 feet below ground surface. The calculated groundwater flow direction at the Site is northeast, with a gradient of approximately 0.005 feet per foot. The flow direction of groundwater at the Site is most likely controlled by north-trending Saratoga Creek, the north-trending ancestral Saratoga Creek stream deposits, the gently north sloping topography, and deep production wells located in the vicinity.

Concentrations of PCE have been detected in groundwater down gradient of the Site to the north, from the northeast to the northwest. This distribution of contamination in groundwater is consistent with the controlling factors that influence the groundwater flow direction.

VI. Investigation and Cleanup

Significant releases of the dry cleaning chemical PCE can be attributed to the former Moonlite Cleaners. PCE has been detected in indoor air samples, in soil gas samples, and in groundwater samples in quantities far exceeding Environmental Screening Levels (ESLs) for each media. PCE is day lighting in the adjacent Saratoga Creek. Other potential dry cleaning chemicals, such as Stoddard solvent, were not detected during the investigations.

The highest historical detections of PCE in groundwater, soil gas, and indoor air are in the immediate vicinity of or directly beneath the Site, indicating a discharge directly beneath the dry cleaner. This statement is supported by the following Site data:

- PCE has consistently been detected in groundwater immediately down gradient of the Site in MW3, MW4, MW4A, MW5, and MW5A. Recent groundwater monitoring results from June 2012 detected PCE in groundwater at 1,280 ug/L in MW4, over 200 times higher than the ESL of 5 ug/L.
- The highest soil gas concentration of PCE was detected immediately beneath the former dry cleaner at 5,700,000 ug/m3, over 2,000 times higher than the ESL of 2,100 ug/m3. Soil gas concentrations decrease with distance from the former dry cleaner.
- The highest indoor air concentration of PCE was detected in the former dry cleaner at 150 ug/m3 PCE, about 70 times higher than the ESL of 2.1 ug/m3. Indoor air concentrations of PCE in the adjacent tenant spaces decrease with distance from the former dry cleaner.
- The highest surface water concentration of PCE collected from Saratoga Creek was detected downstream of the former dry cleaner at 49 ug/L, approximately half of the ESL of 120 ug/L. Surface water samples collected upstream from the former dry cleaners have never contained any PCE.

The Site data clearly indicate that the highest concentrations of PCE are immediately beneath, down gradient, and downstream of the former dry cleaner, and decrease with distance away from the former dry cleaner. This pattern indicates that significant releases of PCE occurred directly beneath the former dry cleaner and are likely from common release mechanisms discussed in Section IV.C.

A soil vapor extraction (SVE) system was installed in February 2010 beneath the former dry cleaner facility and has been operating continuously since then. The SVE system consists of five horizontal extraction pipes and eight vertical extraction wells. The purpose of the SVE system is to provide vapor intrusion mitigation to the tenants and to remove PCE mass. Approximately 300 pounds of PCE have been removed by the SVE system as of December 2012.

VII. Response to March 12, 2013, EKI Report

UATC retained Erler & Kalinowski, Inc. (EKI) to assess the likelihood of a PCE release between 1962 and 1978. EKI concluded in its March 12, 2013, report that there is no evidence of a pre-1978 PCE release for the following reasons.

- EKI infers from a review of groundwater data that groundwater at the Site would have flowed to the northwest prior to the mid-1990s; therefore, if there was a pre-1978 PCE release, there would be evidence of a northwest-trending groundwater plume, which according to EKI does not exist.
- EKI infers from a review of groundwater data that groundwater flow at the Site shifted to the northeast in the mid-1990s, and since the current groundwater plume travels to the northeast, the PCE release that caused the groundwater plume happened in the mid-1980s or early 1990s.
- EKI infers from a review of groundwater data that groundwater levels at the Site were deeper during the pre-1978 period, therefore if a PCE release occurred pre-1978, it would have resulted in a deeper groundwater plume, which according to EKI does not exist.

These conclusions are not technically supportable, as explained below.

A. PCE Plume Can't Be Age-Dated Based on Current Groundwater Flow Direction and Depth

The release timeframe of the PCE groundwater plume cannot be age-dated based on the current direction of groundwater flow and depth of groundwater compared to an inferred pre mid-1990s direction of groundwater flow and depth of groundwater. The PCE releases likely occurred from the common release mechanisms previously discussed during the span of 35 years of operation of the dry cleaner. The PCE would have leaked on the floor of the dry cleaner and would have slowly seeped into the concrete floor. It could take years to decades for small amounts of PCE to seep through the concrete and then enter soil beneath the concrete, before migrating through soil to groundwater. This probable decades-long delay from the release of PCE to when PCE entered the groundwater raises questions as to the validity of EKI's age-dating of the groundwater plume hypothesis.

The EKI report assumes a continual leak of wastewater from a leaking sanitary sewer line as the driver for carrying PCE through soil to groundwater. Cleanup Staff disagree and assert that the extremely high PCE indoor air concentrations more likely indicate a direct release to the floor of the dry cleaner. The PCE could have been bound up for years to decades in the soil immediately beneath the concrete slab and above the sewer line. This would cause a delay in PCE reaching groundwater. Therefore the northeast-trending groundwater plume that is seen today is most likely partially attributable to PCE discharges from the 1960s and 70s.

B. PCE Plume is Detected in the Northeast, North, and Northwest

EKI infers from a review of groundwater data that groundwater at the Site would have flowed to the northwest prior to the mid-1990s; therefore, if there was a pre-1978 PCE release, there would be evidence of a northwest-trending groundwater plume, which according to EKI does not exist. Staff disagrees with EKI's analysis and concludes that PCE does exist to the north and northwest, as well as to the northeast.

EKI used time-series groundwater elevation data from a deep well to make inferences about groundwater elevations in shallow groundwater at the Site. The index well that EKI used to compare the Site with is a deep well located approximately six miles to the southeast and screened in a different aquifer. The index well is located in the recharge zone, while the Site is located in the confined zone. This is too great a distance away to be able to draw conclusions for shallow groundwater at the Site.

EKI used 1990 to 2000 groundwater data from a Shell gas station 1000 feet away from the Moonlite Cleaners Site, and on the opposite side of Saratoga Creek, to estimate the groundwater flow direction at the Moonlite Cleaners Site in the 1960s and 70s. The time and distance involved in this comparison is too large and could lead to variations in the correlations of groundwater flow directions between the two sites.

EKI's depiction of a northwest trending groundwater plume in Figure 10 of the EKI report is not supported by the groundwater flow variations seen at the Shell gas station. Staff reviewed the groundwater flow directions from the Shell gas station contained in Attachment A of the EKI report and observed a roughly 45 degree variation in the groundwater flow direction from the time when Saratoga Creek was purportedly losing or gaining. This is less than the 60 degree variation EKI cites in Attachment A of the report, and less than the 90 degree variation EKI shows on Figures 10 and 11 for a hypothetical groundwater plume under losing-creek conditions compared to the present day groundwater plume under gaining-creek conditions. Using a 45 degree amount of variation in the groundwater flow direction from a losing to a graining creek, the groundwater flow direction at the Moonlite Cleaners Site could have varied from its present northeast direction under gaining-creek conditions to a northerly direction under losing-creek conditions. This is consistent with the areal spread of groundwater contamination seen in the current groundwater plume with groundwater concentrations in northerly borings B2, B17, B18, and B32 at 27 ug/L PCE, 4.6 ug/L PCE, 18 ug/L PCE, and 96 ug/L PCE, respectively (see figure 3).

EKI concludes that there is no evidence of groundwater contamination in the northwest direction. This statement is not accurate, since borings B2 and B17 described above are located to the northwest. Also, since the common release mechanisms from dry cleaners occur and accumulate over time, the discharge of PCE to shallow groundwater would have been delayed in time, causing the northeast trending plume seen today.

C. Northeast-trending PCE Plume Partially Caused by PCE Discharges from the 1960s and 70s

EKI infers from a review of groundwater data that groundwater flow at the Site shifted to the northeast in the mid-1990s, and since the current groundwater plume travels to the northeast, the PCE release that caused the groundwater plume happened in the mid-1980s or early 1990s. This conclusion is incorrect because the PCE could have been bound up for years to decades in the soil immediately beneath the concrete slab and above the sewer line. This would cause a delay in PCE reaching groundwater. Therefore, PCE released during UATC’s ownership and control from 1962 to 1978 would not have started to migrate in groundwater until the northeast gradient was established.

D. PCE Contamination is Found at Deeper Depths Beneath the Site

EKI infers from a review of groundwater data that groundwater levels at the Site were deeper during the pre-1978 period, therefore if a PCE release occurred pre-1978, it would have resulted in a deeper groundwater plume, which according to EKI does not exist. This is incorrect. Groundwater in boring B32 located 50 feet north of the Site contained 96 ug/L PCE at approximately 40 feet below ground surface. Groundwater monitoring well MW5A located 50 feet northeast of the Site contained 1,130 ug/L PCE at approximately the same depth. These concentrations of PCE at depth are immediately above a relatively thick clay layer that extends from approximately 40 to 60 feet bgs at B32 that would slow any further downward vertical migration of PCE regardless of the time of release. Given that the PCE could have been bound up for years to decades in the soil immediately beneath the concrete slab and above the sewer line, these PCE concentrations at 40 feet below ground surface are most likely partially attributable to PCE discharges from the 1960s and 70s.

