NW 1805

*A Report Prepared For:*
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**FEBRUARY 2007 GROUNDWATER MONITORING**
**LEATHERCARE INC**
**901/921 ELLIOTT AVENUE W**
**SEATTLE, WASHINGTON**

June 15, 2007

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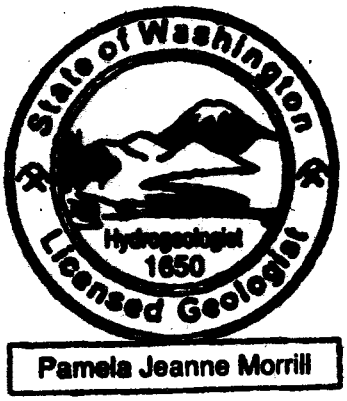


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CDM Project No. 38057.47522

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# Section 1
# Introduction

## 1.1 General

This report presents the results of groundwater monitoring conducted by Camp Dresser & McKee Inc. (CDM) in February 2007 for the LeatherCare, Inc. site located at 901 & 921 Elliott Avenue West in Seattle, Washington (**Figure 1**). Ryan, Swanson & Cleveland, PLLC retained CDM to perform this work on behalf of the current property owner, Mr. Steven Ritt.

## 1.2 Background

LeatherCare is a large, industrial dry cleaning facility that has occupied this location since 1985. LeatherCare initially used tetrachloroethene (PCE) as a dry cleaning solvent. PCE use was discontinued in phases beginning in March 2000 when the PCE machine for leather was replaced. The replacement of PCE dry cleaning machines for regular clothing began in September 2003 and the conversion was completed in October 2005 when the last of the PCE machines were replaced.

In July 2006, CDM completed an assessment of volatile organic compounds (VOC) and petroleum hydrocarbons throughout the LeatherCare parcel, an adjacent parcel to the northwest (also owned by Mr. Ritt), West Roy Street to the southwest, and the Darigold property (formerly referred to as WestFarm Foods) north and central parking lots.[1] The two Ritt-owned parcels and W Roy Street are collectively referred to as the "Subject Property." The Subject Property and the Darigold parking lots are collectively referred to as the "Investigation Area." **Figure 2** shows the layout of the Subject Property and Investigation Area.

PCE and/or its degradation products were identified in groundwater in areas of the Subject Property, but at relatively low concentrations. The contaminant profile across the Subject Property was found to be indicative of small, incidental releases that may have occurred at several locations. PCE concentrations are not high enough to be indicative of the presence of free phase product.

Low concentrations of chlorinated VOCs (cVOCs), in particular, vinyl chloride, which is the last degradation product of PCE prior to degradation into nontoxic compounds, also occur in the north parking lot area of the Darigold property where there is also a petroleum hydrocarbon plume that originates on the Darigold property.

CDM's July 2006 investigation and a subsequent groundwater monitoring round completed in September 2006,[2] indicated that biological degradation processes are actively occurring to reduce cVOC concentrations, as based on field monitoring and

[1] CDM. 2006. Contamination Assessment, LeatherCare, Inc., 901/921 Elliott Avenue, Seattle, Washington. July 25. CDM Project No. 38057-47522.
[2] CDM. 2006. September 2006 Groundwater Monitoring, LeatherCare, Inc., 901/921 Elliott Avenue, Seattle, Washington. November 3. CDM Project No. 38057-47522.

chemical and biological testing data conducted in soil and groundwater, along with historical groundwater chemical data. In contrast, the petroleum hydrocarbon plume within the Darigold north parking lot contains free phase hydrocarbons and this source of hydrocarbons continues to contribute to dissolved hydrocarbons in groundwater. The petroleum likely resulted from a fuel supplier (wood, coal, petroleum) that had occupied the Darigold north parking lot area between about 1921 and 1956, so the hydrocarbon plume is between 50 and 75 years old.

## 1.3 Purpose and Scope of Work

The purpose of continued groundwater monitoring over time is to establish the natural variation in contaminant concentrations (i.e., seasonal), to determine whether the plume is expanding or collapsing, to characterize degradation processes, and to confirm natural attenuation of cVOCs.

This report represents a third round of groundwater monitoring conducted at the Subject Property by CDM since its initial investigation in May 2006. The second round of groundwater monitoring was conducted in September 2006. During the first two sampling rounds, ENTRIX, Inc. (ENTRIX) oversaw CDM's work and collected duplicate groundwater samples. During this round, ENTRIX conducted the purging and sampling and CDM collected duplicate groundwater samples. This sampling was conducted in conjunction with ENTRIX's ongoing quarterly monitoring program at the Darigold site.

The scope of work completed during this sampling event consisted of the following:

- Conducted a complete round of water level measurements for all existing monitoring wells throughout the Investigation Area.
- Purged and sampled each of the groundwater monitoring wells on the Subject Property and all eight monitoring wells located in the north parking lot of the Darigold property.
- Submitted collected groundwater samples for laboratory analysis of selected cVOCs, dissolved gasses (ethane, ethene, and methane), and diesel and oil range petroleum hydrocarbons.
- Evaluated the data and prepared this report documenting our findings and conclusions.

Finally, as an additional scope of work, CDM collected split samples during ENTRIX's sampling of interior and exterior sumps/drains/catch basins in the LeatherCare building.

# Section 2
# Site Setting and Description

## 2.1 Location and Setting

The Investigation Area is located between the addresses of 635 and 921 Elliott Avenue W in the City of Seattle (**Figure 1**). Properties west of Elliott Avenue W are zoned IC-45 (industrial-commercial). Properties to the east of Elliott Avenue W are zoned commercial. Several railroad lines exist immediately west of the Investigation Area, followed by a large grain depot. Otherwise, various commercial and industrial businesses surround the Investigation Area.

## 2.2 Investigation Area Description

**Figure 2** shows the Investigation Area features. The Subject Property consists of two tax parcels and W Roy Street. Parcel 3879902235, addressed as 901 Elliott Avenue W, is completely covered by a 16,800 square foot (sf) (0.39 acre) masonry building. The building is entirely occupied by LeatherCare. On the northwest side of the LeatherCare parcel is Parcel 7666201980, a 27,770 sf (0.64 acre) property that contains three wood-frame structures. The structures are used as office, storage, and warehouse facilities. Open areas between the buildings are asphalt and concrete-paved, and also contain several small storage sheds. This parcel is occupied by Greg Thompson Productions (GTP). Greg Thompson Productions designs and creates the stage, screen and studio sets for Hollywood, Broadway, and Las Vegas productions. Access and parking for LeatherCare are on W Roy Street, a dead-end road that bounds the southeast side of the LeatherCare parcel. LeatherCare has a use permit with the City of Seattle for part of W Roy Street.

On the southeast side of W Roy Street is a large asphalt-paved parking area (Darigold north parking area) for Darigold employees. The Darigold parking lot is surrounded by chain-link fencing and is accessed by a gated entrance on W Roy Street. To the southeast of the north parking lot, beyond a concrete block wall, are the Darigold building and additional parking (central parking area).

## 2.3 Physical Setting

The Investigation Area is located at the base of Queen Anne Hill, about 650 feet northwest of the shoreline of Elliott Bay. The elevation of the Investigation Area and Elliott Avenue W ranges from approximately 13 to 20 feet above mean level (MSL). The overall land surface in the area slopes both downward from east to west (Elliott Avenue W toward Elliott Bay) and from south to north (i.e., from the Darigold property northward through the north end of the Subject Property).

The Subject Property is located on approximately 14 feet of fill, which overlies former tidelands. Groundwater underlying the Subject Property occurs in the fill at approximately 1 to 6 feet below ground surface (ft bgs). The depth to groundwater is deeper in portions of the Darigold property (nearly 10 ft bgs) where the fill is thicker.

# Section 3
# Field Investigation Methods

Groundwater monitoring was conducted on February 12 through 14, 2007. ENTRIX conducted all of the field work. All field equipment was supplied by ENTRIX. CDM observed the field work and collected duplicate groundwater samples at each location.

## 3.1 Water Levels

Water levels were measured in all monitoring wells throughout the Investigation Area between 0918 hours (hr) and 1105 hr on February 12, 2007. About midway through collecting the water level data, ENTRIX's Instrumentation Northwest oil/water interface probe malfunctioned and they switched to using a Keck water level sounder. The potential presence of free phase hydrocarbons (light nonaqueous phase liquid [LNAPL]) was checked in MW3 and MW7 using disposable bailers.

## 3.2 Water Sampling

Prior to collecting groundwater samples, each monitoring well/piezometer was purged using a peristaltic pump fitted with tygon tubing. Physical parameters were monitored using a Horiba U-22 meter. In order to minimize contact with ambient air, the Horiba meter was secured in a flow-through cell that was situated after the pump and before the tubing discharge. Parameters measured during purging included: pH, temperature, specific conductance (SC), turbidity, dissolved oxygen (DO), and oxidation reduction potential (ORP). In addition, at the conclusion of purging, ferrous iron was tested using a Hach field test kit. The wells were purged until physical parameter measurements stabilized.

The samples were collected directly into laboratory-supplied containers appropriate for the analyses to be conducted. Collected samples were stored in chilled coolers and delivered under chain-of-custody protocol to the analytical laboratories described in Section 3.4.

Upon reviewing the field data, CDM became concerned that the dissolved oxygen concentrations were inaccurately high. On February 20, 2007 CDM conducted a comparison of the different field meters used at the site (the Horiba U-22 and the YSI 556, which CDM had previously used). This work entailed repurging three of the monitoring wells (LC4, LC5, and LC6) and obtaining *in situ* parameter measurements from three additional monitoring wells. A memo discussing the work that was conducted on this date and our findings is presented in **Appendix A**. As a result of this field check, the DO meter on the Horiba was found to be improperly calibrated, resulting in DO readings that were too high. All of ENTRIX's DO data were rejected.

At this time, CDM also collected a second set of groundwater samples from LC5 and LC6 for analysis of petroleum hydrocarbons.

## 3.3 Catch Basin, Sump, Drain Sampling

During this field work, ENTRIX collected sludge samples from one exterior drain located next to the gas meter (CB4) and two sludge samples from floor drains located inside the LC building (CB3, CB3B), near the west end, and two water samples from sumps that are located near the washers at the east end of the building (CB1, CB2). Sample locations are shown on **Figure 3**. CDM collected split samples at these locations. ENTRIX also collected a water sample at CB4, but there was insufficient water in the catch basin for CDM to collect a sample.

The water samples were collected into hydrochloric acid preserved 40 ml VOA vials. The sludge samples were collected using an approximately 5-gram core sampler, and dispensed immediately into preweighed 40 milliliter (ml) VOA vials containing sodium bisulfate (2 vials) and methanol (2 vials) and sealed in accordance with EPA Method 5035A.

## 3.4 Laboratory Analysis

CDM submitted the groundwater samples to Analytical Resources Inc. (ARI) in Renton, Washington and MicroSeeps in Pittsburg, Pennsylvania. The catch basin, sump, and drain water and sludge samples were submitted to ARI for analysis.

ARI conducted analyses on the groundwater samples for the following:

- Total petroleum hydrocarbons quantified as diesel (TPH-D) and motor oil (TPH-O) by northwest method NWTPH-Dx (groundwater only).

- Chlorinated volatile organic compounds by EPA Method 8260 (using a 20-milliliter purge for groundwater in order to reach a detection limit of 0.2 micrograms per liter (µg/L) for vinyl chloride). Specifically, the analytes included PCE, trichloroethene (TCE), *cis*-1,2-dichloroethene (*c*-1,2-DCE) , *trans*-1,2-dichloroethene (*t*-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and vinyl chloride (VC).

With the exception of samples collected from wells LC1, LC2, GT1, GT2, and GT3, which were not analyzed for petroleum hydrocarbons, all groundwater samples were analyzed for the compounds listed above. Petroleum hydrocarbon analyses were not conducted at LC1, LC2, GT1, GT2, and GT3 because earlier sampling rounds indicated this was not a contaminant of concern at these locations. The reanalysis of TPH-D in the second set of samples from LC5 and LC6 was run with a silica gel cleanup to remove any potential naturally occurring organics that might influence the petroleum hydrocarbon data.

MicroSeeps conducted analyses of the dissolved gasses methane, ethane, and ethene by method AM20GAX.

The catch basin, sump, and drain water and sludge samples were analyzed the same cVOCs listed above by EPA Method 8260.

# Section 4
# Findings and Discussion

## 4.1 Water Levels

Depth to groundwater on February 12, 2007, ranged between approximately 1.1 and 8.8 ft bgs as summarized in **Table 1**. Stabilized water elevations are also summarized on **Table 1** and ranged between 11.05 ft and 11.82 ft. Water levels in the individual wells rose by 0.77 to 1.15 ft between the September 5, 2006 and February 12, 2007 sampling rounds, as would be expected between the fall when water levels are at their seasonal lowest and the recharge of the groundwater system during winter.

Measurable LNAPL was not observed at any monitoring well. However, LNAPL was indicated at MW3 and MW7 by the presence of small oil droplets in the water brought up in the bailers. Based on visual observations and historical data, it is possible that a layer of LNAPL exists at these wells, but is not observable because the water level is above the top of the well screen.

**Figure 4** shows the potentiometric surface on February 12, 2007. Groundwater contours for February are consistent with those observed in May and September 2006. The gradient throughout the Investigation Area is very flat – almost nonexistent in W Roy Street and the Darigold north parking lot. The W Roy Street and the Darigold north parking lot form a groundwater divide. In the area underlying the LeatherCare building and the GTP parcel, the groundwater flow direction is toward the north (previously it was more northwesterly). In the Darigold north parking lot, there essentially is no gradient. A measurable southerly gradient is observed in the central parking area and, as observed previously at MW10 near the entrance to the Darigold building on Elliott Avenue W, there may be a preferential flow path that is controlling groundwater flow and causing the gradient to swing toward the southeast.

## 4.2 Field Monitored Parameters

A discussion of field measured parameters is provided below and the data are summarized in **Tables 2** and **3**.

*Temperature:* Groundwater temperature varied between 9.3 and 12.8 degrees Celsius (°C) in monitoring wells located outside of the LeatherCare building. Groundwater sampled from the two wells under the building (LC1 and LC2) continues to be significantly higher than the outside wells at over 16 °C. In the individual wells, the temperatures have declined by 6.4 °C to 14.6 °C since the September sampling round, and this is consistent with the colder winter temperatures.

*Dissolved Oxygen:* DO concentrations recorded by ENTRIX ranged from approximately 4 to 11 milligrams per liter (mg/L). DO concentrations in this range indicate highly aerobic conditions. Instead, with the existing hydrocarbon plume, low gradient regime, and warm water temperatures under the building, we expect generally low DO concentrations. This was confirmed by CDM during the prior two

sampling rounds where DO concentrations were all less than 1 mg/L, and generally less than 0.5 mg/L. During CDM's evaluation of the meters on February 20 (**Appendix A**), we found that the Horiba meter had not been appropriately calibrated and did not provide accurate low end DO measurements. The YSI meter produced readings (see **Table 1**) that are more consistent with that expected for the site and previous sampling rounds.

Of the limited data collected on February data, DO concentrations for LC5, LC6, GT1 and GT2 indicate anoxic conditions and are consistent with historic DO measurements at these locations. The DO data for LC3 and LC4 indicate relatively oxic conditions. DO concentrations over 1 mg/L at this site may indicate transitory conditions of a fresh flush of water into the system from winter rainfall, a very possible scenario, considering higher water levels at the site. Also, it is notable that DO concentrations are mostly lower in the summer (when the water is warmer) than in the winter. Warmer water cannot carry as much DO as colder water. Seasonally higher DO concentrations can increase the rate of biodegradation of VC.

***Oxidation Reduction Potential:*** The ORP values ranged between 117 millivolts (mV) and -84 mV. Overall, ORP values are higher than those observed in September 2006, and similar to or higher than those observed in May 2006. This is consistent with the seasonal variations of DO and temperature discussed above.

***Specific Conductance:*** SC values ranged between 496 and 1,110 microsiemens per centimeter (µS/cm). Overall, the values appear similar to the September 2007 SC data.