VIII. UATC is a Discharger under Water Code section 13304

Water Code section 13304 authorizes the Regional Water Board to issue cleanup and abatement orders to any person who caused or permitted waste to be discharged or deposited where it is, or probably will be, discharged into waters of the State and creates, or threatens to create, a condition of pollution or nuisance. Whether a person caused or permitted such waste discharges has been broadly construed by the State Water Resources Control Board (State Water Board) in numerous precedential orders to include owners and operators at the time of discharge. A prior landowner and lessees may be named as a discharger if it (1) owned or were in possession of the property at the time of discharge, (2) had knowledge of the activities which resulted in the discharge, and (3) had the legal ability to prevent the discharge. State Water Board Orders WQ 85-7, 86-15, and 93-13. In this case, UATC meets all the criteria to be named as a discharger as discussed below.

A. UATC Owned the Property during the Time of Discharge

As discussed previously, UATC owned the property from 1961 to 1975 and then continued as master lessor until 1978. During this time, Moonlite Cleaners used PCE in its dry cleaning business and discharged PCE to soil and groundwater, as previously discussed.

B. UATC had Knowledge of Activities that Resulted in the Discharge

UATC had knowledge of the activities that resulted in the discharge. As previously stated, on May 11, 1961, the State Fire Marshall issued a permit to Moonlite Cleaners for the establishment of a dry cleaning business, which required numerous interior and exterior building improvements such as the installation of a piping system and exhaust fans and ducts. In furtherance of this, on June 27, 1961, UATC obtained a building permit for Moonlite Cleaners. On July 10, 1962, UATC received, on behalf of Moonlite Cleaners, a certificate of occupancy from the City of Santa Clara. UATC was therefore actively involved in the establishment of the dry cleaner site. Importantly, the Fire Marshall Permit put UATC on notice that the business had risks related to solvent handling not inherent in other businesses. The permit required all processes to take place only in the equipment approved by the Fire Marshall and required reclaimed solvent to be transferred only through an approved piping system. The permit also alerted UATC of the potential for “toxic concentration of vapor” developing around the cleaning equipment and the need for floor level ventilation or an approved “breathing mask.” Thus, UATC had actual knowledge of the hazardous nature of solvent handling at the Site and the need for careful handling of solvents. Even if one accepts that UATC did not have actual knowledge, the historical record shows that UATC should have known of the use of chemicals at the Site and its dangers, including the potential for unauthorized discharges. As the State Water Board held, actual knowledge of contamination need not be shown where it is reasonable for a person to be aware of the dangers generally inherent in the activity. State Water Board Order No. 86-15.

C. UATC had the Legal Ability to Prevent the Discharge

As the owner of the Site (as well as master lessor) and landlord to Moonlite Cleaners, UATC exercised ultimate control over the property and had the legal ability to prevent the discharge. UATC would have had a lease with Moonlite Cleaners for operation of the dry cleaning business. This lease would have given UATC legal control over Moonlite Cleaners’ activities and would have given UATC the legal ability to prevent the discharge.

IX. UATC Did Not Discharge its Cleanup Obligations as a Result of its Bankruptcy

UATC filed for bankruptcy in 2000 and emerged from Chapter 11 bankruptcy as a newly reorganized entity in 2001. An obligation to cleanup and ameliorate ongoing pollution is not a claim that is dischargeable through bankruptcy. (*In re Chateaugay* (2d Cir. 1991), 944 F.2d 997). Even if it were a claim that could be discharged through bankruptcy, the claim never arose in time for it to be discharged. The Regional Water Board was not aware of the Site and its contamination until 2009—almost a decade after UATC filed for bankruptcy. Under the "fair contemplation" test commonly used by bankruptcy courts, a claim only arises if the government has actual or constructive knowledge of a release or threatened release and could tie the debtor to the release prior to confirmation of the bankruptcy. (*In re National Gypsum Co*. (N.D. Tex 1992 139 B.R. 397; *In re Jensen* (9th Cir. 1993) 995 F.2d 925.) Knowledge, notification, investigation, cleanup activities, and incurring response costs are all indicia of "fair contemplation." (*In re Gypsum Co.* at 407.) None applies here since the Regional Water Board only became aware of the Site and the contamination nine years after the bankruptcy filing. In sum, UATC's cleanup obligation was not a claim that could be discharged and even if it could be, the claim never arose for it to be discharged by the bankruptcy proceeding and UATC remains liable for cleaning up the Site.

X. Conclusion

Based on a review of all relevant information Staff recommends that the Regional Water Board adopt Site Cleanup Requirements naming Moonlite and UATC as dischargers for the Site.

Attachments:

Figure 1: Site Vicinity Map
Figure 2: Site Location Map
Figure 3: PCE in Groundwater