***pH:*** The pH values ranged between approximately 6.1 and 6.7. These values are slightly lower than previously observed (typically 7 to 7.3). The pH is still within an optimal range for microbial mediated degradation of the cVOCs.

***Ferrous Iron:*** Similar to the May and September 2006 sampling events, ferrous iron was detected in all wells except MW1. Ferrous iron concentrations ranged between 0.2 and 2.5 mg/L. No specific increasing or decreasing trends were evident. VC is biodegradable by iron reducing bacteria and the presence of ferrous iron is a sign of the presence of iron reducing bacteria.

## 4.3 Groundwater Analytical Results

Copies of the analytical reports are included in **Appendix B**. Groundwater analytical data are summarized in **Tables 2** and **3**. Contaminant concentrations are compared against the Model Toxics Control Act (MTCA) Method A groundwater cleanup levels. In the absence of Method A cleanup levels, contaminant concentrations are compared against Method B cleanup levels as obtained from Ecology's Cleanup Levels and Risk Calculations (CLARC) database tables. **Figure 5** summarizes contaminant concentrations of individual wells and shows the estimated outer plume limits of the site contaminants exceeding Method A cleanup levels.

### 4.3.1 Petroleum Hydrocarbons

During the current sampling round, TPH-D was detected in six groundwater samples from the Darigold north parking lot. Oil-range petroleum hydrocarbons were also detected in the MW3 sample. TPH-D concentrations ranged between 0.70 and 4.0 mg/L; therefore, the Method A cleanup level of 0.5 mg/L was exceeded in all six of these samples. In addition, the concentrations of hydrocarbons reported at MW3 (0.70 mg/L) and MW7 (2.4 mg/L) represent only the dissolved fraction; they do not reflect the LNAPL that may be present at these locations. Review of all the historical data indicates the hydrocarbon data are quite variable. Even the split sample data can be quite variable. For example, TPH-D reported in CDM's MW4 sample collected in September 2007 was 1.3 mg/L, and in ENTRIX's sample it was 4.1 mg/L.

TPH-D was detected in LC3, LC5, and LC6 in W Roy Street at concentrations of 0.28, 0.42, and 0.76 mg/L, respectively during the initial February 2007 sampling. The resampling of LC5 and LC6 on February 20, 2007 did not confirm the presence of TPH-D. It is possible that the initially reported hydrocarbon concentrations were due to naturally occurring organics, but the original chromatogram profiles did not indicate this. The TPH-D data for W Roy Street wells is variable and not well understood at this time. In May 2006, TPH-D was reported in LC5 and LC6 at 0.35 mg/L. In September 2006 TPH-D was not detected (<0.25 mg/L). Considering the source and areal extent of the Darigold hydrocarbon plume, and the groundwater flow directions in W Roy Street and the Darigold north parking lot, it is very possible that the hydrocarbon plume is diffusing into W Roy Street. Subsequent monitoring rounds will further our understanding regarding this possible impact.

### 4.3.2 Chlorinated VOCs

#### 4.3.2.1 PCE

PCE was detected in eight groundwater samples and ranged from 0.6 to 20 µg/L. Only two samples (LC3 and LC4) exceeded the Method A cleanup level of 5 µg/L. At LC2, the PCE concentration declined from approximately 9 µg/L during the last two sampling rounds to 2.8 µg/L, below the Method A cleanup level.

The Method A exceedance at LC3 was minimal, since the sample contained only 5.9 µg/L PCE. The 20 µg/L PCE at LC4 (in W Roy Street) is the highest PCE concentration historically observed in any well, but the concentration is not out of line with previous data from this well and this location. It is noteworthy, that ENTRIX observed a concentration of 100 µg/L PCE at this location during its December 2004 geoprobe study. Considering that both samples were collected in winter, we expect this is the seasonal high PCE concentration for this well - which is five times lower than the 100 µg/L PCE reported by ENTRIX only 2 years previously. It is notable that at MW1 (on the Darigold property), which is quite close to LC4, the PCE concentration declined from 6.5 to 1.9 µg/L between the September and February sampling rounds and in fact, the PCE concentration at MW1 has been below its Method A cleanup level three out of the last four sampling rounds.

#### 4.3.2.2 TCE

TCE was detected in 12 groundwater samples, similar to previous sample data, with concentrations ranging between 0.2 and 6.9 µg/L. TCE exceeded its Method A cleanup level (5 µg/L) at only one location, GT3, which is located downgradient of the LeatherCare building. Minor exceedances of the Method A cleanup level seem to fluctuating at GT3 and LC1. Whereas the TCE exceeded its cleanup level at LC1 in September 2006, it did not at GT3, the opposite was true in May 2006.

#### 4.3.2.3 *c*-1,2-DCE, *t*-1,2-DCE, 1,1-DCE

Of these degradation products of PCE, *c*-1,2-DCE was detected in 15 groundwater samples, *t*-1,2-DCE in 7 samples, and 1,1-DCE was not detected in any sample. Concentrations ranged between 0.2 and 35 µg/L. The concentrations of *c*-1,2-DCE and *t*-1,2-DCE did not exceed their respective Method B cleanup levels (80 and 160 µg/L, respectively) in any samples.

#### 4.3.2.4 Vinyl Chloride

Vinyl chloride was detected in 13 groundwater samples ranging between 0.2 and 14 µg/L. VC concentrations showed substantial declines in several wells between the September 2006 and February 2007 sampling rounds as follows: GT2 from 35 to 14 µg/L; GT3 from 5.7 to 1.9 µg/L; LC1 from 3.0 to 0.7 µg/L; and MW6 from 6.6 to 2.9 µg/L. The most downgradient well on the GTP parcel continues to show VC concentrations below the Method A cleanup level of 0.2 µg/L, even with the highest VC concentrations being observed at the next upgradient well (GT2), only 110 feet away.

During the current sampling round, the VC Method A cleanup level was exceeded in only three wells in the Darigold north parking lot. The VC concentrations exceeding the cleanup level ranged from 0.4 to 2.9 µg/L. The average concentration of VC in the north parking lot area is currently 0.58 µg/L.

#### 4.3.2.5 Dissolved Gasses

Methane was detected in every groundwater sample, ranging between 8.8 µg/L and 790 µg/L. Methane concentrations were generally lower than the previous sampling round. Methane concentrations over 500 mg/L were observed at MW7, MW8, LC2, and GT2. The presence of methane is indicative of methanogenesis – a favorable condition for reductive dechlorination.

Ethene, the end product of the reductive dechlorination of PCE, was detected in all groundwater samples collected from the Subject Property at concentrations ranging between 0.031 and 1.2 µg/L. Ethene concentrations on Subject Property were the highest at GT2 (1.2 µg/L), where the highest reduction of VC concentrations were observed. The next highest concentration of ethene was observed at LC2 (0.92 µg/L) where some of the highest methane concentrations and lowest DO concentrations are observed, indicating methanogenic conditions. As proof of reductive dechlorination, on the Darigold site, ethene was only detected in wells where VC was also detected. While ethene concentrations are low (0.028 to 0.14 µg/L), they also correlate from low

to high, with the VC concentrations at those wells. **Figures 5** and **6** are scatter plots that show the correlation of ethene with vinyl chloride concentrations for September 2006 (r=0.916) and February 2007 (r=0.864), respectively.

Ethane was detected in 14 of the groundwater samples, ranging between 0.034 and 0.42 µg/L. Reduction of vinyl chloride under strongly reducing conditions may contribute to the ethane concentrations. On the Subject Property the highest ethane concentrations did correspond with the highest methane and VC concentrations.

### 4.3.2.6 Overall cVOC Trends

CDM applied the Mann-Kendall statistical test to concentrations of PCE, TCE, *c*-1,2-DCE, VC, diesel, and oil in groundwater at monitoring wells MW1 through MW8, since there are multiple sets of contaminant data at these wells. The Mann-Kendall test indicates the presence or absence of a statistically significant increasing or decreasing trend in concentrations at a monitoring point. The results of the Mann-Kendall trend analysis are summarized on **Table 4**.

For the chlorinated ethenes, 16 of the 17 Mann-Kendall tests showed decreasing trends. The only increasing trend indicated was *c*-1,2-DCE at MW7. At this location, *c*-1,2-DCE concentrations are always low, with the highest concentration recorded being only 2.2 µg/L back in October 2005, which is significantly less than the MTCA Method B level of 80 µg/L. Most (10) of these decreasing trends are statistically significant ($\alpha = 0.1$) (i.e., less than 10% probability that there is no real trend). It is also worthy to note that since the last time this test was applied (September 2006 sampling round), the decreasing trends have become stronger (i.e., more statistically significant) and two prior increasing trends (c-1,2-DCE and VC at MW5) have switched to decreasing trends.

**Figures 7** and **8** show the progression of PCE to TCE, *c*-1,2-DCE, and finally to VC over time at MW1 and MW6. During the February 2007 sampling round, the only compound in either of these wells that exceeded its Method A cleanup level was VC in MW6. The concentration of this compound alone declined by over 50% between the two most recent sampling rounds. The same graphs were not created for the remaining MW wells simply because PCE, TCE, and *c*-1,2-DCE concentrations have always been low at these monitoring wells (i.e., less than MTCA cleanup levels) and they would therefore provide no additional useful illustrative purpose.

**Figures 9** through **11** specifically show the VC concentration trends for MW1, MW2, and MW5 through MW8 over time. No graph was produced for MW3 since VC has never been detected at this location. Even with the data being skewed by the initial, March 2001 sampling event where cVOCs were mostly undetected, some remarkable declining trends are observed in the VC concentrations, particularly at MW2, MW6 and MW8. Recent groundwater data also shows significant declining VC concentrations, even when not indicated by the over all trends. For example at MW5 where the VC trend seems to be increasing, the VC concentration has not exceeded

the cleanup level during the last three sampling rounds. As noted previously, the Mann Kendall tests also indicated decreasing trends for VC in all instances.

#### 4.3.2.7 Hydrocarbon Trends

The Mann-Kendall tests did not show as favorable results for the diesel range petroleum hydrocarbons in the Darigold north parking lot. Increasing trends were noted in four of the of the seven Mann Kendall tests. In addition, where decreasing trends are indicated at MW3 and MW7, the data are skewed due to changes in sampling methods. MW3 has free phase product and MW7 may also have free phase product. Since prior sampling methods used a bailer (recent sampling methods use a peristaltic pump), the free product becomes mixed with the sample during bailing resulting in very high petroleum hydrocarbon concentrations. Also, free product is only observed seasonally when the water level is low enough to be below the top of the well screen.

## 4.4 Catch Basin, Sump, Drain Samples

The sump water sample CB1 contained 13 µg/L PCE. CB2 sump water sample contained PCE, TCE, c-1,2-DCE, t-1,2-DCE, and VC, but still at relatively low concentrations of 8.1, 6.1, 52, 0.6 and 14 µg/L, respectively. Sludge samples contained much higher concentrations, ranging up to 16,000 milligrams per kilogram (mg/kg) PCE, 580 mg/kg TCE, and 720 mg/kg *c*-1,2-DCE. A vacuum cleanout of the sumps and catch basins at the subject property was scheduled following this sampling.

# Section 5
# Conclusions and Recommendations

The February 2007 groundwater monitoring round, combined with historical groundwater data, continues to show that cVOC concentrations are relatively low in the Investigation Area, and that natural attenuation processes are actively occurring. As can be expected, at individual sample locations cVOC concentrations vary between one sampling event and the next, but the data do not indicate that the plume is expanding (**Figure 12**). The data collected over time indicate that overall, cVOC concentrations are decreasing and that biological degradation processes are actively occurring to promote such contaminant reductions.

Based on these findings, CDM continues to recommend implementation of a program of regular groundwater sampling to ensure that monitored natural attenuation is a viable remedial approach for this site. Groundwater sampling for the Subject Property should also continue to include analysis of diesel-range petroleum hydrocarbons for wells LC3 through LC6 in order to further evaluate potential expansion of the hydrocarbon plume from the Darigold north parking lot into W Roy Street.

On March 16, 2007, LeatherCare removed and appropriately disposed of all sump water and catch basin/drain sludge and thoroughly cleaned all catch basins, sumps, and accessible drain lines at its facility. These actions removed any known sources of cVOCs at the site.

# Distribution

| | |
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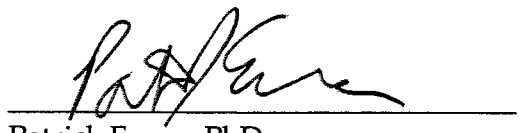

Patrick Evans, PhD
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Camp Dresser & McKee Inc.

# Tables

**Table 1**
**Groundwater Elevation Data**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Monitoring Well I.D. | Date Measured | Time (hours) | Top of Casing Elevation [a] (feet) | Depth to Groundwater (ft below TOC) | Groundwater Elevation (feet) |
|---|---|---|---|---|---|
| GT1 | 05/10/06 | 0912 | 12.74 | 1.84 | 10.90 |
| | 09/05/06 | 0955 | | 2.46 | 10.28 |
| | 02/12/07 | 0918 | | 1.69 | 11.05 |
| GT2 | 05/10/06 | 0910 | 12.45 | 1.23 | 11.22 |
| | 09/05/06 | 1000 | | 1.99 | 10.46 |
| | 02/12/07 | 0920 | | 1.09 | 11.36 |
| GT3 | 05/10/06 | 0909 | 13.36 | 2.18 | 11.18 |
| | 09/05/06 | 1004 | | 2.91 | 10.45 |
| | 02/12/07 | 0922 | | 1.95 | 11.41 |
| LC1 | 05/10/06 | 0916 | 13.17 | 1.57 | 11.60 |
| | 09/05/06 | 1010 | | 2.43 | 10.74 |
| | 02/12/07 | 0941 | | 1.40 | 11.77 |
| LC2 | 05/10/06 | 0919 | 13.41 | 2.01 | 11.40 |
| | 09/05/06 | 1012 | | 2.74 | 10.67 |
| | 02/12/07 | 0943 | | 1.80 | 11.61 |
| LC3 | 05/10/06 | 0925 | 14.16 | 2.56 | 11.60 |
| | 09/05/06 | 1014 | | 3.41 | 10.75 |
| | 02/12/07 | | | 2.37 | 11.79 |
| LC4 | 05/10/06 | 0921 | 14.72 | 3.16 | 11.56 |
| | 09/05/06 | 1026 | | 3.99 | 10.73 |
| | 02/12/07 | | | 2.93 | 11.79 |
| LC5 | 05/10/06 | 0922 | 14.13 | 2.57 | 11.56 |
| | 09/05/06 | 1030 | | 3.46 | 10.67 |
| | 02/12/07 | | | 2.37 | 11.76 |
| LC6 | 05/10/06 | 0928 | 16.85 | 5.26 | 11.59 |
| | 09/05/06 | 1022 | | 6.10 | 10.75 |
| | 02/12/07 | 0933 | | 5.03 | 11.82 |
| MW1 | 05/10/06 | 0932 | 14.02 | 2.42 | 11.60 |
| | 09/05/06 | 1037 | | 3.30 | 10.72 |
| | 02/12/07 | 0947 | | 2.23 | 11.79 |
| MW2 | 05/10/06 | 0933 | 13.14 | 1.52 | 11.62 |
| | 09/05/06 | 1040 | | 2.45 | 10.69 |
| | 02/12/07 | | | 1.36 | 11.78 |
| MW3 | 05/10/06 | 0937 | 17.40 | 5.80 | 11.60 |
| | 09/05/06 | 1046 | | 6.76 FP | 10.64 |
| | 02/12/07 | 1007 | | 5.61 FP | 11.79 |
| MW4 | 05/10/06 | 0950 | 14.95 | 3.38 | 11.57 |
| | 09/05/06 | 1117 | | -- | -- |
| | 02/12/07 | 0951 | | 3.19 | 11.76 |