Figure 1: Site Vicinity Map

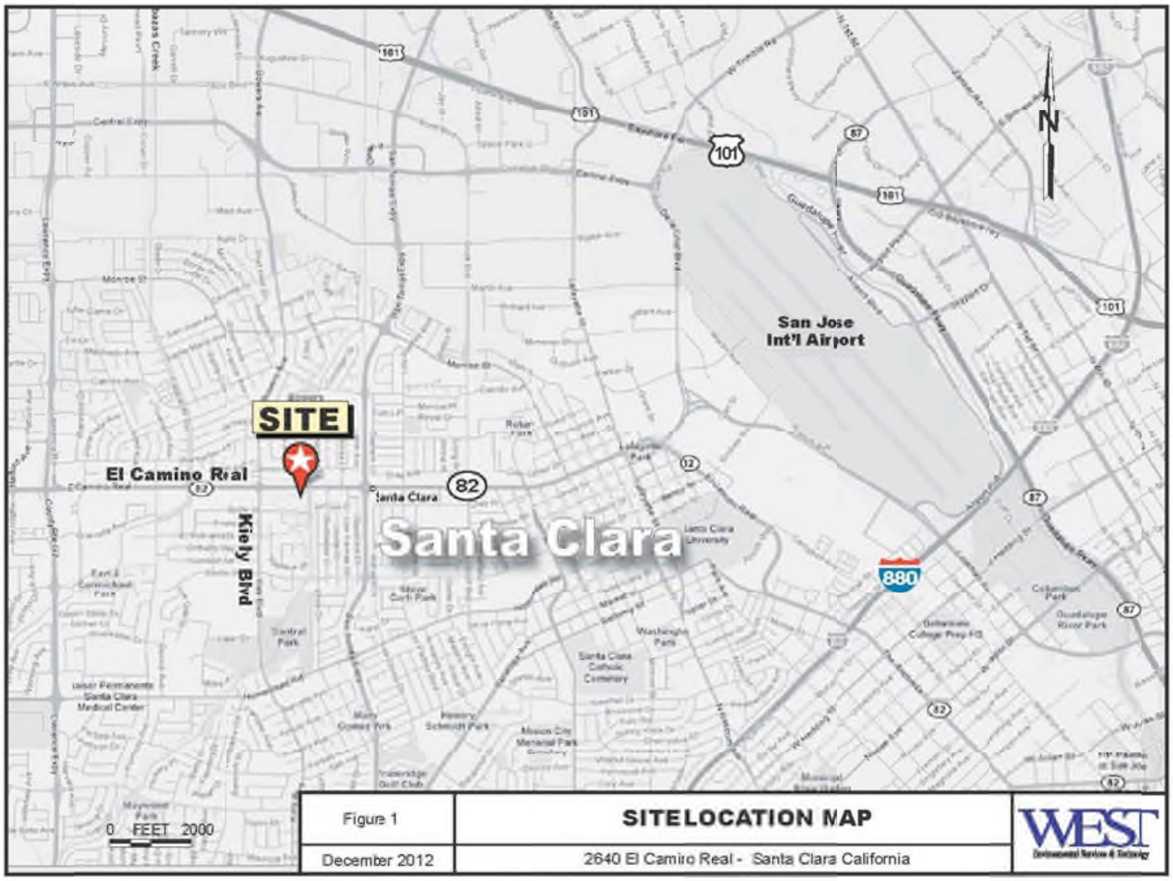


Figure 2: Site Location Map

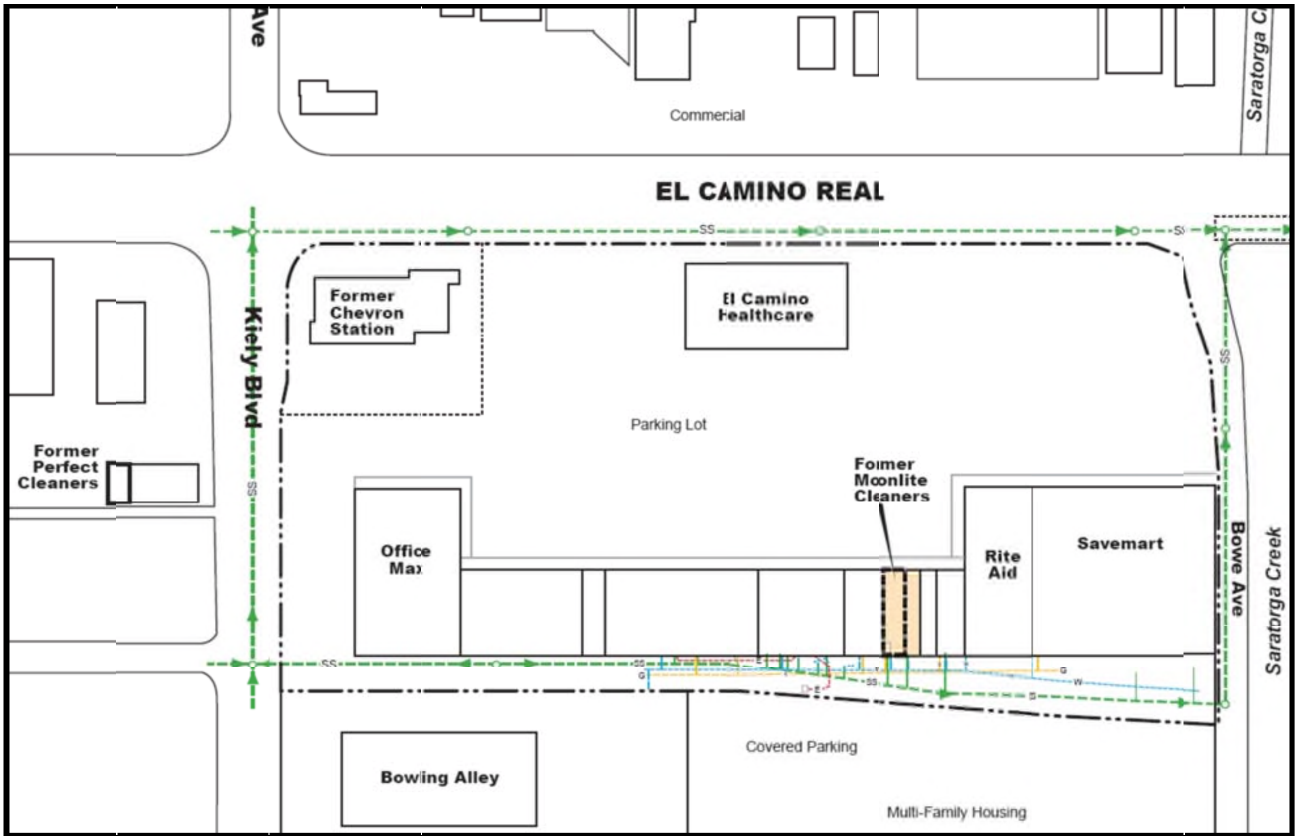


EXHIBIT 6

UATC PRESENTATION

2640 El Camino Real
Santa Clara, California

Regional Board Hearing
11 September 2013

Hogan Lovells US LLP
Erler & Kalinowski, Inc.

UATC SHOULD NOT BE NAMED AS A DISCHARGER

The Legal Standard

The Regional Board may issue a CAO to "[a]ny person … who has caused or permitted, causes or permits, or threatens to cause or permit any waste to be discharged or deposited where it is, or probably will be, discharged into the waters of the state and creates, or threatens to create, a condition of pollution or nuisance…." Cal. Water Code § 13304(a).

UATC SHOULD NOT BE NAMED AS A DISCHARGER

Elements For Establishing A Landlord <u>“Caused Or Permitted” A Discharge</u>

I. Ownership/Possession During Discharge

II. Knew or Should Have Known of the Discharge

III. Legal Ability to Prevent the Discharge

I. DISCHARGE TIMING: TECHNICAL OVERVIEW

A. The Change in Groundwater Flow Direction at the Site Allows us to Determine that the PCE Release Occurred Well After 1978

B. Staff's Counter-Arguments are Not Supported

   1. "Inconsistent Local Groundwater Flow" Theory
   2. "Suspended PCE" Theory

C. Staff's Conclusion that Sewer Leaks Were Not a Primary Source of Contamination at the Site is Indefensible

Proximity of Site to Saratoga Creek

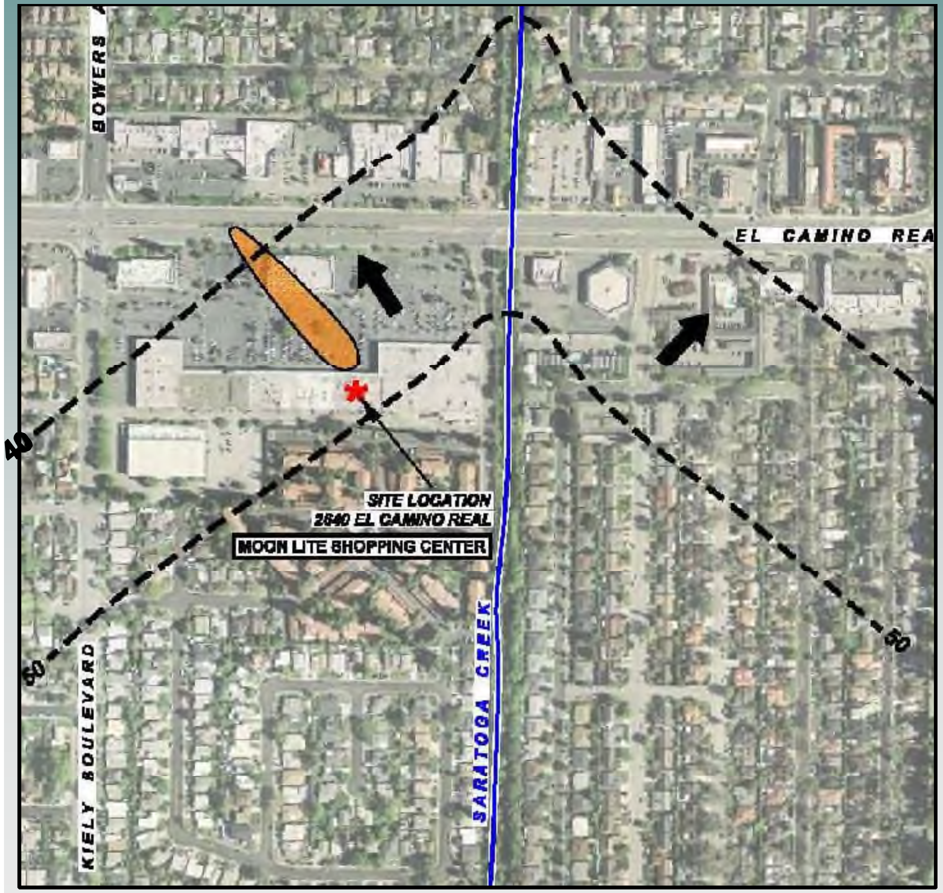
A. CHANGE IN GROUNDWATER FLOW DIRECTION ALLOWS US TO DATE RELEASE

- GW elevations and flow directions can change over time
- When GW elevations at the Site are below Saratoga Creek, groundwater flows northwesterly: ↖ plume
- When GW elevations at the Site are above Saratoga Creek, groundwater flows northeasterly: ↗ plume

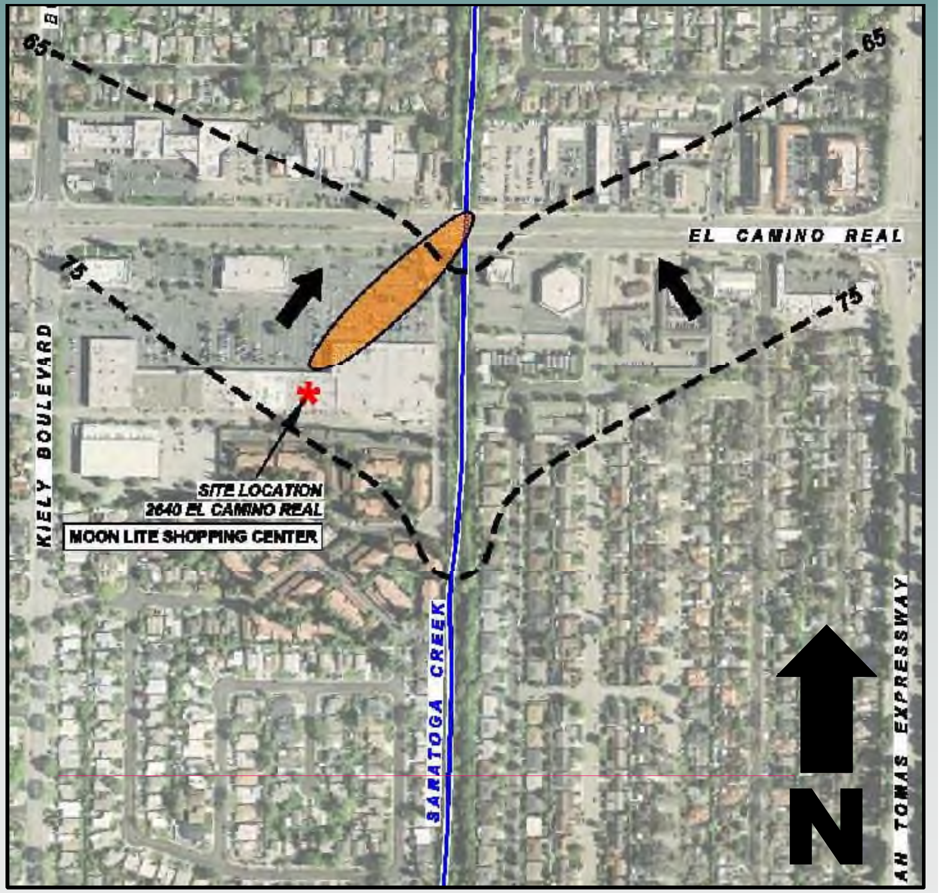
- GW flow shifted from northwesterly ↖ to northeasterly ↗ in ~1993
- Site has a northeasterly ↗ plume and no northwesterly ↖ plume, so contamination must have reached GW post-1993
- Calculations show that it would take ~6 years for contaminated water to reach GW, so release occurred after 1987