CDM

**Table 1**
**Groundwater Elevation Data**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Monitoring Well I.D. | Date Measured | Time (hours) | Top of Casing Elevation [a] (feet) | Depth to Groundwater (ft below TOC) | Groundwater Elevation (feet) |
|---|---|---|---|---|---|
| MW5 | 05/10/06 | 0952 | 14.49 | 2.87 | 11.62 |
| | 09/05/06 | 1119 | | 3.72 | 10.77 |
| | 02/12/07 | 0950 | | 2.68 | 11.81 |
| MW6 | 05/10/06 | 0930 | 13.77 | 2.17 | 11.60 |
| | 09/05/06 | 1036 | | 3.05 | 10.72 |
| | 02/12/07 | 0945 | | 1.98 | 11.79 |
| MW7 | 05/10/06 | 0935 | 13.88 | 2.31 | 11.57 |
| | 09/05/06 | 1112 | | 3.21 | 10.67 |
| | 02/12/07 | | | 2.14 FP | 11.74 |
| MW8 | 05/10/06 | 0938 | 15.42 | 3.85 | 11.57 |
| | 09/05/06 | 1043 | | 4.75 | 10.67 |
| | 02/12/07 | 1028 | | 3.63 | 11.79 |
| MW9 | 05/10/06 | 0941 | 14.12 | 2.53 | 11.59 |
| | 09/05/06 | 1124 | | 3.50 | 10.62 |
| | 02/12/07 | 1047 | | 2.39 | 11.73 |
| MW10 | 05/10/06 | 0948 | 19.93 | 8.62 | 11.31 |
| | 09/05/06 | 1142 | | 9.55 | 10.38 |
| | 02/12/07 | 1105 | | 8.46 | 11.47 |
| MW11 | 05/10/06 | 0945 | 20.38 | 8.91 | 11.47 |
| | 09/05/06 | 1133 | | 9.81 | 10.57 |
| | 02/12/07 | 1053 | | 8.72 | 11.66 |
| MW12 | 05/10/06 | 0942 | 20.44 | 8.95 | 11.49 |
| | 09/05/06 | 1127 | | 9.86 | 10.58 |
| | 02/12/07 | 1050 | | 8.77 | 11.67 |
| MW13 | 05/10/06 | 0946 | 20.06 | 8.55 | 11.51 |
| | 09/05/06 | 1135 | | 9.47 | 10.59 |
| | 02/12/07 | NM | | NM | NM |

Notes:

FP - Free product measured or indicated. MW3, 0.04 ft on 9/6/06. Trace indicated in MW3 & MW7 on 2/12/07

a) Top of casing elevations in feet relative to a brass monument located at the south corner of Elliot Avenue W. and W. Roy Street, marked as Elevation 19.78 feet. No verifiable City of Seattle datum could be found in the site area.

ft bgs - feet below ground surface

TOC - top of casing

NM - not measured.

-- field measurement determined inaccurate and not used

**Table 2**
**Groundwater Analytical Summary - LeatherCare, Greg Thompson Productions, and W. Roy Street Properties**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Analyte | Date Sampled | Method A Cleanup Levels [a] | Monitoring Well I.D. GT1 | GT2 | GT3 [b] | LC1 | LC2 [c] | LC3 | LC4 [b] | LC5 | LC6 | Field Blank | Trip Blank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field-Measured Parameters** | | | | | | | | | | | | | |
| pH | 05/06 | N/A | 7.23 | 7.03 | 7.10 | 7.05 | 7.43 | 6.95 | 7.18 | 6.95 | 6.99 | -- | -- |
| | 09/06 | | 7.33 | 7.19 | 7.13 | 7.19 | 7.26 | 7.07 | 7.03 | 7.05 | 7.07 | -- | -- |
| | 02/07 | | 6.77 | 6.64 | 6.57 | 6.46 | 6.42 | 6.62 | 6.06 | 6.43 | 6.70 | -- | -- |
| ORP [d] (mV) | 05/06 | N/A | -33 | -27 | -56 | -72 | -152 | -33 | -50 | -82 | -50 | -- | -- |
| | 09/06 | | -119 | -97 | -68 | -113 | -90 | -71 | -50 | -107 | -78 | -- | -- |
| | 02/07 | | -33 | -2 | 17.0 | -60 | -32 | 56 | 80 | -30 | 31 | -- | -- |
| Temperature (°C) | 05/06 | N/A | 16.0 | 16.2 | 15.1 | 18.3 | 18.2 | 15.9 | 14.1 | 13.8 | 14.2 | -- | -- |
| | 09/06 | | 20.0 | 21.3 | 20.8 | 23.1 | 22.6 | 22.6 | 22.2 | 22.5 | 20.6 | -- | -- |
| | 02/07 | | 13.6 | 9.3 | 10.0 | 16.8 | 16.2 | 11.4 | 9.7 | 10.0 | 11.8 | -- | -- |
| Specific Conductivity (µS/cm) | 05/06 | N/A | 1,243 | 1,283 | 1,264 | 1,190 | 1,183 | 1,345 | 1,360 | 1,322 | 1,281 | -- | -- |
| | 09/06 | | 811 | 856 | 864 | 866 | 736 | 870 | 853 | 856 | 856 | -- | -- |
| | 02/07 | | 831 | 971 | 915 | 951 | 519 | 1,020 | 496 | 795 | 948 | -- | -- |
| Dissolved Oxygen (mg/L) | 05/06 | N/A | 0.70 | 0.34 | 0.70 | 0.24 | 0.40 | 0.42 | 0.43 | 0.33 | 0.39 | -- | -- |
| | 09/06 | | 0.15 | 0.17 | 0.14 | 0.20 | 0.35 | 0.23 | 0.19 | 0.09 | 0.09 | -- | -- |
| | 02/07 | | 0.31 [g] | 0.13 [g] | -- [g] | -- [g] | -- [g] | 1.18 [g] | 1.14 [g] | 0.14 [g] | 0.28 [g] | -- | -- |
| Turbidity (NTU) | 05/06 | N/A | 1.76 | 0.83 | 0.66 | 5.76 | 62.0 | 1.05 | 1.79 | 2.82 | 2.01 | -- | -- |
| | 09/06 | | * | 0.47 | 0.70 | 0.7 | * | 5.5 | 2.4 | 1.8 | * | -- | -- |
| | 02/07 | | 3.1 | 0.0 | >999 [h] | 0.0 | 0.0 | 22.4 [h] | 0.0 | 16.3 | 26 [h] | -- | -- |
| Ferrous Iron (ppm) | 05/06 | N/A | 0.1 | 0.2 | 0.2 | 0.5 | 0.3 | 0.3 | 0.2 | 1 | 0.5 | -- | -- |
| | 09/06 | | 0.3 | 0.2 | 0.6 | -- | 0.1 | 0.6 | 0.4 | 1 | 1 | -- | -- |
| | 02/07 | | 0.4 | 0.6 | 0.3 | 0.6 | -- | 0.2 | 0.1 | 1 | 0.4 | -- | -- |
| **General Groundwater Chemistry** | | | | | | | | | | | | | |
| Chloride (EPA Method 325.2) (mg/L) | 05/06 | N/A | 7.4 | 7.9 | 16.5 | 20.5 | 8.8 | 16.1 | 6.8/6.7 | 14.0 | 17.5 | -- | -- |
| Sulfate (EPA Method 375.2) (mg/L) | 05/06 | N/A | 62.3 | 64.4 | 77.8 | 88.9 | 52.7 | 69.7 | 39.3/39.5 | 39.5 | 54.2 | -- | -- |
| Chemical Oxygen Demand (EPA Method 410.4) (mg/L) | 05/06 | N/A | 6.18 | 5.68 | 9.29 | 12.8 | 12.4 | 7.71 | 10.1/6.87 | 10.1 | 12.8 | -- | -- |
| Alkalinity (SM 2320) (mg/L $CaCO_3$) | 05/06 | N/A | 336 | 406 | 358 | 368 | 309 | 398 | 233/233 | 372 | 401 | -- | -- |
| Carbonate (SM 2320) (mg/L CaCO3) | 05/06 | N/A | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0/<1.0 | <1.0 | <1.0 | -- | -- |
| Bicarbonate (SM 2320) (mg/L CaCO3) | 05/06 | N/A | 336 | 406 | 358 | 368 | 309 | 398 | 233/233 | 372 | 401 | -- | -- |
| Hydroxide (SM 2320) (mg/L CaCO3) | 05/06 | N/A | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0/<1.0 | <1.0 | <1.0 | -- | -- |
| ***Dehalococcoides spp.* (QCPR) [e]** | 05/06 | N/A | - | + | + | + | - | + | -/- | + | + | -- | -- |
| **Reductive Dechlorination End Products (µg/L)** | | | | | | | | | | | | | |
| Methane | 05/06 | N/A | 98 | 140 | 100 | 110 | 590 | 33 | 98/87 | 220 | 77 | -- | -- |
| | 09/06 | | 160 | 1,400 | 140/130 | 94 | 310 | 28 | 130 | 170 | 92 | | |
| | 02/07 | | 150 | 510 | 51/50 | 45 | 710 | 96 | 88 | 140 | 150 | | |
| Ethane | 05/06 | N/A | <12 | <12 | <12 | <12 | <12 | <12 | <12/<12 | <12 | <12 | -- | -- |
| | 09/06 | | 0.49 | 0.34 | 0.05/0.045 | 0.24 | 0.22 | 0.04 | 0.11 | 0.21 | 0.097 | | |
| | 02/07 | | 0.18 | 0.37 | 0.088/0.087 | 0.093 | 0.42 | 0.078 | 0.054 | 0.140 | 0.12 | | |
| Ethene | 05/06 | N/A | <11 | <11 | <11 | <11 | <11 | <11 | <11/<11 | <11 | <11 | -- | -- |
| | 09/06 | | 0.041 | 1.8 | 0.21/0.19 | 0.82 | 0.46 | <0.025 | 0.05 | 0.31 | <0.025 | | |
| | 02/07 | | 0.031 | 1.2 | 0.079/0.072 | 0.034 | 0.92 | 0.035 | 0.046 | 0.210 | 0.046 | | |

**Table 2**
**Groundwater Analytical Summary - LeatherCare, Greg Thompson Productions, and W. Roy Street Properties**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Analyte | Date Sampled | Method A Cleanup Levels [a] | Monitoring Well I.D. GT1 | GT2 | GT3 [b] | LC1 | LC2 [c] | LC3 | LC4 [b] | LC5 | LC6 | Field Blank | Trip Blank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Petroleum Hydrocarbons (NWTPH-Dx) (mg/L)** | | | | | | | | | | | | | |
| Diesel | 05/06 | 0.50 | <0.25 | 0.32 | <0.25 | <0.25 | <0.25 | <0.25 | <0.25/<0.25 | 0.35 | 0.35 | -- | -- |
| | 09/06 | 0.50 | <0.25 | <0.25 | <0.25/<0.25 | <0.25 | <0.25 | <0.25 | <0.25 | <0.25 | <0.25 | -- | -- |
| | 02/07 | 0.50 | -- | -- | -- | -- | -- | 0.28 | <0.25 | 0.42/<0.25 [i] | **0.76**/<0.25 [i] | -- | -- |
| Motor Oil | 05/06 | 0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50/<0.50 | <0.50 | <0.50 | -- | -- |
| | 09/06 | 0.50 | <0.50 | <0.50 | <0.50/0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | -- | -- |
| | 02/07 | 0.50 | -- | -- | -- | -- | -- | <0.50 | <0.50 | <0.50/<0.5 [i] | <0.50/<0.5 [i] | -- | -- |
| **Detected Volatile Organic Compounds (EPA SW8260B) (µg/L)** | | | | | | | | | | | | | |
| Tetrachloroethene | 05/06 | 5 | <0.2 | <0.2 | 0.4 | 2 | **9.4** | 2.9 | **14/14** | 0.4 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 5 | <0.2 | <0.2 | <0.2/<0.2 | 4.4 | **9.3** | 2.8 | **8.6** | <0.2 | <0.2 | -- | |
| | 02/07 | 5 | <0.2 | <0.2 | 0.4/0.4 | 2.2 | 2.5 | **5.9** | **20** D | 0.3 | <0.2 | -- | <0.2 |
| Trichloroethene | 05/06 | 5 | 0.4 | 0.6 | **11** | 2.8 | 4 | 0.6 | 2.4/2.4 | 0.5 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 5 | 0.3 | 0.6 | **1.2/1.2** | **6.5** | 3 | 1.2 | 2.9 | 0.4 | 0.3 | -- | |
| | 02/07 | 5 | 0.4 | 0.4 | **6.3/6.9** | 2.8 | 1.4 | 1.2 | 3.8 | 1.0 | 0.2 | -- | <0.2 |
| cis-1,2-Dichloroethene | 05/06 | 80 [f] | 4.2 | 16 | 49 D | 5.9 | 14 | 2.4 | 7.6/7.9 | 3.4 | 2.4 | <0.2 | <0.2 |
| | 09/06 | 80 [f] | 3.7 | 24 D | 13/13 | 15 | 15 | 4.3 | 10 | 2.5 | 2.6 | -- | |
| | 02/07 | 80 [f] | 4.9 | 10 | 35/34 D | 6.3 | 8.4 | 2.4 | 7.7 | 4.9 | 2.5 | -- | <0.2 |
| trans-1,2-Dichloroethene | 05/06 | 160 [f] | <0.2 | 5 | 9.4 | <0.2 | 0.9 | <0.2 | 0.4/0.4 | 0.2 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 160 [f] | <0.2 | 6.9 | 5.4/5.4 | 0.4 | 1.3 | <0.2 | 0.5 | <0.2 | <0.2 | -- | |
| | 02/07 | 160 [f] | 0.2 | 3.3 | 5.1/5.2 | <0.2 | 0.5 | <0.20 | 0.3 | 0.3 | <0.20 | -- | <0.2 |
| 1,1-Dichloroethene | 05/06 | 0.073 [f] | <0.2 | <0.2 | **0.3** | <0.2 | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 0.073 [f] | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | -- | |
| | 02/07 | 0.073 [f] | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.20 | -- | <0.2 |
| Vinyl Chloride | 05/06 | 0.2 | <0.2 | **19** D | **9.7** | **1.1** | **2.8** | **2** | **2.6/2.6** | **4.8** | **1.2** | <0.2 | <0.2 |
| | 09/06 | 0.2 | 0.2 | **35** D | **5.7/5.4** | **3.0** | **3.8** | **1.6** | **1.6** | **2.4** | **1.0** | -- | |
| | 02/07 | 0.2 | <0.2 | **14** | **1.9/1.6** | **0.7** | **3.1** | **1.8** | **1.2** | **3.3** | **1.9** | -- | <0.2 |
| 1,1,1-Trichloroethane | 05/06 | 200 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | 0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 1,1,2-Trichloroethane | 05/06 | 0.77 [f] | 0.3 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 1,1-Dichloroethane | 05/06 | 800 [f] | <0.2 | <0.2 | <0.2 | <0.2 | 0.9 | <0.2 | 0.4/0.4 | <0.2 | <0.2 | <0.2 | <0.2 |
| Benzene | 05/06 | 5 | <0.2 | 1.5 | 1.4 | <0.2 | 0.4 | <0.2 | 0.7/0.6 | <0.2 | <0.2 | <0.2 | <0.2 |
| Toluene | 05/06 | 1,000 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | 0.4 | <0.2 |
| Dibromochloromethane | 05/06 | 0.52 [f] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| tert-Butylbenzene | 05/06 | N/A | 0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Acetone | 05/06 | 800 [f] | 3.4 M | 5.3 M | <1.0 | 1.5 | 2.3 | 1.3 | 1.5/1.7 | 2.1 | 1.7 | 5.2 | 1.5 |
| Methylene Chloride | 05/06 | 5 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3/<0.3 | <0.3 | <0.3 | <0.3 | 0.4 |

## Table 2
## Groundwater Analytical Summary - LeatherCare, Greg Thompson Productions, and W. Roy Street Properties
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

Notes:

Bold and boxed values exceed Method A/B cleanup level.
* Turbidity meter malfunctioned; judged to be <10 NTU prior to sampling based on clarity of water.
a) Washington Administrative Code Chapter 173-340, Model Toxics Control Act Cleanup Regulation, promulgated August 15, 2001. Method A suggested groundwater cleanup level used when available.
b) Second set of concentrations are from a blind duplicate sample.
c) Water in LC2 had a strong hydrogen sulfide odor and would not clear up fully; suspect turbidity is suspended organics.
d) Silver-silver chloride reference electrode.
e) + means dehalococcoides detected; - means dehalococoides not detected.
f) Method B cleanup level from Washington Dept. of Ecology's Cleanup Levels and Risk Calculations (CLARC) tables.
g) Dissolved oxygen meter not working correctly. Measurements, when provided were taken on 2/20/07 and were in situ down hole measurements.
h) Purge water contains an orange biofloc.
i) These two wells were resampled and reanalyzed for TPH on February 20, 2007. The TPH analyses were run with a silica gel cleanup to remove interference by potential naturally occurring organics.
°C - degrees Celsius.
mV - millivolts.
NTU - Nephelometric turbidity units.
ORP - oxidation reduction potential.
N/A - not applicable.
µS/cm - microsiemens per centimeter.
µg/L - micrograms per liter.
mg/L - milligrams per liter.
ppm - parts par million.
J - estimated value.
D - value from a diluted sample.
M - estimated amount of analyte found and confirmed by analyst but with low GC/MS spectral match.
-- not analyzed.
< - analyte not detected at or greater than the listed concentration.