Groundwater Flow Directions With Hypothetical Chemical Plumes

Pre ~ 1993

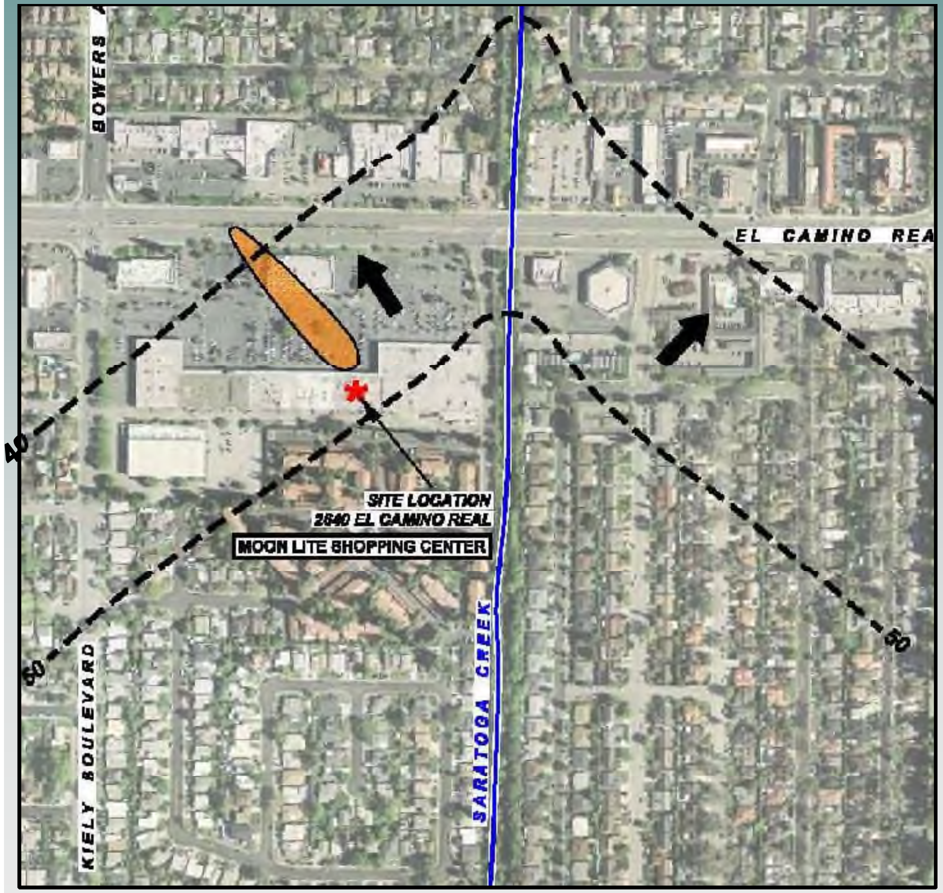


Post ~ 1993

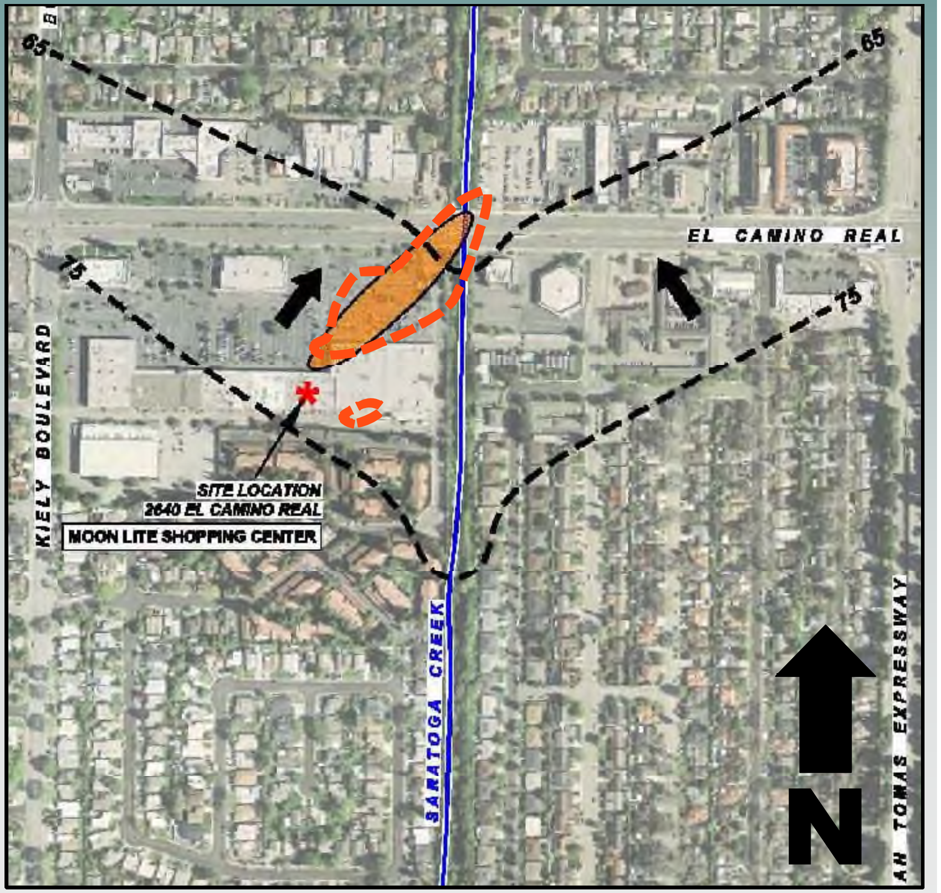


Current Site PCE Plumes

Pre ~ 1993



Post ~ 1993



General Agreement Regarding Northwesterly to Northeasterly Groundwater Flow Direction Shift In Early 1990s

"Groundwater flow directions therefore, have *varied from toward the northwest*, when surface water exfiltrated from Saratoga Creek. As groundwater elevations rose above the base of Saratoga Creek, *groundwater flow shifted to the northeast* toward the Saratoga Creek."

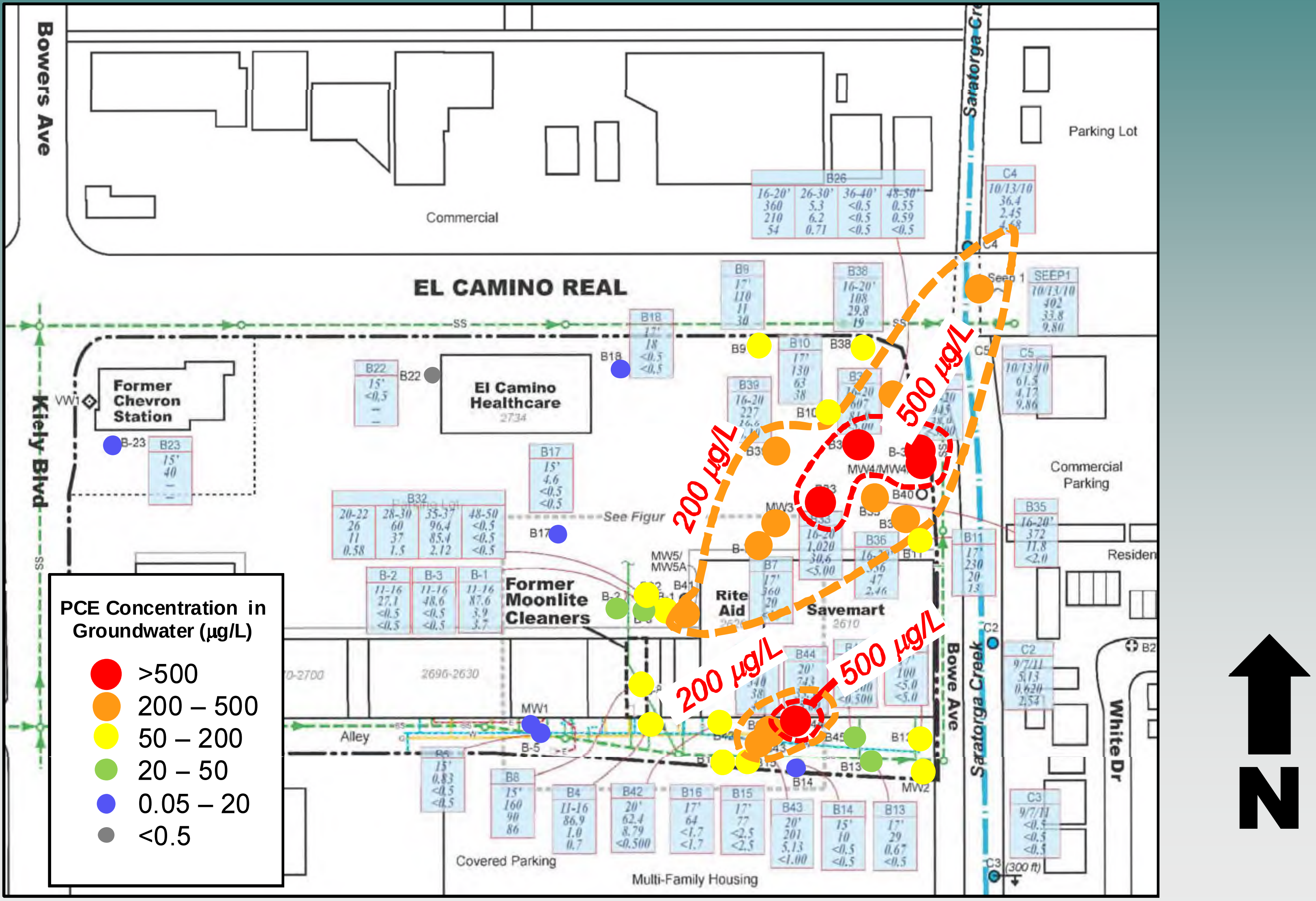
West Environmental Services and Technologies, 2011, *Site Investigation Report.*

General Agreement Regarding Northwesterly to Northeasterly Groundwater Flow Direction Shift In Early 1990s

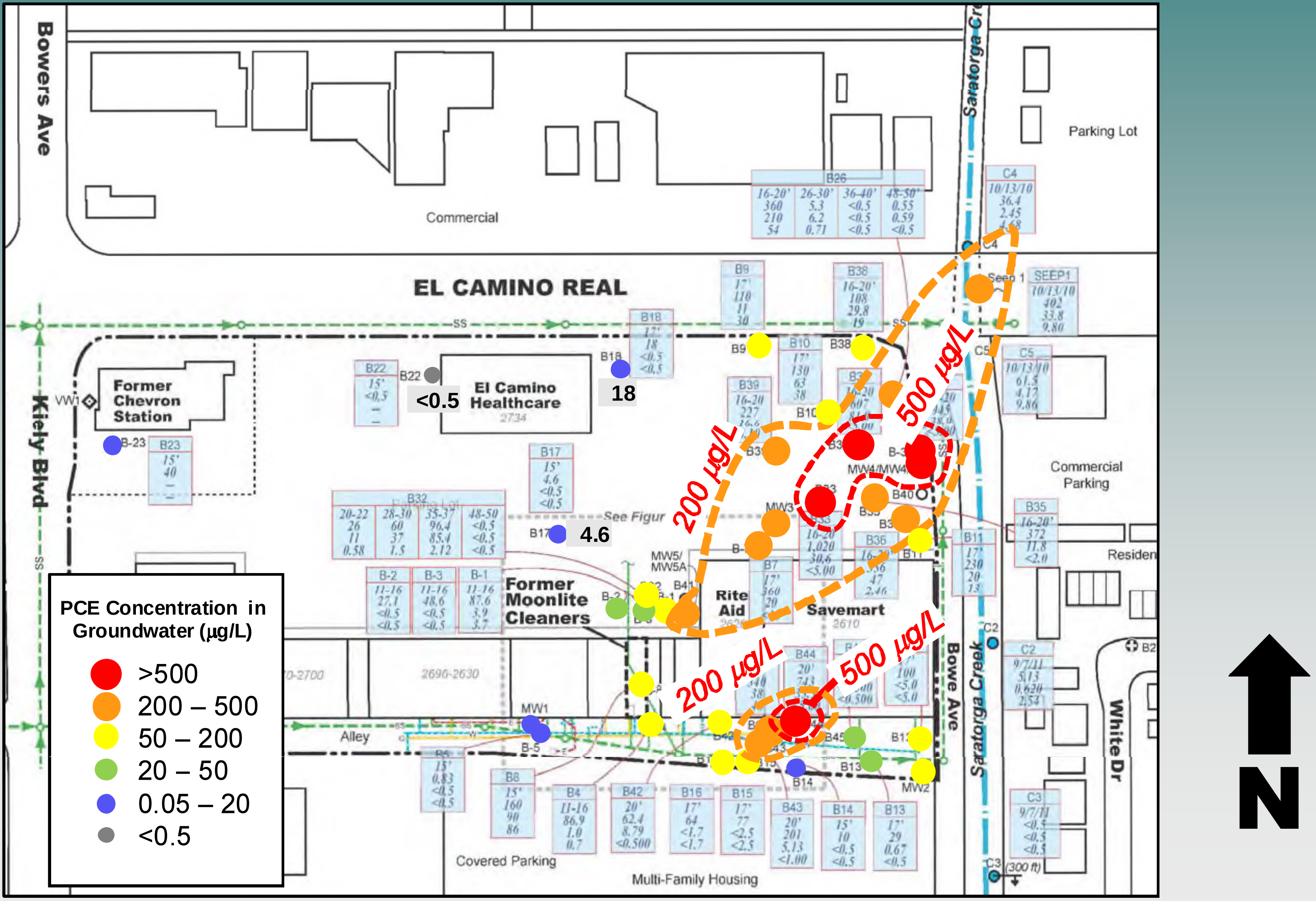
"In the early 1990s as rising groundwater levels surpassed the surface water elevation in the creek, *the northerly regional gradient shifted to the northeast near the creek*, as is seen today."

Revised Cleanup Staff Report, August 29, 2013.

Site PCE Plumes Consistent with Post ~1993 Flow Direction



Site PCE Plumes Consistent with Post ~1993 Flow Direction



B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory

“ The timing of the release of PCE, either before or after 1978, cannot be predicted solely on the lack of significant contamination in the subsurface to the northwest of the Site due to *uncertainty of the historic groundwater flow direction*. As seen in the Chevron station site adjacent to the Moonlite Site, flow direction varied widely in the early and mid-1990s, contrary to EKI’s hypothesis that groundwater flowed only to the northwest pre-1994.”

Revised Cleanup Staff Report, August 29, 2013.

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory

- New Theory. Staff presented this for the first time last week.
- Completely dependent on one obviously anomalous data point from the former Chevron Station and flawed Interpretations of Chevron’s consultant.

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory

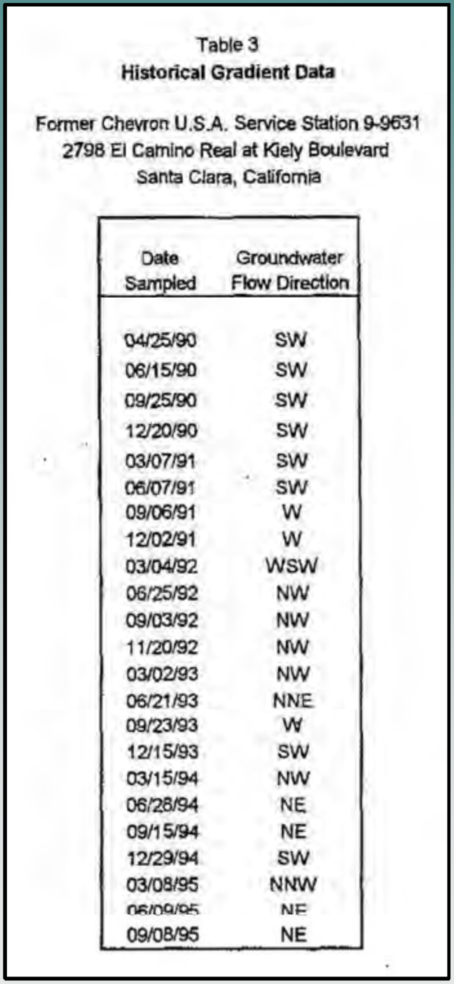


Table 3
Historical Gradient Data

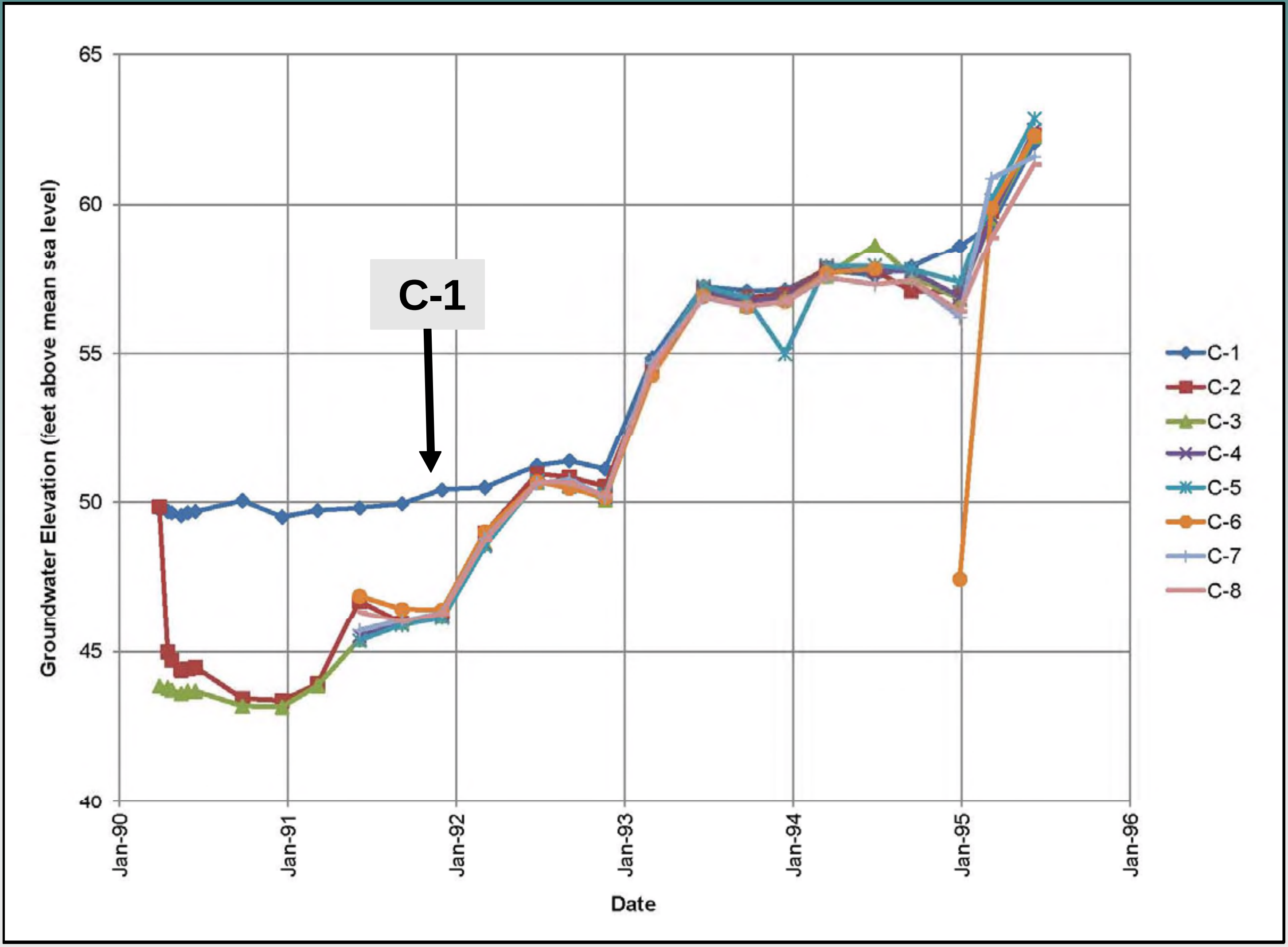
Former Chevron U.S.A. Service Station 9-9631
2798 El Camino Real at Kiely Boulevard
Santa Clara, California