**Table 3**
**Groundwater Analytical Summary - Darigold Property**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Analytes and Test Methods | Date Sampled | Method A Cleanup Levels [a] | Monitoring Well I.D. MW1 | MW2 | MW3 | MW4 | MW5 | MW6 | MW7 | MW8 | MW12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field-Measured Parameters** | | | | | | | | | | | |
| pH | 05/06 | N/A | 7.39 | 7.31 | 7.09 | 6.99 | 7.01 | 7.03 | 6.93 | 6.89 | 7.20 |
| | 09/06 | | 7.31 | 7.16 | 7.14 | 7.09 | 7.08 | 7.05 | 7.07 | 7.04 | -- |
| | 02/07 | | 6.10 | 6.45 | 6.34 | 6.28 | 6.39 | 6.59 | 6.47 | 6.51 | -- |
| ORP [b] (mV) | 05/06 | N/A | 97 | -32 | -156 | -38 | -95 | -76 | -94 | -84 | -17 |
| | 09/06 | | -28 | -57 | -223 | -152 | -125 | -96 | -115 | -105 | -- |
| | 02/07 | | 117 | -53 | -54 | -7 | -84 | -56 | -54.0 | -59.0 | -- |
| Temperature (°C) | 05/06 | N/A | 15.2 | 16.1 | 14.7 | 15.3 | 15.6 | 13.8 | 14.2 | 14.2 | 12.4 |
| | 09/06 | | 22.8 | 24.3 | 20.9 | 22.8 | 20.9 | 22.0 | 22.5 | 20.8 | -- |
| | 02/07 | | 9.8 | 9.7 | 12.8 | 11.3 | 11.2 | 10.2 | 10.2 | 12.8 | -- |
| Specific Conductivity (µS/cm) | 05/06 | N/A | 1,322 | 1,244 | 1,277 | 1,251 | 1,261 | 1,332 | 1,296 | 1,302 | 1,358 |
| | 09/06 | | 557 | 742 | 947 | 906 | 869 | 832 | 910 | 884 | -- |
| | 02/07 | | 348 | 430 | 943 | 1,110 | 904 | 702 | 926 | 852 | -- |
| Dissolved Oxygen (mg/L) | 05/06 | N/A | 0.89 | 0.17 | 0.22 | 0.38 | 0.32 | 0.26 | 0.52 | 0.32 | 0.58 |
| | 09/06 | | 0.30 | 0.12 | 0.07 | 0.14 | 0.18 | 0.13 | 0.10 | 0.17 | -- |
| | 02/07 | | -- [f] | -- [f] | -- [f] | -- [f] | -- [f] | -- [f] | -- [f] | -- [f] | -- |
| Turbidity (NTU) | 05/06 | N/A | 0.89 | 1.06 | 0.86 | 1.54 | 1.47 | 3.54 | 2.43 | 2.46 | 0.47 |
| | 09/06 | | 0.50 | 1.50 | 0.25 | 0.81 | 3.25 | 0.52 | * | * | -- |
| | 02/07 | | 0.0 | 0.0 | 0.0 | 0.0 | 58.6 | 0.0 | 0.0 | 0.0 | -- |
| Ferrous Iron (ppm) | 05/06 | N/A | 0 | 0.1 | 0.5 | 0.9 | 2 | 0.9 | 0.6 | 0.8 | 0 |
| | 09/06 | | 0 | 0.2 | 0.2 | 2 | 3 | 1 | 0.2 | 0.8 | -- |
| | 02/07 | | 0 | 0.1 | 0.1 | 0.1 | 2.5 | 1.5 | 1 | 1 | -- |
| **General Groundwater Chemistry** | | | | | | | | | | | |
| Chloride (EPA Method 325.2) (mg/L) | 05/06 | N/A | 4.8 | 7.7 | 19.7 | 14.3 | 17.6 | 13.3 | 15.5 | 12.7 | 10.2 |
| Sulfate (EPA Method 375.2) (mg/L) | 05/06 | N/A | 30.0 | 32.1 | 56.1 | 47.4 | 48.7 | 42.8 | 13.6 | 24.1 | 31.7 |
| Chemical Oxygen Demand (EPA Method 410.4) (mg/L) | 05/06 | N/A | 7.56 | <5.0 | 28.6 | 57.1 | 17.2 | 12.7 | 41.4 | 36.2 | 11.7 |
| Alkalinity (SM 2320) (mg/L $CaCO_3$) | 05/06 | N/A | 161 | 190 | 416 | 407 | 405 | 344 | 450 | 427 | 296 |
| Carbonate (SM 2320) (mg/L CaCO3) | 05/06 | N/A | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Bicarbonate (SM 2320) (mg/L CaCO3) | 05/06 | N/A | 161 | 190 | 416 | 407 | 405 | 344 | 450 | 427 | 296 |
| Hydroxide (SM 2320) (mg/L CaCO3) | 05/06 | N/A | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| ***Dehalococcoides spp.*** **(QCPR)** [d] | | N/A | - | - | - | - | - | + | - | - | - |
| **Reductive Dechlorination End Products (µg/L)** | | | | | | | | | | | |
| Methane | 05/06 | N/A | 12 | 10 | 250 | 250 | 190 | 120 | 700 | 540 | 180 |
| | 09/06 | | 45 | 200 | 330 | 490 | 150 | 230 | 870 | 650 | -- |
| | 02/07 | | 8.8 | 15 | 140 | 61 | 290 | 130 | 790 | 710 | -- |
| Ethane | 05/06 | N/A | <12 | <12 | <12 | <12 | <12 | <12 | <12 | <12 | <12 |
| | 09/06 | | 0.044 | 0.088 | 0.16 | 0.16 | 0.22 | 0.21 | 0.17 | 0.17 | -- |
| | 02/07 | | <0.025 | <0.025 | <0.082 | 0.034 | 0.20 | 0.12 | 0.19 | 0.150 | -- |
| Ethene | 05/06 | N/A | <11 | <11 | <11 | <11 | <11 | <11 | <11 | <11 | <11 |
| | 09/06 | | <0.025 | 0.088 | <0.025 | 0.063 | 0.035 | 0.58 | 0.049 | 0.076 | -- |
| | 02/07 | | <0.025 | <0.025 | <0.025 | <0.025 | <0.025 | 0.14 | 0.038 | 0.028 | -- |

**Table 3**
**Groundwater Analytical Summary - Darigold Property**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Analytes and Test Methods | Date Sampled | Method A Cleanup Levels [a] | Monitoring Well I.D. MW1 | MW2 | MW3 | MW4 | MW5 | MW6 | MW7 | MW8 | MW12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Petroleum Hydrocarbons (NWTPH-Dx) (mg/L) | | | | | | | | | | | |
| Diesel | 03/01 | 0.50 | <0.25 | <0.25 | 6.44 | <0.25 | <0.25 | <0.25 | 19.6 | <0.25 | <0.25 |
| | 05/03 | 0.50 | 0.325 | 0.789 | 12.9 FP | 0.954 | 0.765 | 0.752 | 8.0 | 6.43 | 1.76 |
| | 10/03 | 0.50 | 0.317 | 0.488 | 209 FP | 2.7 | <0.25 | 0.289 | 2.31 | 0.82 | 1.34 |
| | 05/04 | 0.50 | 0.271 | 0.498 | NS FP | 2.83 | 0.381 | 0.394 | 4.37 | 4.0 | 0.626 |
| | 11/04 | 0.50 | <0.25 | <0.25 | NS FP | <0.25 | 0.27 | <0.25 | 1.4 | 0.75 | 0.48 |
| | 03/05 | 0.50 | <0.25 | <0.25 | 4.7 | 1.0 | 0.43 | 0.37 | 3.7 | 1.8/1.8 | <0.25 |
| | 08/05 | 0.50 | 0.390 | 0.86 | 13 FP | 1.9 | 0.68 | 0.28 | 2.1 | 1.3 | <0.25 |
| | 10/05 | 0.50 | 0.310 | 0.52 | 4.1 | 1.4/1.7 | 0.64 | 0.42 | 2.8 | 1.7 | 0.27 |
| | 12/05 | 0.50 | <0.25/<0.25 | – | 13 | 3.4 | 1.1 | 0.38 | 2.6 | 1.8 | 0.33 |
| | 03/06 | 0.50 | 0.330 | 0.59 | 4.4 | 1.3 | 1.2 | 1.2 | 0.30 | 0.52 | <0.25 |
| | 05/06 | 0.50 | <0.25 | <0.25 | 0.61 | 2.3 | 0.66 | 0.5 | 2.6 | 1.6 | <0.25 |
| | 09/06 | 0.50 | <0.25 | 0.65 | 0.55 FP | 1.3 | <0.25 | <0.25 | 2.4 | 1.8 | – |
| | 02/07 | 0.50 | <0.25 | <0.25 | 0.70 FP | 4.0 | 0.72 | 0.71 | 2.4 FP | 1.1 | – |
| Motor Oil | 03/01 | 0.50 | <0.50 | <0.50 | 15.4 FP | <0.50 | <0.50 | <0.50 | 3.51 | <0.50 | <0.50 |
| | 05/03 | 0.50 | <0.50 | <0.50 | 26.2 FP | <0.50 | <0.50 | <0.50 | 1.05 | 0.538 | <0.50 |
| | 10/03 | 0.50 | <0.50 | <0.50 | 705 FP | <0.50 | <0.50 | 0.289 | 0.71 | <0.50 | <0.50 |
| | 05/04 | 0.50 | <0.50 | <0.50 | NS FP | 0.501 | <0.50 | <0.50 | 0.89 | <0.50 | <0.50 |
| | 11/04 | 0.50 | <0.50 | <0.50 | NS FP | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| | 03/05 | 0.50 | <0.50 | <0.50 | 15 | <0.50 | <0.50 | <0.50 | 0.90 | <0.50/<0.50 | <0.50 |
| | 08/05 | 0.50 | <0.50 | 0.68 | 49 FP | 0.98 | <0.50 | <0.50 | 0.54 | <0.50 | <0.50 |
| | 10/05 | 0.50 | <0.50 | <0.50 | 16 | 0.68/0.92 | <0.50 | <0.50 | 0.82 | <0.50 | <0.50 |
| | 12/05 | 0.50 | <0.50/<0.50 | – | 50 | 0.95 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| | 03/06 | 0.50 | <0.50 | 0.68 | 17 | <0.50 | <0.50 | <0.50 | 1.4 | <0.50 | <0.50 |
| | 05/06 | 0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| | 09/06 | 0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | – |
| | 02/07 | 0.50 | <0.50 | <0.50 | 0.77 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | – |
| Detected Volatile Organic Compounds (EPA SW8260B) (µg/L) | | | | | | | | | | | |
| Tetrachloroethene | 03/01 | 5 | – | – | <0.1 | – | <0.1 | 2.48 | <0.1 | – | – |
| | 05/03 | 5 | 12.8 | – | – | – | – | 2.25 | – | – | – |
| | 10/03 | 5 | 4.84 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 11/04 | 5 | 12 | <0.2 | <0.2 | <0.2 | <0.2 | 2.1/0.3 | <0.2 | <0.2 | <0.2 |
| | 03/05 | 5 | 19 | <0.2 | <0.2 | <0.2 | <0.2 | 1.5 | <0.2 | <0.2/<0.2 | 0.3/0.4 [c] |
| | 08/05 | 5 | 18 | <0.2 | <0.6 | <0.2 | <0.2 | 0.8 | <0.2 | <0.2 | <0.2 |
| | 10/05 | 5 | 8.2 | <0.2 | <0.2 | <0.2 | <0.2 | 0.4 | <0.2 | <0.2 | <0.2 |
| | 12/05 | 5 | 17 | – | <0.2 | <0.2 | <0.2 | 0.6 | <0.2 | <0.2 | 0.2 J |
| | 03/06 | 5 | 2.6 | <0.2 | <0.2 | <0.2 | <0.2 | 0.7 | <0.2 | <0.2 | <0.2 |
| | 05/06 | 5 | 4.1 | <0.2 | <0.2 | <0.2 | <0.2 | 1 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 5 | 6.5 | <0.2 | <0.2 | <0.2 | <0.2 | 0.6 | <0.2 | <0.2 | – |
| | 02/07 | 5 | 1.9 | <0.2 | <0.2 | <0.2 | <0.2 | 0.7 | <0.2 | <0.2 | – |
| Trichloroethene | 03/01 | 5 | – | – | <0.1 | – | <0.1 | 1.37 | <0.1 | – | – |
| | 05/03 | 5 | 2.59 | – | – | – | – | 1.23 | – | – | – |
| | 10/03 | 5 | 2.79 | 1.08 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 11/04 | 5 | 2.4 | 0.8 | <0.2 | <0.2 | <0.2 | 0.7/0.3 | <0.2 | <0.2 | <0.2 |
| | 03/05 | 5 | 2.4 | 0.8 | <0.2 | <0.2 | 0.2 J | 0.4 | 0.2 J | <0.2/<0.2 | <0.2/<0.2 [c] |
| | 08/05 | 5 | 3.3 | 0.8 | <0.6 | <0.2 | <0.2 | 0.5 | <0.2 | <0.2 | <0.2 |
| | 10/05 | 5 | 3.0 | 1.0 | <0.2 | <0.2 | 0.2 | 0.4 | <0.2 | <0.2 | <0.2 |
| | 12/05 | 5 | 2.5 | – | <0.2 | <0.2 | 0.1 J | 0.3 | 0.1 J | <0.2 | <0.2 |
| | 03/06 | 5 | 1.1 | 0.3 | <0.2 | <0.2 | <0.2 | 0.5 | <0.2 | <0.2 | <0.2 |
| | 05/06 | 5 | 1.5 | 0.3 | <0.2 | <0.2 | <0.2 | 0.4 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 5 | 2.6 | 0.6 | <0.2 | <0.2 | <0.2 | 0.5 | <0.2 | <0.2 | – |
| | 02/07 | 5 | 0.9 | 0.2 | <0.2 | <0.2 | <0.2 | 0.4 | <0.2 | <0.2 | – |

**Table 3**
**Groundwater Analytical Summary - Darigold Property**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Analytes and Test Methods | Date Sampled | Method A Cleanup Levels [a] | Monitoring Well I.D. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW1 | MW2 | MW3 | MW4 | MW5 | MW6 | MW7 | MW8 | MW12 |
| cis-1,2-Dichloroethene | 03/01 | 80 [e] | -- | -- | <0.1 | -- | <0.1 | <0.1 | <0.1 | -- | -- |
| | 05/03 | 80 [e] | 7.62 | -- | -- | -- | -- | 7.4 | -- | -- | -- |
| | 10/03 | 80 [e] | 13.8 | 12 | <0.1 | <0.1 | 1.17 | 13 | <0.1 | 1.55 | <0.1 |
| | 11/04 | 80 [e] | 6.8 | 6.8 | <0.2 | <0.2 | 3.0 | 4.2/2.4 | 1.4 | 1.8 | <0.2 |
| | 03/05 | 80 [e] | 4.2 | 6.2 | 0.2 J | 0.2 | 1.4 | 3.0 | 1.8 | 1.4/1.3 | <0.2/<0.2 [c] |
| | 08/05 | 80 [e] | 5.6 | 7.1 | <0.6 | <0.2 | 1.3 | 3.7 | 0.6 | 1.0 | <0.2 |
| | 10/05 | 80 [e] | 8.6 | 7.4 | 0.2 | <0.2 | 3.1 | 3.6 | 2.2 | 1.4 | 0.2 |
| | 12/05 | 80 [e] | 4.7/4.5 | -- | 0.2 J | 0.1 J | 1.9 | 2.9 | 1.6 | 1.4 | 0.1 |
| | 03/06 | 80 [e] | 2.4 | 2.6 | <0.2 | <0.2 | 1.5 | 4.0 | 1.0 | 1.4 | 0.2 |
| | 05/06 | 80 [e] | 3.1 | 2.4 | 0.2 | 0.3 | 0.8 | 2.7 | 0.7 | 1.3 | <0.2 |
| | 09/06 | 80 [e] | 6.4 | 6.2 | 0.2 | <0.2 | 0.9 | 3.6 | 0.8 | 1.0 | -- |
| | 02/07 | 80 [e] | 1.9 | 1.7 | <0.2 | <0.2 | 0.6 | 2.6 | 1.1 | 1.2 | -- |
| trans-1,2-Dichloroethene | 03/01 | 160 [e] | -- | -- | <0.1 | -- | <0.1 | <0.1 | <0.1 | -- | -- |
| | 05/03 | 160 [e] | <0.1 | -- | -- | -- | -- | 0.5 | -- | -- | -- |
| | 10/03 | 160 [e] | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 11/04 | 160 [e] | 0.2 | 0.3 | <0.2 | <0.2 | <0.2 | 0.3/0.2 | <0.2 | <0.2 | <0.2 |
| | 03/05 | 160 [e] | 0.2 | 0.4 | <0.2 | <0.2 | <0.2 | 0.3 | <0.2 | <0.2/<0.2 | <0.2/<0.2 [c] |
| | 08/05 | 160 [e] | 0.4 | 0.4 | <0.6 | <0.2 | <0.2 | 0.3 | <0.2 | <0.2 | <0.2 |
| | 10/05 | 160 [e] | 0.6 | 0.4 | <0.2 | <0.2 | <0.2 | 0.3 | <0.2 | <0.2 | <0.2 |
| | 12/05 | 160 [e] | 0.3/0.3 | -- | <0.2 | <0.2 | <0.2 | 0.3 | 1.1 J | <0.2 | <0.2 |
| | 03/06 | 160 [e] | 0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 05/06 | 160 [e] | 0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 160 [e] | 0.5 | 0.3 | <0.2 | <0.2 | <0.2 | 0.3 | <0.2 | <0.2 | -- |
| | 02/07 | 160 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | 0.2 | <0.2 | <0.2 | -- |
| 1,1-Dichloroethene | 03/01 | 0.073 [e] | -- | -- | <0.1 | -- | <0.1 | 2.02 | <0.1 | -- | -- |
| | 05/03 | 0.073 [e] | <0.1 | -- | -- | -- | -- | <0.1 | -- | -- | -- |
| | 10/03 | 0.073 [e] | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 11/04 | 0.073 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2/<0.2 | <0.2 | <0.2 | <0.2 |
| | 03/05 | 0.073 [e] | 0.2 J | 0.1 J | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2/<0.2 | <0.2/<0.2 [c] |
| | 08/05 | 0.073 [e] | <0.4 | <0.2 | <0.6 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 10/05 | 0.073 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 12/05 | 0.073 [e] | <0.2/<0.2 | -- | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 03/06 | 0.073 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 05/06 | 0.073 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| | 09/06 | 0.073 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | -- |
| | 02/07 | 0.073 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | -- |

## Table 3
## Groundwater Analytical Summary - Darigold Property
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Analytes and Test Methods | Date Sampled | Method A Cleanup Levels [a] | Monitoring Well I.D. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW1 | MW2 | MW3 | MW4 | MW5 | MW6 | MW7 | MW8 | MW12 |
| Vinyl Chloride | 03/01 | 0.20 | -- | -- | <0.1 | -- | <0.1 | **3.21** | <0.1 | -- | -- |
| | 05/03 | 0.20 | **0.665** | -- | -- | -- | -- | **11.1** | -- | -- | -- |
| | 10/03 | 0.20 | **1.21** | **20.4** | <0.1 | <0.1 | <0.1 | **41.2** | **1.74** | **1.38** | <0.1 |
| | 11/04 | 0.20 | **0.5** | **5.8** | <0.2 | <0.2 | **2.1** | **7.9/8.8** | **1.4** | **1.7** | <0.2 |
| | 03/05 | 0.20 | **0.5** | **3.3** | <0.2 | <0.2 | **0.4** | **6.1** | **1.6** | **1.3/1.1** | <0.2/<0.2 [c] |
| | 08/05 | 0.20 | **0.7** | **2.0** | <0.6 | <0.2 | **0.3** | **7.7** | 0.2 | **0.4** | <0.2 |
| | 10/05 | 0.20 | **2.1** | **4.1** | <0.2 | <0.2 | **1.3** | **9.2** | **1.4** | **0.8** | <0.2 |
| | 12/05 | 0.20 | **1.2/1.0** | -- | <0.2 | <0.2 | **0.6** | **11** | **1.0** | **1.0** | <0.2 |
| | 03/06 | 0.20 | **0.3** | 0.2 | <0.2 | <0.2 | **0.8** | **3.5** | **0.7** | **0.7** | <0.2 |
| | 05/06 | 0.20 | **0.4** | 0.2 | <0.2 | <0.2 | 0.2 | **3.2** | **0.4** | **0.4** | <0.2 |
| | 09/06 | 0.20 | **1.4** | **1.4** | <0.2 | <0.2 | <0.2 | **6.6** | 0.2 | **0.3** | -- |
| | 02/07 | 0.20 | 0.2 | <0.2 | <0.2 | <0.2 | 0.2 | **2.9** | **0.7** | **0.4** | -- |
| 1,1,1-Trichloroethane | 03/01 | 200 | -- | -- | <0.1 | -- | <0.1 | <0.1 | <0.1 | -- | -- |
| | 05/03 | 200 | <0.1 | -- | -- | -- | -- | <0.1 | -- | -- | -- |
| | 10/03 | 200 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| | 05/06 | 200 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 1,1,2-Trichloroethane | 05/06 | 0.77 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 1,1-Dichloroethane | 05/06 | 800 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Benzene | 05/06 | 5 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Toluene | 05/06 | 1,000 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Dibromochloromethane | 05/06 | 0.52 [e] | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| tert-Butylbenzene | 05/06 | N/A | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Acetone | 05/06 | 800 [e] | <1.0 | <1.0 | 1.2 | 2 | <1.0 | 1.4 | 3.3 | <1.0 | 1.8 |
| Methylene Chloride | 05/06 | 5 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 |

Notes:

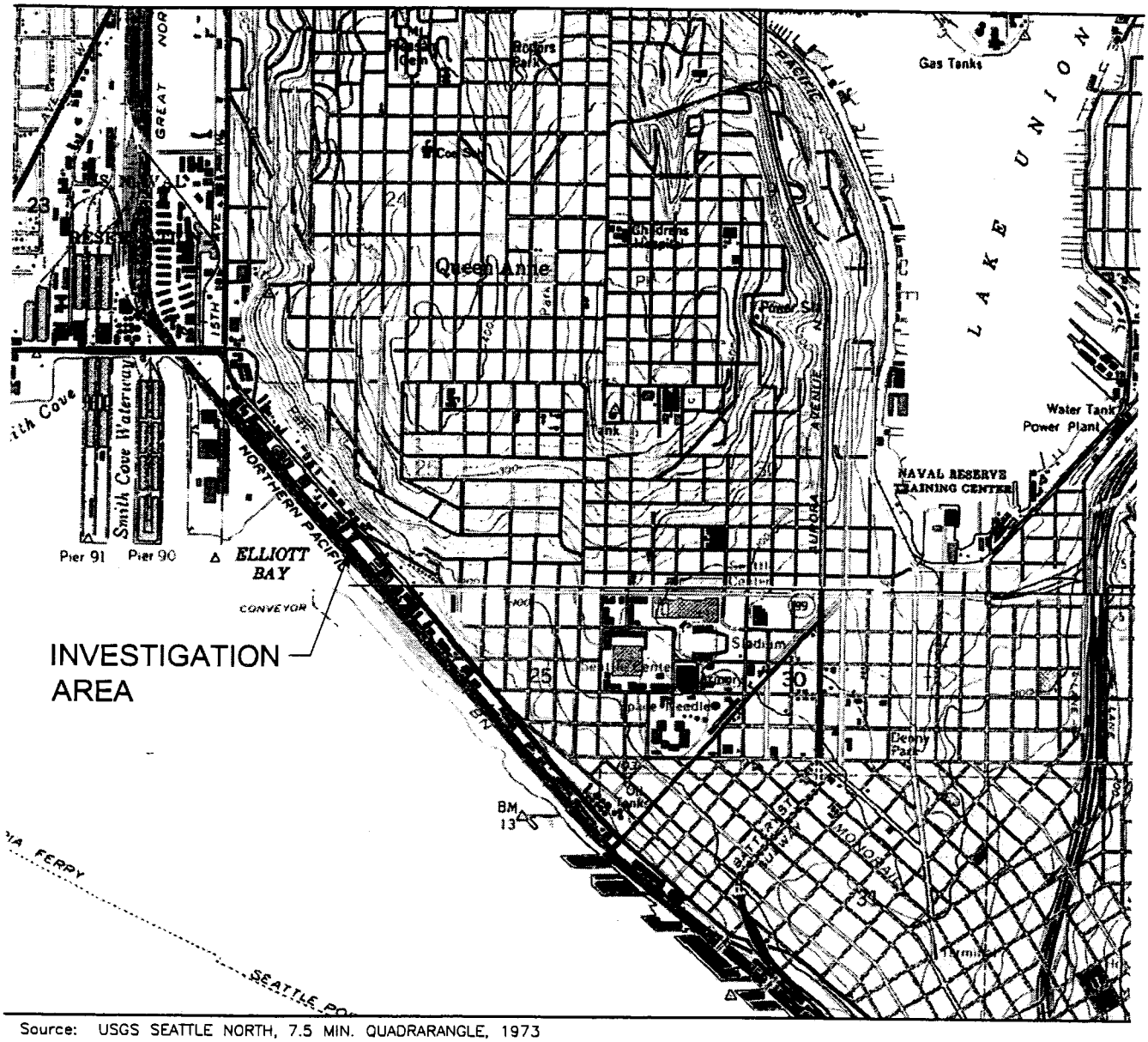
Bold and boxed values exceed Method A/B cleanup level.
* Turbidity meter malfunctioned; judged to be <10 NTU prior to sampling based on clarity of water.
a) Washington Administrative Code Chapter 173-340, Model Toxics Control Act Cleanup Regulation, promulgated August 15, 2001. Method A suggested groundwater cleanup level used when available.
b) Silver-silver chloride reference electrode.
c) MW12 was resampled on 4/4/05.
d) + means *Dehalococcoides spp*. detected; - means *Dehalococcoides spp*. not detected.
e) Method B cleanup level from Washington Dept. of Ecology's Cleanup Levels and Risk Calculations (CLARC) tables.
f) Dissolved oxygen meter not working correctly.
°C - degrees Celsius.
D - value from a diluted sample.
NS - not sampled.
FP - free product measured or indicated.
J - estimated value.
M - Estimated amount of analyte found and confirmed by analyst but with low GC/MS spectral match.
mV - millivolts.
NTU - nephelometric turbidity units.
ORP - oxidation reduction potential.
µS/cm - microsiemens per centimeter.
µg/L - micrograms per liter.
ppm - parts per million.
mg/L - milligrams per liter.
-- not analyzed.
< - analyte not detected at or greater than the listed concentration.

**Table 4**
**Mann-Kendall Trend Analysis**
Ryan, Swanson & Cleveland, PLLC/LeatherCare, Inc.
Seattle, Washington

| Statistic | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 |
|---|---|---|---|---|---|---|---|---|---|
| Tetra-chloroethene | Count (n) | 11 | 9 | 11 | 10 | 11 | 12 | 11 | 10 |
| | Count (nondetects) | 0 | 9 | 11 | 10 | 11 | 1 | 11 | 10 |
| | S Statistic | -23 | NA | NA | NA | NA | -24 | NA | NA |
| | Var(S) | 165 | NA | NA | NA | NA | 211 | NA | NA |
| | Trend | Decreasing | NA | NA | NA | NA | Decreasing | NA | NA |
| | prob (%) [1] | 4.34% | NA | NA | NA | NA | 5.65% | NA | NA |
| Trichloroethene | Count (n) | 11 | 9 | 9 | 10 | 11 | 12 | 11 | 10 |
| | Count (nondetects) | 0 | 0 | 9 | 10 | 10 | 1 | 11 | 10 |
| | S Statistic | -18 | -22 | NA | NA | NA | -19 | NA | NA |
| | Var(S) | 164 | 87 | NA | NA | NA | 200 | NA | NA |
| | Trend | Decreasing | Decreasing | NA | NA | NA | Decreasing | NA | NA |
| | prob (%) [1] | 9.22% | 1.23% | NA | NA | NA | 10.17% | NA | NA |
| cis-1,2-Dichloroethene | Count (n) | 11 | 9 | 11 | 10 | 11 | 12 | 11 | 9 |
| | Count (nondetects) | 0 | 0 | 8 | 8 | 1 | 1 | 2 | 0 |
| | S Statistic | -29 | -21 | NA | NA | -7 | -17 | 10 | -18 |
| | Var(S) | 165 | 91 | NA | NA | 165 | 212 | 164 | 83 |
| | Trend | Decreasing | Decreasing | NA | NA | Decreasing | Decreasing | Increasing | Decreasing |
| | prob (%) [1] | 1.46% | 1.80% | NA | NA | 32.02% | 13.57% | 24.11% | 3.13% |
| Vinyl Chloride | Count (n) | 11 | 9 | 11 | 10 | 11 | 12 | 11 | 10 |
| | Count (nondetects) | 0 | 1 | 11 | 10 | 3 | 0 | 1 | 0 |
| | S Statistic | -10 | -25 | NA | NA | -1 | -24 | -16 | -30 |
| | Var(S) | 164 | 88 | NA | NA | 160 | 213 | 162 | 121 |
| | Trend | Decreasing | Decreasing | NA | NA | Decreasing | Decreasing | Decreasing | Decreasing |
| | prob (%) [1] | 24.11% | 0.53% | NA | NA | 50.00% | 5.74% | 11.93% | 0.42% |
| NWTPH-Dx-Diesel | Count (n) | 13 | 12 | 11 | 13 | 13 | 13 | 13 | 13 |
| | Count (nondetects) | 7 | 5 | 0 | 2 | 3 | 3 | 0 | 1 |
| | S Statistic | NA | 2 | -28 | 28 | 27 | 19 | -32 | -1 |
| | Var(S) | NA | 196 | 164 | 267 | 265 | 265 | 267 | 265 |
| | Trend | NA | Increasing | Decreasing | Increasing | Increasing | Increasing | Decreasing | Decreasing |
| | prob (%) [1] | NA | 47.15% | 1.75% | 4.91% | 5.51% | 13.44% | 2.88% | 50.00% |
| NWTPH-Dx-Motor Oil | Count (n) | 13 | 12 | 11 | 13 | 13 | 13 | 13 | 13 |
| | Count (nondetects) | 13 | 10 | 2 | 9 | 13 | 12 | 5 | 12 |
| | S Statistic | NA | NA | -18 | NA | NA | NA | -36 | NA |
| | Var(S) | NA | NA | 164 | NA | NA | NA | 252 | NA |
| | Trend | NA | NA | Decreasing | NA | NA | NA | Decreasing | NA |
| | prob (%) [1] | NA | NA | 9.22% | NA | NA | NA | 1.37% | NA |

Notes:
1) The "p" value = Probability of no real increasing or decreasing trend given S, Var(S), and n.
NA - not applicable (insufficient number of detections to calculate statistics).