Date Sampled	Groundwater Flow Direction
04/25/90	SW
06/15/90	SW
09/25/90	SW
12/20/90	SW
03/07/91	SW
06/07/91	SW
09/06/91	W
12/02/91	W
03/04/92	WSW
06/25/92	NW
09/03/92	NW
11/20/92	NW
03/02/93	NW
06/21/93	NNE
09/23/93	W
12/15/93	SW
03/15/94	NW
06/28/94	NE
09/15/94	NE
12/29/94	SW
03/08/95	NNW
06/09/95	NE
09/08/95	NE

Pacific Environmental Group, Inc., 1996, *Technical Response/Work Plan, Former Chevron USA Service Station 9-9631, 2798 El Camino Real at Kiely Boulevard, Santa Clara, California.*

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory



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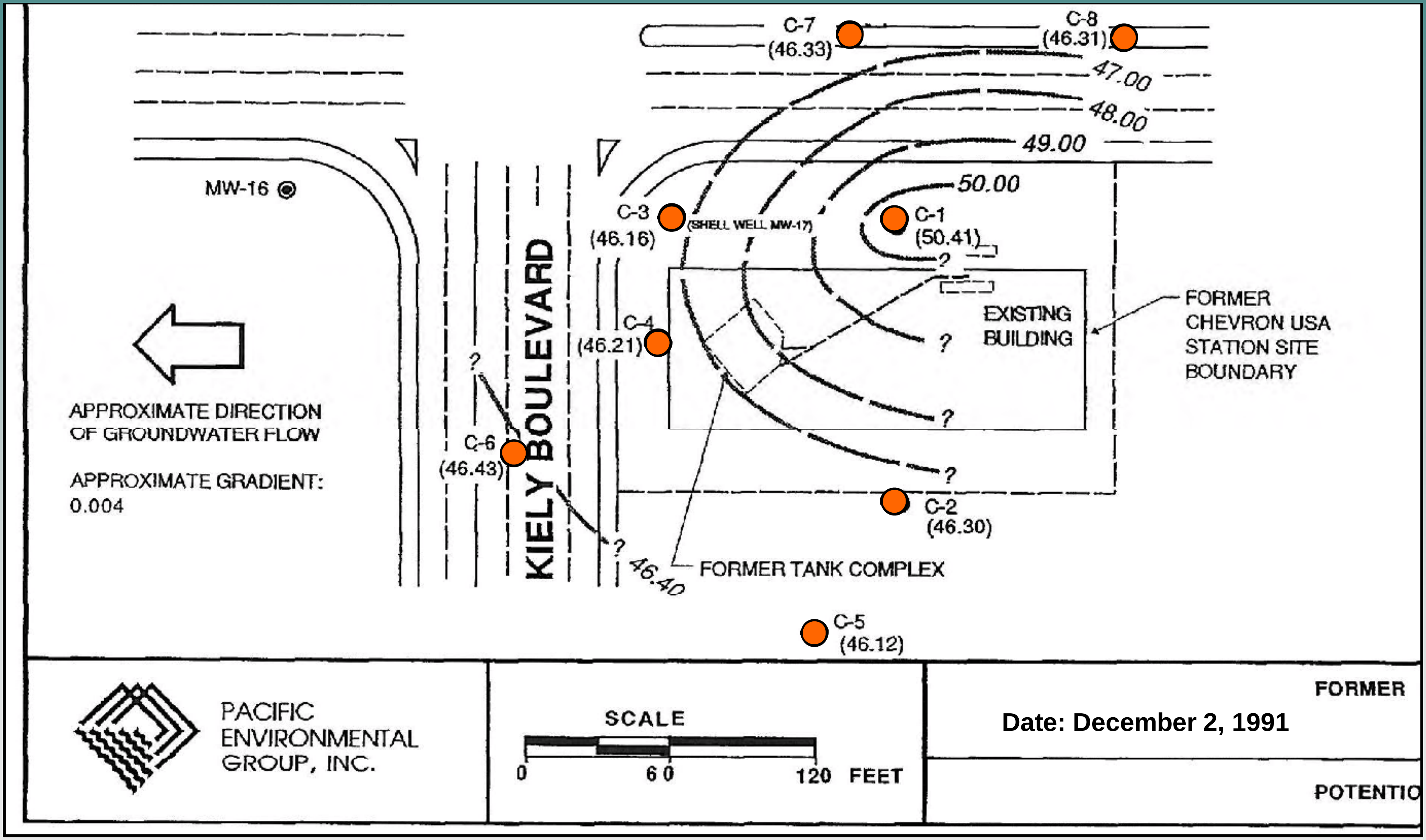
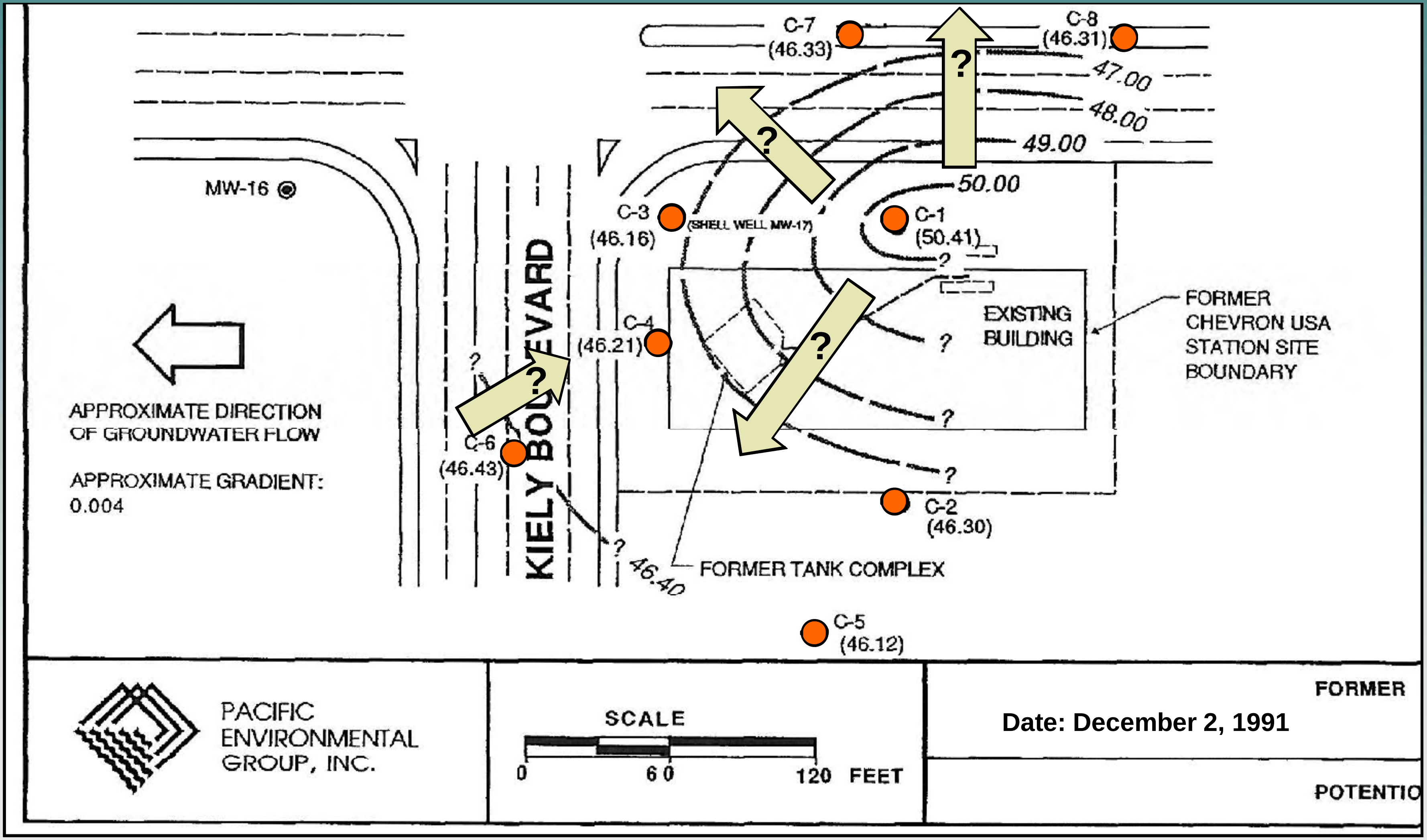


Pacific Environmental Group, Inc., 1992, *Results of 4th Quarter Groundwater Sampling and Analytical Program, Former Chevron USA Service Station 9-9631, 2798 El Camino Real, Santa Clara, California*.