# Figures




Source: USGS SEATTLE NORTH, 7.5 MIN. QUADRARANGLE, 1973

N

0 2000

Scale in Feet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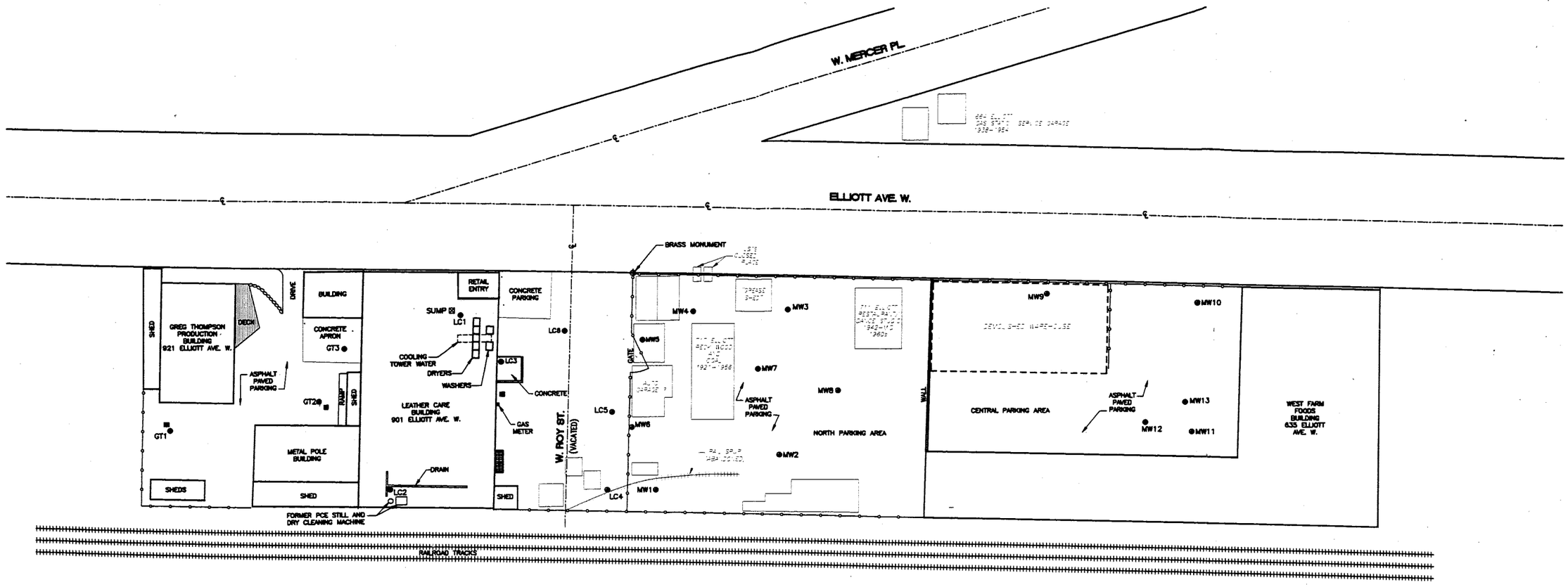
SEATTLE, WASHINGTON

Figure No. 1
VICINITY MAP

CDM




REFERENCES:

- SURVEY OF MONITORING WELL LOCATIONS BY APEX ENGINEERING ON MAY 10, 2006 USING AN ASSUMED VERTICAL DATUM AND BASIS OF BEARING.
- FIELD MEASUREMENTS OF LEATHERCARE AND GREG THOMPSON PRODUCTION BUILDINGS BY CDM ON MAY 10, 2006.
- ENTRIX, WEST FARM FOODS FIELD INVESTIGATION DATA SUMMARY REPORT, MAY 10, 2001, FIGURE 2.
- ENTRIX ENVIRONMENTAL DATA SUMMARY FROM PREVIOUS STUDIES AND REPORTS, WEST FARM FOODS SITE, MAY 10, 2001. FIGURE-3.
- -HISTORICAL AERIAL PHOTOGRAPHS DATED 1936 AND 1946.
- -SANBORN MAP DATED 1950.
- -POLK DIRECTORIES DATED 1938-1996

SITE PLAN

N

1" = 80'

40 0 80

LEGEND:

- MW1 ● MONITORING WELL LOCATION AND DESIGNATION AND ELEVATION IN FEET
- FENCE
- RAILROAD TRACKS
- CATCH BASIN
- HISTORICAL FEATURES
- SURVEY MONUMENT

VERTICAL DATUM:

STAMPED ON BRASS MONUMENT NOT TIED TO CITY OF SEATTLE (NOT PUBLISHED)

BASIS OF BEARING:

BASIS OF BEARING ASSUMED DUE WEST

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SEATTLE, WASHINGTON

Figure No. 2
SITE PLAN

CDM

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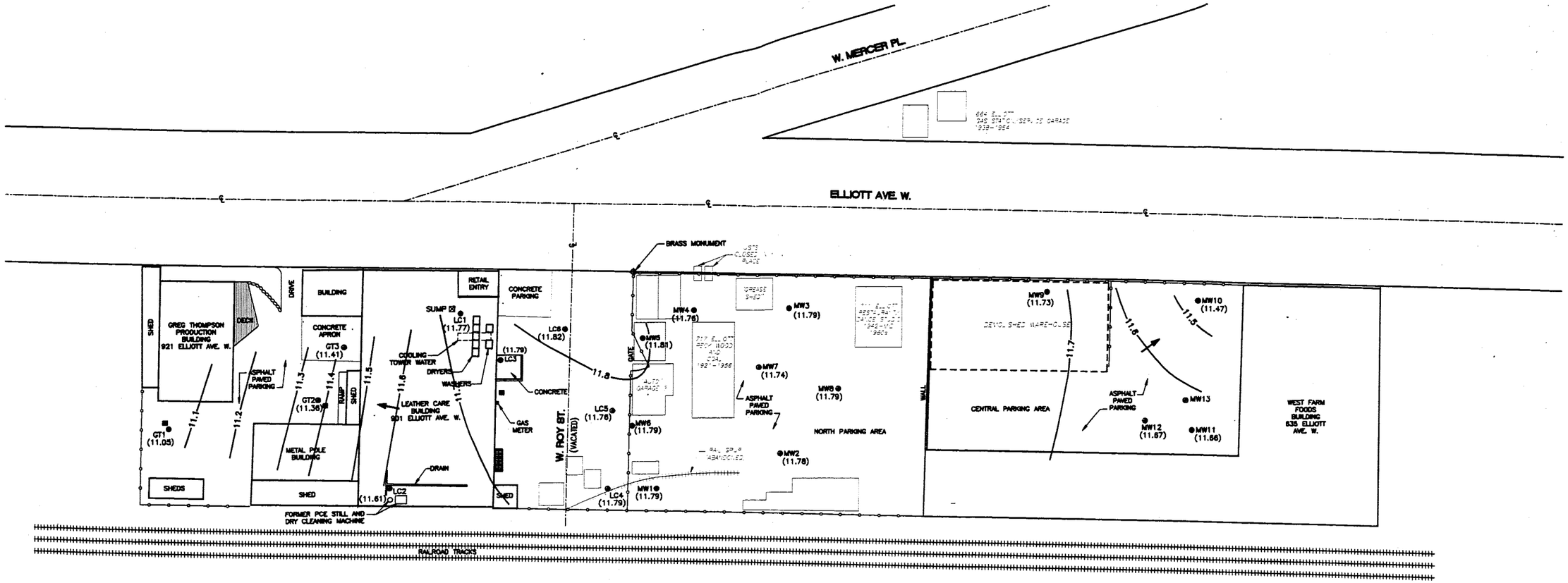


REFERENCES:

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- SANBORN MAP DATED 1950.
- POLK DIRECTORIES DATED 1938-1998

SITE PLAN

N

1" = 80'

40 0 80

LEGEND:

- MW1 (11.79) — MONITORING WELL LOCATION AND DESIGNATION AND ELEVATION IN FEET
- 11.2 — POTENTIOMETRIC CONTOURS, CONTOUR INTERVAL IS 0.1 FT (AVERAGE)
- DIRECTION OF GROUNDWATER FLOW
- FENCE
- RAILROAD TRACKS
- CB CATCH BASIN
- HISTORICAL FEATURES
- SURVEY MONUMENT

VERTICAL DATUM:

STAMPED ON BRASS MONUMENT NOT TIED TO CITY OF SEATTLE (NOT PUBLISHED)

BASIS OF BEARING:

BASIS OF BEARING ASSUMED DUE WEST

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SEATTLE, WASHINGTOM

Figure No. 4
POTENTIOMETRIC SURFACE MAP
FEBRUARY 12, 2007

CDM

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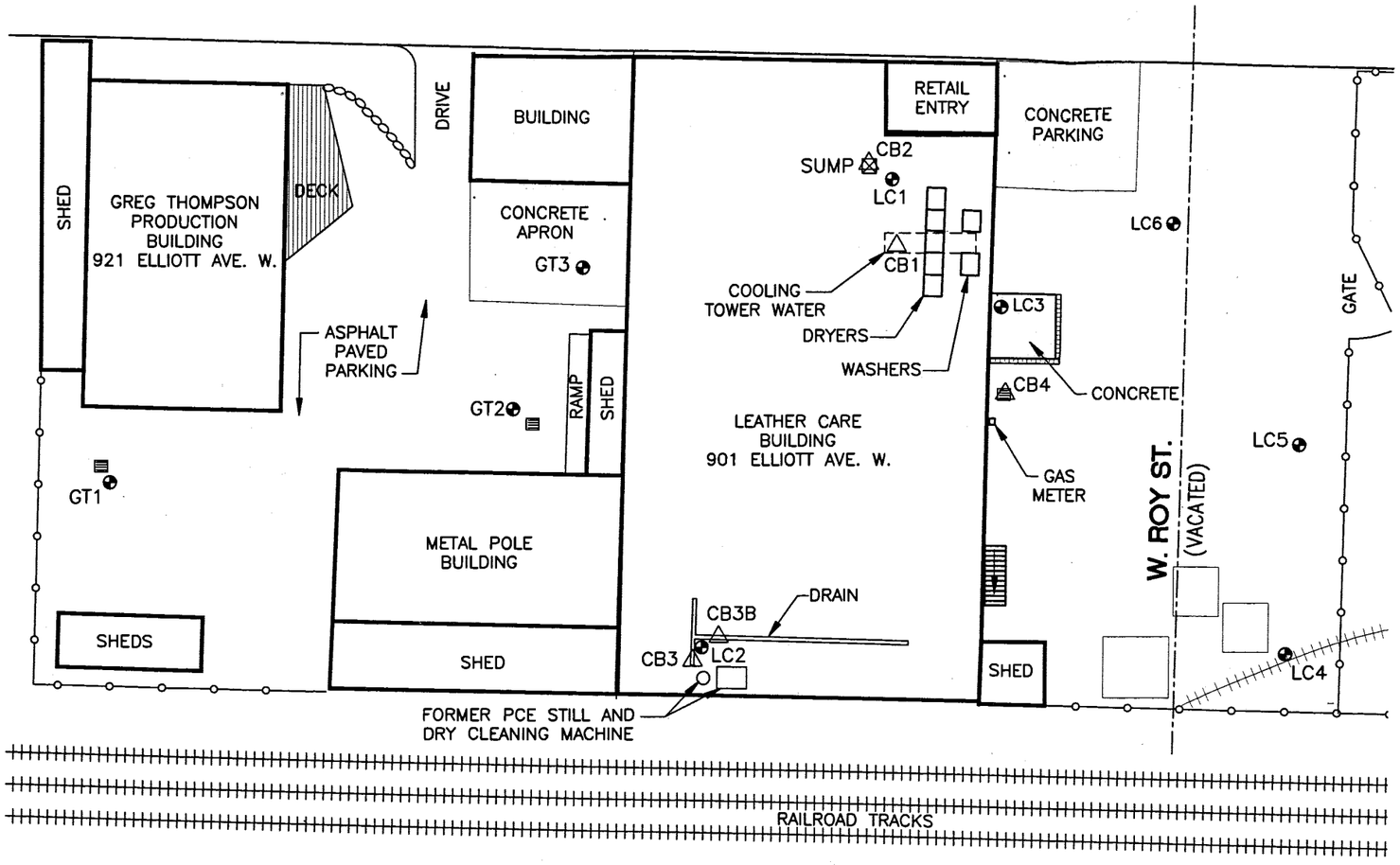


# SITE PLAN

1" = 40'

20 0 40

REFERENCES:

- SURVEY OF MONITORING WELL LOCATIONS BY APEX ENGINEERING ON MAY 10, 2006 USING AN ASSUMED VERTICAL DATUM AND BASIS OF BEARING.
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- SANBORN MAP DATED 1950.
- POLK DIRECTORIES DATED 1938-1996

LEGEND:

- MW1 ⊕ MONITORING WELL LOCATION AND DESIGNATION AND ELEVATION IN FEET
- FENCE
- RAILROAD TRACKS
- CB4 △ SUMP/TRENCH/CATCH BASIN SAMPLE LOCATION AND DESIGNATION
- CATCH BASIN
- INDICATES HISTORICAL FEATURES — HISTORICAL FEATURES
- SURVEY MONUMENT

VERTICAL DATUM:

STAMPED ON BRASS MONUMENT NOT TIED TO CITY OF SEATTLE (NOT PUBLISHED)

BASIS OF BEARING:

BASIS OF BEARING ASSUMED DUE WEST

RYAN SWANSON & CLEVELAND PLLC
LEATHERCARE
SEATTLE, WASHINGTOM

Figure No. 3
SUMP/TRENCH/CATCH BASIN
SAMPLE LOCATION MAP

CDM

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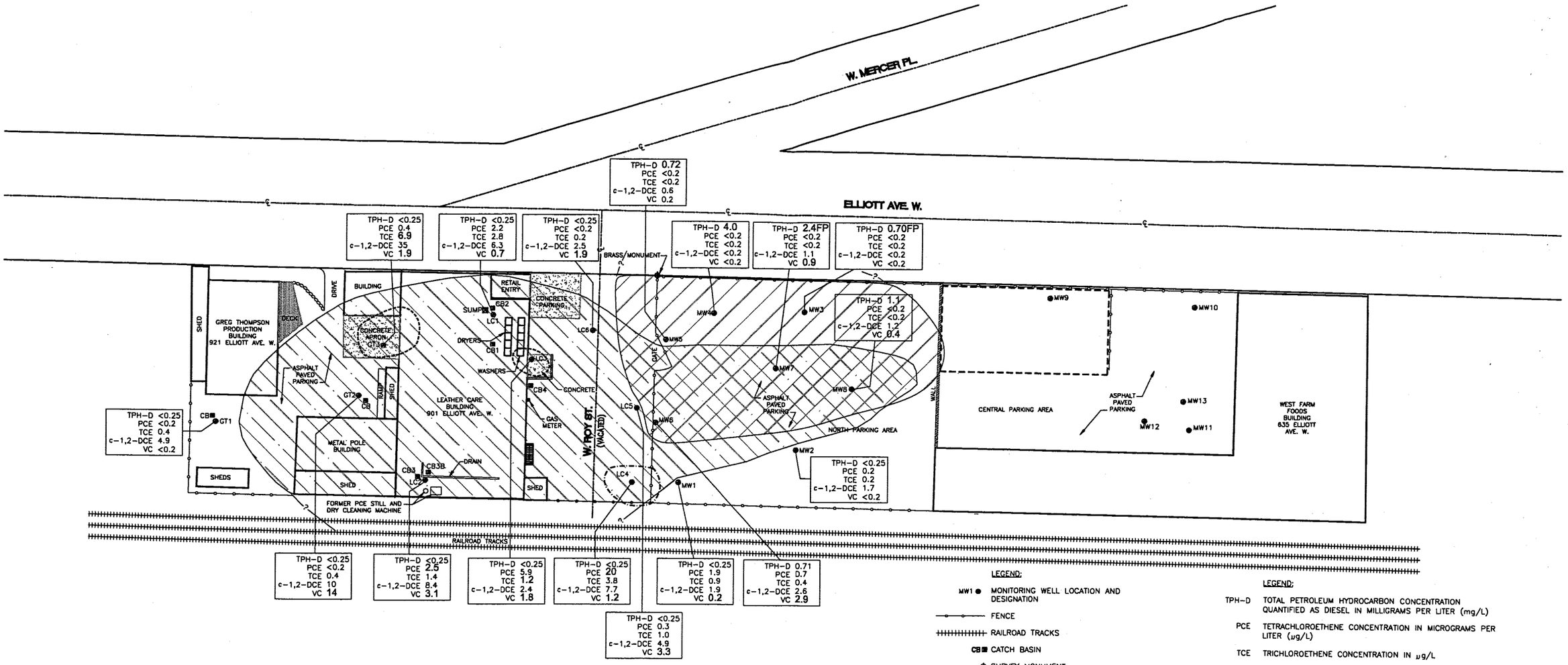


REFERENCES:

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- FIELD MEASUREMENTS OF LEATHERCARE AND GREG THOMPSON PRODUCTION BUILDINGS BY CDM ON MAY 10, 2006.
- ENTRIX, WEST FARM FOODS FIELD INVESTIGATION DATA SUMMARY REPORT, MAY 10, 2001. FIGURE 2.