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory

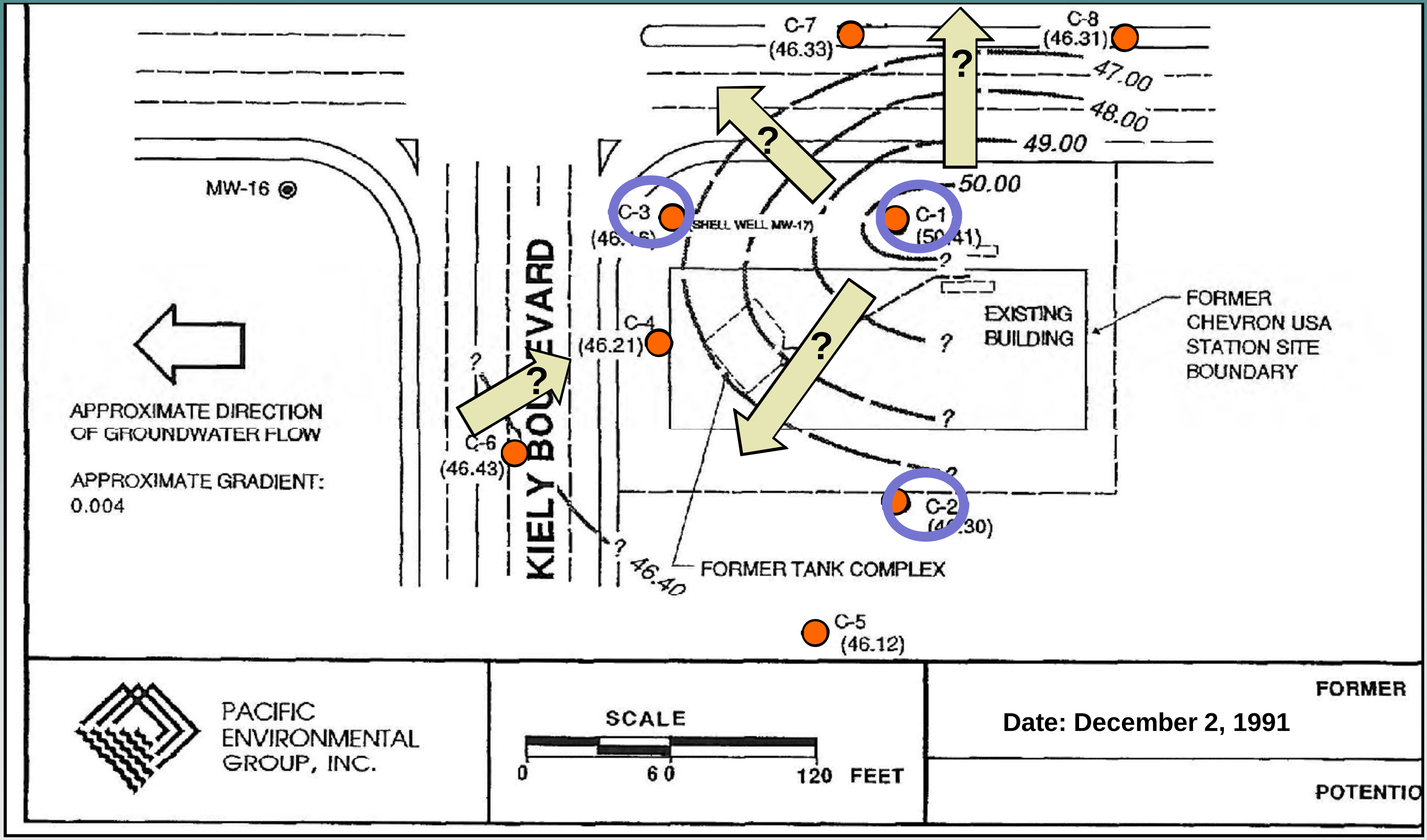


Date: December 2, 1991

Pacific Environmental Group, Inc., 1992, *Results of 4th Quarter Groundwater Sampling and Analytical Program, Former Chevron USA Service Station 9-9631, 2798 El Camino Real, Santa Clara, California*.

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory



Date: December 2, 1991

Pacific Environmental Group, Inc., 1992, *Results of 4th Quarter Groundwater Sampling and Analytical Program, Former Chevron USA Service Station 9-9631, 2798 El Camino Real, Santa Clara, California*.

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory

- Interpreting Anomalous Groundwater Elevation Data

  “Look for ‘bull’s-eyes,’ multiple contours drawn about a single point, showing that the value of that point is much higher or much lower than that of surrounding points. Bull’s-eyes may indicate a true, unusually high or low point in a water surface, such as could be caused by a pumping or injection well. Alternatively, they may simply be bad data (Fig. 10.6). *These points should be examined carefully to determine if the data are real or spurious*.”

Sanders, L., 1998, *A Manual of Field Hydrogeology.*

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

1. “Inconsistent Local Groundwater Flow” Theory

- Well C-1 groundwater elevations are ~5 feet higher than surrounding wells forming a “mound” and for almost 3 years are “stuck” at ~50 feet above mean sea level – clearly anomalous.
- Relying on data from only wells C-1, C-2, and C-3 and concluding that there is a southwest gradient in the early 1990s is an error.
- No evidence for theory that deep production wells caused a southwest gradient at former Chevron Station.
- Gradients calculated without well C-1 data generally trend north or northwest.
- No evidence for a local southwest gradient at former Chevron Station – much less the Moonlite Site.

B. STAFF'S ARGUMENTS ARE NOT SUPPORTED

2. "Suspended PCE" Theory

"The PCE could have been *bound up for years to decades* in the soil immediately beneath the concrete slab and above any sewer lines."

Revised Cleanup Staff Report, August 29, 2013.

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

2. “Suspended PCE” Theory

- Dissolved PCE
  - Model calculations using site-specific input parameters and reasonable assumptions show that dissolved PCE would take only ~6 years to reach groundwater, not 15.
- Free Product
  - No DNAPL detected at the Site
  - DNAPL can move faster than dissolved PCE, so < 6 years
  - DNAPL volatilizes creating groundwater plume

B. STAFF’S ARGUMENTS ARE NOT SUPPORTED

2. “Suspended PCE” Theory

DNAPL in the Vadose Zone

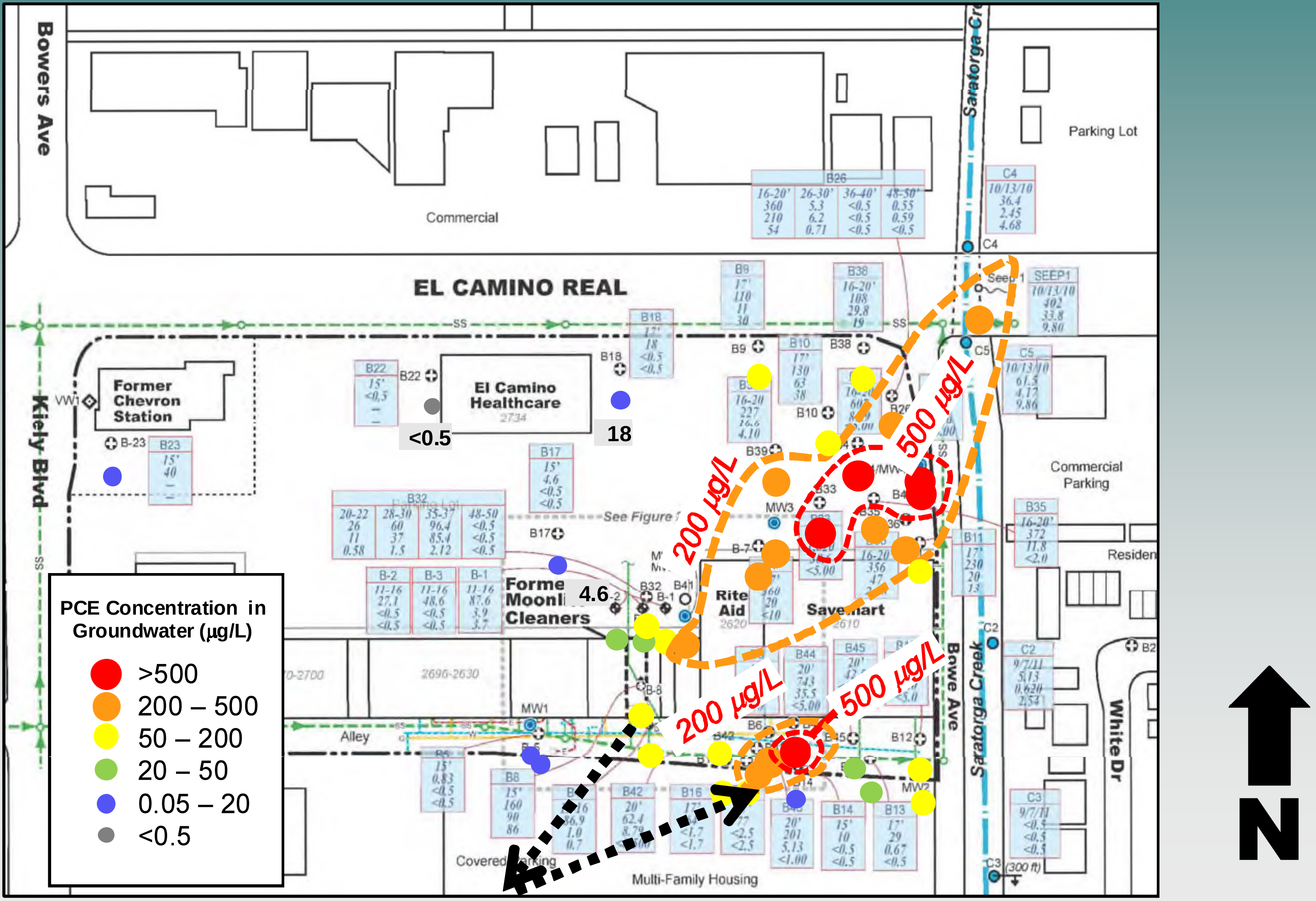
“ The results of Poulsen and Kueper (1992) suggest that small DNAPL releases on the order of only a few gallons have the potential to penetrate to depths of many feet below ground surface within hours or days.”

“In addition, some of DNAPL will volatilize and form a vapor extending beyond the separate phase liquid…These vapors can condense on soil water and the water table, also causing additional groundwater contamination.”

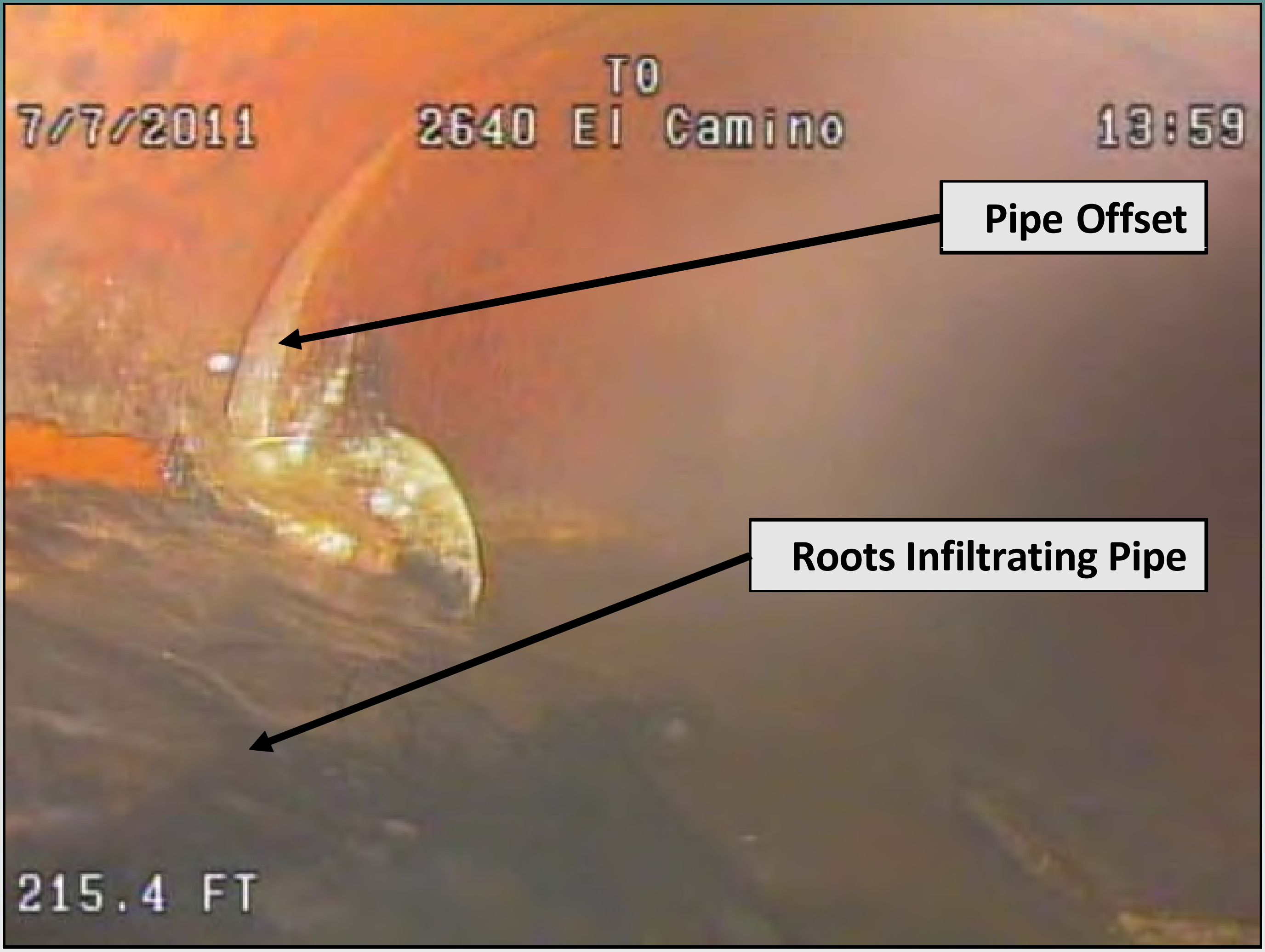
“Modeling studies indicate that contaminated vapors can diffuse tens of yards or more from a DNAPL source in the vadose zone within a period of weeks to months.”

Mercer & Cohen , 1993, *DNAPL Site Evaluation.*

C. STAFF'S CONCLUSION THAT SEWER LEAKS WERE NOT A PRIMARY SOURCE OF CONTAMINATION AT THE SITE IS INDEFENSIBLE



Video Inspection Reveals Poor Condition of City of Santa Clara Sewers



Pipe Offset

Roots Infiltrating Pipe

TECHNICAL CONCLUSIONS

A. The Change in Groundwater Flow Direction at the Site Allows us to Determine that the PCE Release Occurred Well After 1978

B. Staff’s Counter-Arguments are Not Supported

C. Staff’s Conclusion that Sewer Leaks Were Not a Primary Source of Contamination at the Site is Indefensible

II. NO BASIS TO CONCLUDE UATC "KNEW OR SHOULD HAVE KNOWN" PCE WAS DISCHARGED PRE-1978

No Actual Knowledge

- Neither the 1961 Fire Marshall Permit nor the obscure 1975 wastewater regulation even mention the risk of groundwater contamination from dry cleaners.

II. NO BASIS TO CONCLUDE UATC "KNEW OR SHOULD HAVE KNOWN" PCE WAS DISCHARGED PRE-1978

No Constructive Knowledge

- Groundwater contamination from dry cleaners was not identified as a common hazard before 1980s.
- Inspection would not have detected colorless PCE seeping through concrete or leaking from sewers.
- Subsurface investigations very uncommon before the 1980s.

II. NO BASIS TO CONCLUDE UATC "KNEW OR SHOULD HAVE KNOWN" PCE WAS DISCHARGED PRE-1978

Knowledge of a Dry Cleaner at the Site is Not Enough

- Staff misinterpret In Re Stuart (SWRCB, 1986) – sublessor, Stuart Petroleum held liable in 1986 for gas station cleanup where lessor was in the oil industry and "problems of leaking underground tanks have become common knowledge, particularly in the oil industry."

II. NO BASIS TO CONCLUDE UATC “KNEW OR SHOULD HAVE KNOWN” PCE WAS DISCHARGED PRE-1978

Knowledge of a Dry Cleaner at the Site is Not Enough

- Staff ignore Resolution Trust (Calif. Court of Appeals, 1995): (“defendant must be aware of the specific dangerous condition and be able to do something about it before liability will attach.”)

- Staff ignore City of Stockton (9th Cir. , 2011) (possessor of land is liable if it knows or should know of the artificial condition and the nuisance).

III. NO BASIS TO CONCLUDE UATC HAD THE LEGAL ABILITY TO PREVENT A PCE DISCHARGE

No Evidence of a Lease with the Dry Cleaner

- No evidence of lease terms that:
  - Allowed UATC to enter the premises;
  - Allowed UATC to terminate the lease; and
  - Allowed UATC to remediate contamination.

ANY POSSIBLE LIABILITY WAS DISCHARGED IN UATC'S 2001 BANKRUPTCY

- Bankruptcy court issued a broad discharge of liability.
- Cleanup orders are claims dischargeable.
- The Regional Board should have fairly contemplated its claim against UATC by 2001.
  - If UATC should have known of contamination by 1978, it must be true that the Regional Board should have known of contamination by 2001.
  - By 2001, the Regional Board knew of dry cleaner contamination in Santa Clara and had the data necessary information to identify Moonlite Cleaners as an at-risk dry cleaner site.
  - The California State Fire Marshal knew since the 1960s that dry cleaning with solvents occurred at the Site.

CONCLUSION: UATC SHOULD NOT BE NAMED AS A DISCHARGER

- Data-driven analysis shows that the PCE release occurred well after 1978.
- UATC did not know and could not reasonably have known of any PCE contamination.
- Staff seeks unprecedented expansion of landlord liability.
- Case against UATC is unnecessary – Board deploying resources for the benefit of the current and longtime property owner, a liable party that:
  - Leased its property to a dry cleaner for many years after dry cleaner contamination was well known.
  - Failed to disclose contamination to the Board for 5 years, in violation of state law.
  - Has never been asked by the Staff to disclose EVERYTHING it knows about the Site.
- Board should name Santa Clara based on obvious releases from sewer.