LEGEND:

- MW1 ● MONITORING WELL LOCATION AND DESIGNATION
- FENCE
- RAILROAD TRACKS
- CB■ CATCH BASIN
- SURVEY MONUMENT

VERTICAL DATUM:

STAMPED ON BRASS MONUMENT NOT TIED TO CITY OF SEATTLE (NOT PUBLISHED)

BASIS OF BEARING:

BASIS OF BEARING ASSUMED DUE WEST

LEGEND:

- TPH-D TOTAL PETROLEUM HYDROCARBON CONCENTRATION QUANTIFIED AS DIESEL IN MILLIGRAMS PER LITER (mg/L)
- PCE TETRACHLOROETHENE CONCENTRATION IN MICROGRAMS PER LITER (µg/L)
- TCE TRICHLOROETHENE CONCENTRATION IN µg/L
- c-1,2-DCE CIS-1,2-DICHLOROETHENE CONCENTRATION IN µg/L
- VC VINYL CHLORIDE CONCENTRATION IN µg/L
- FP FREE PHASE PRODUCT PRESENT
- + *DEHALOCOCCOIDES SPP.* PRESENT
- 0.0 BOLDED VALUES EXCEED THE MODEL TOXICS CONTROL ACT METHOD A CLEANUP LEVEL

- APPROXIMATE EXTENT OF TPH-D EXCEEDING 0.5 mg/L
- APPROXIMATE EXTENT OF VC EXCEEDING 0.2 µg/L
- APPROXIMATE EXTENT OF TCE EXCEEDING 5 µg/L
- APPROXIMATE EXTENT OF PCE EXCEEDING 5 µg/L

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SEATTLE, WASHINGTON

Figure No. 5
Diesel and Chlorinated Compounds in Groundwater
February 2007

CDM

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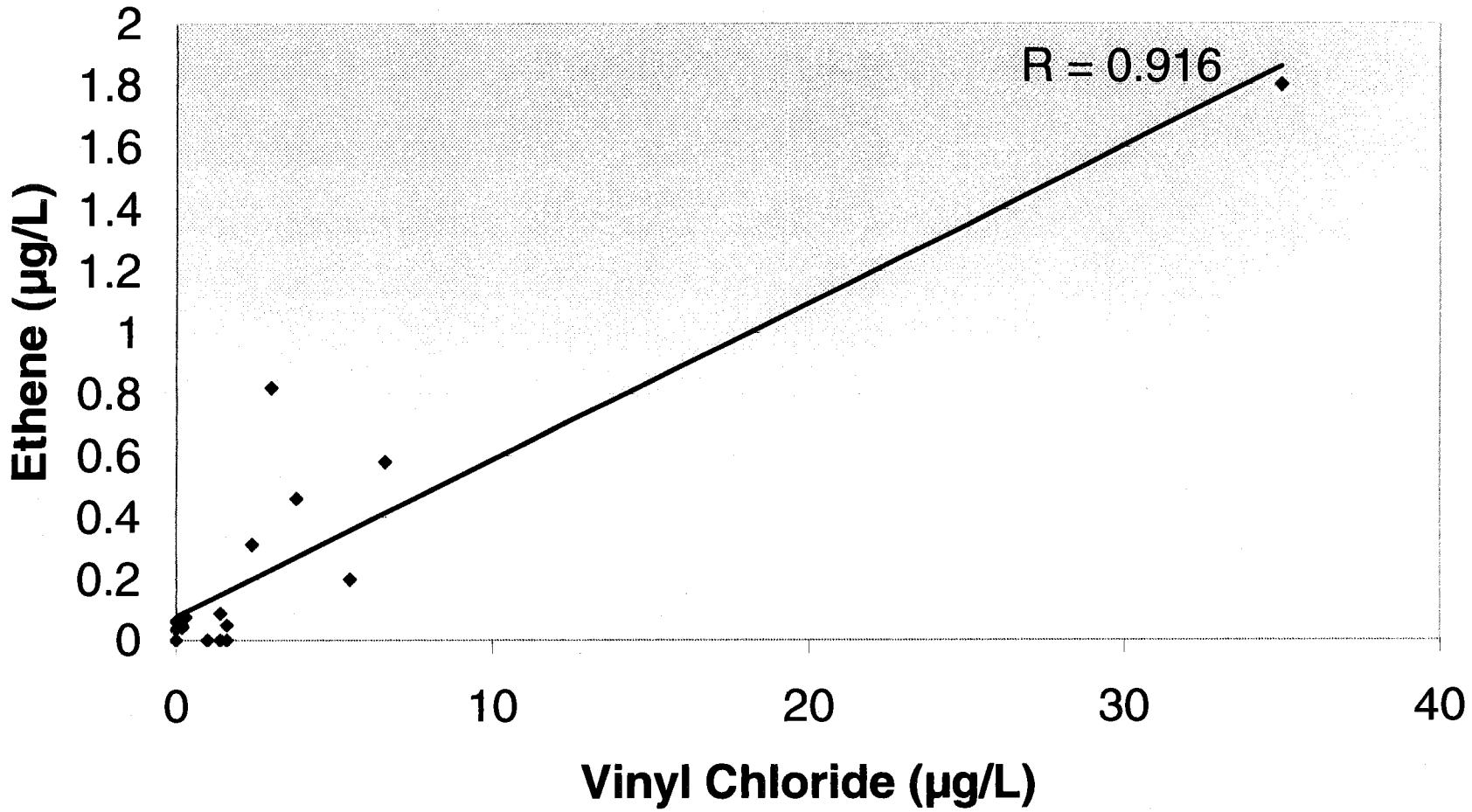



Figure 6
Vinyl Chloride vs. Ethene Concentrations
in MW1-MW8, September 2006

CDM

P:\38057 - Ryan Swanson & Cleveland\47522 - Leathercare\6-Project Data\6.4 Field Data\Groundwater Analytical Results.xls

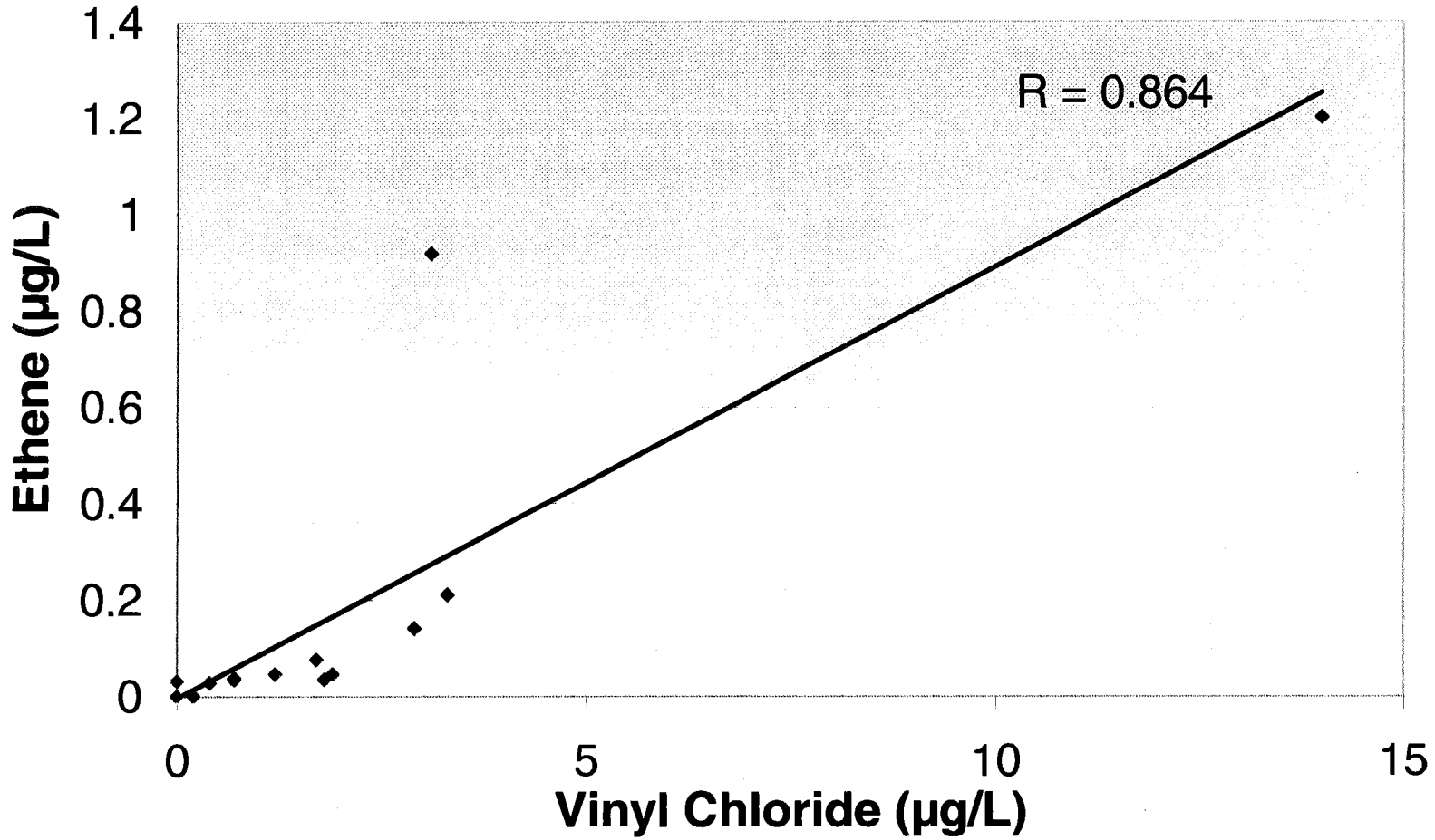
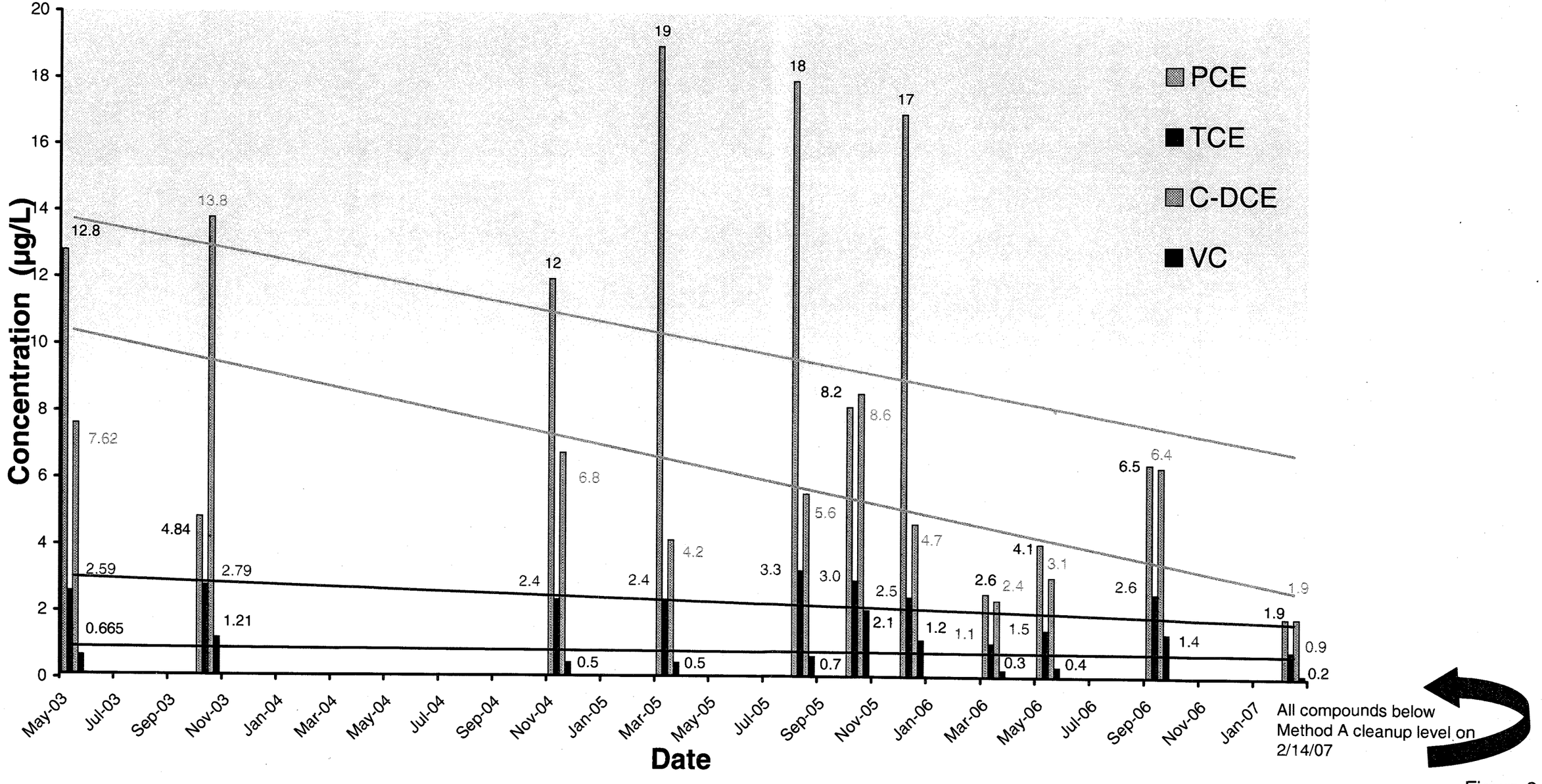



Figure 7
Vinyl Chloride vs. Ethene Concentrations
in MW1-MW8, February 2007

# MW 1

## Tetrachloroethene, Trichloroethene, cis-1,2-Dichloroethene, Vinyl Chloride




CDM

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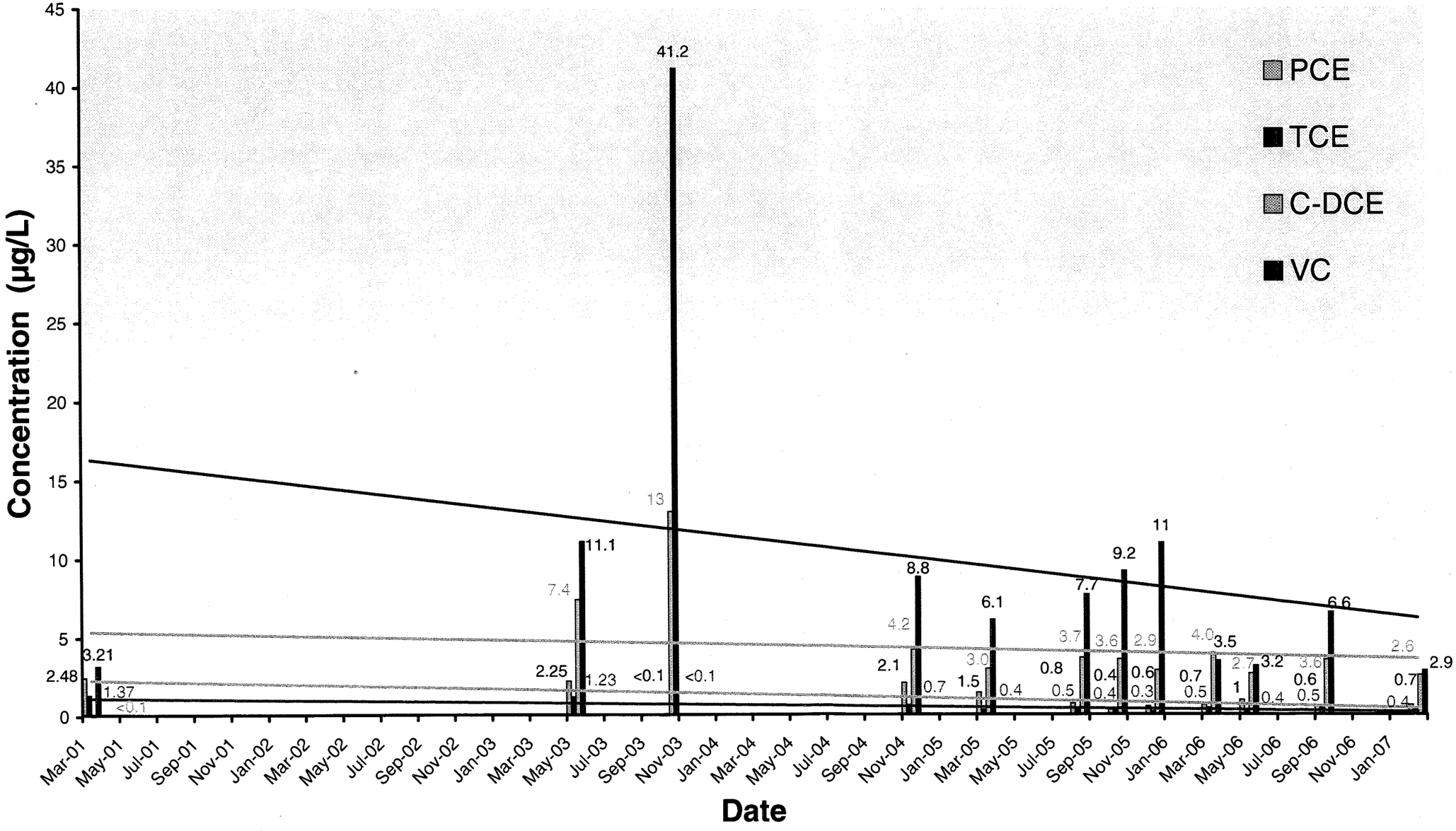
Figure 8
PCE and Degradation Products
in MW-1

# MW 6

## Tetrachloroethene, Trichloroethene, cis-1,2-Dichloroethene, Vinyl Chloride

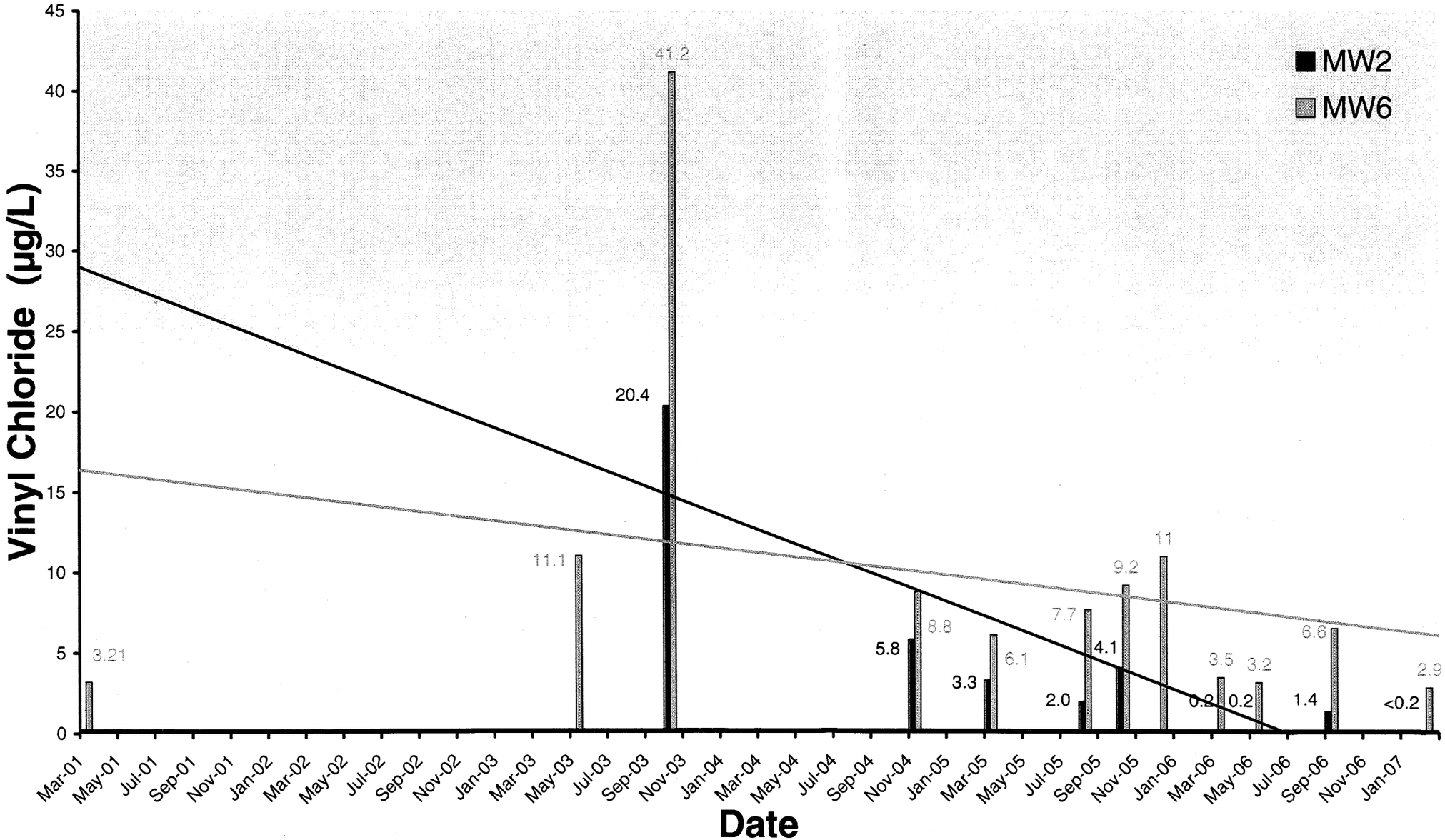



CDM

P:\38057 - Ryan Swanson & Cleveland\47522 - Leathercare\6-Project Data\6.0 Project Data\Leathercare VC, PCE Data Summary - LINEAR TIME SCALE.xls

Figure 9
PCE and Degradation Products
in MW-6

# Vinyl Chloride



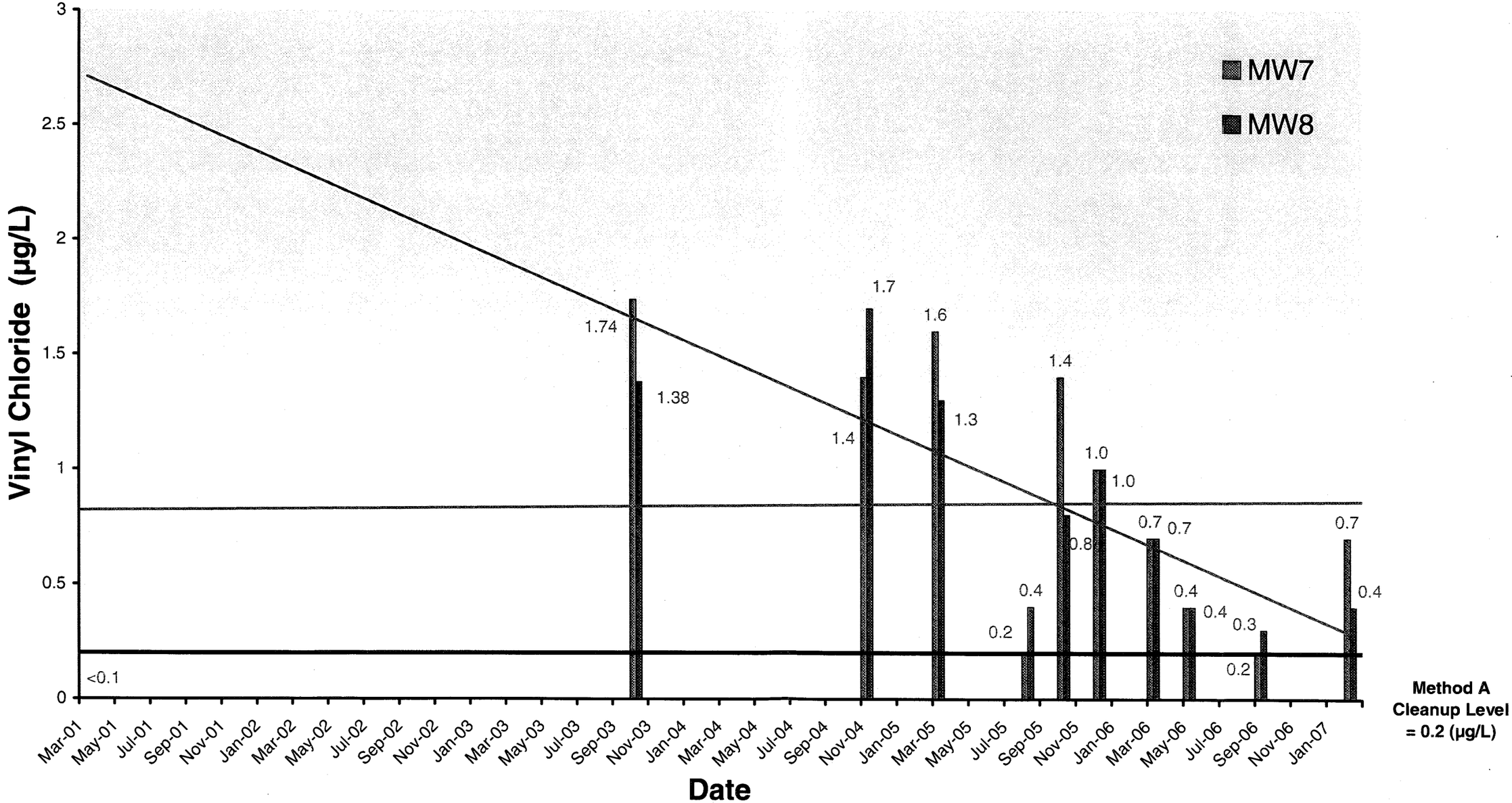

**Method A Cleanup Level = 0.2 (µg/L)**

CDM

P:\38057 - Ryan Swanson & Cleveland\47522 - Leathercare\6-Project Data\6.0 Project Data\Leathercare VC, PCE Data Summary - LINEAR TIME SCALE.xls

Figure 10
Vinyl Chloride
in MW-2 and MW-6

# Vinyl Chloride

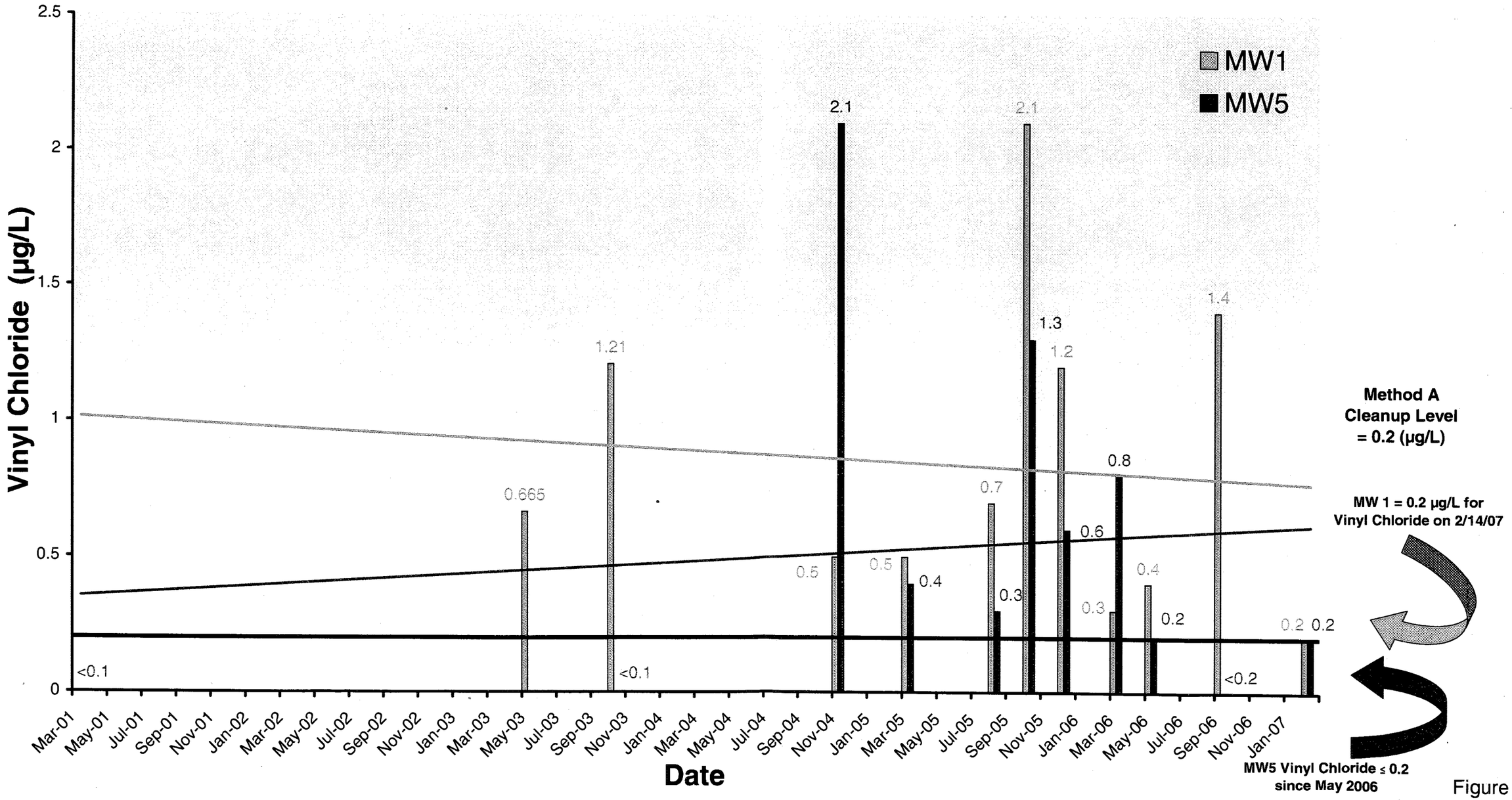



CDM

P:\38057 - Ryan Swanson & Cleveland\47522 - Leathercare\6-Project Data\6.0 Project Data\Leathercare VC. PCE Data Summary - LINEAR TIME SCALE.xls

Figure 11
Vinyl Chloride
in MW-7 and MW-8

# Vinyl Chloride




CDM

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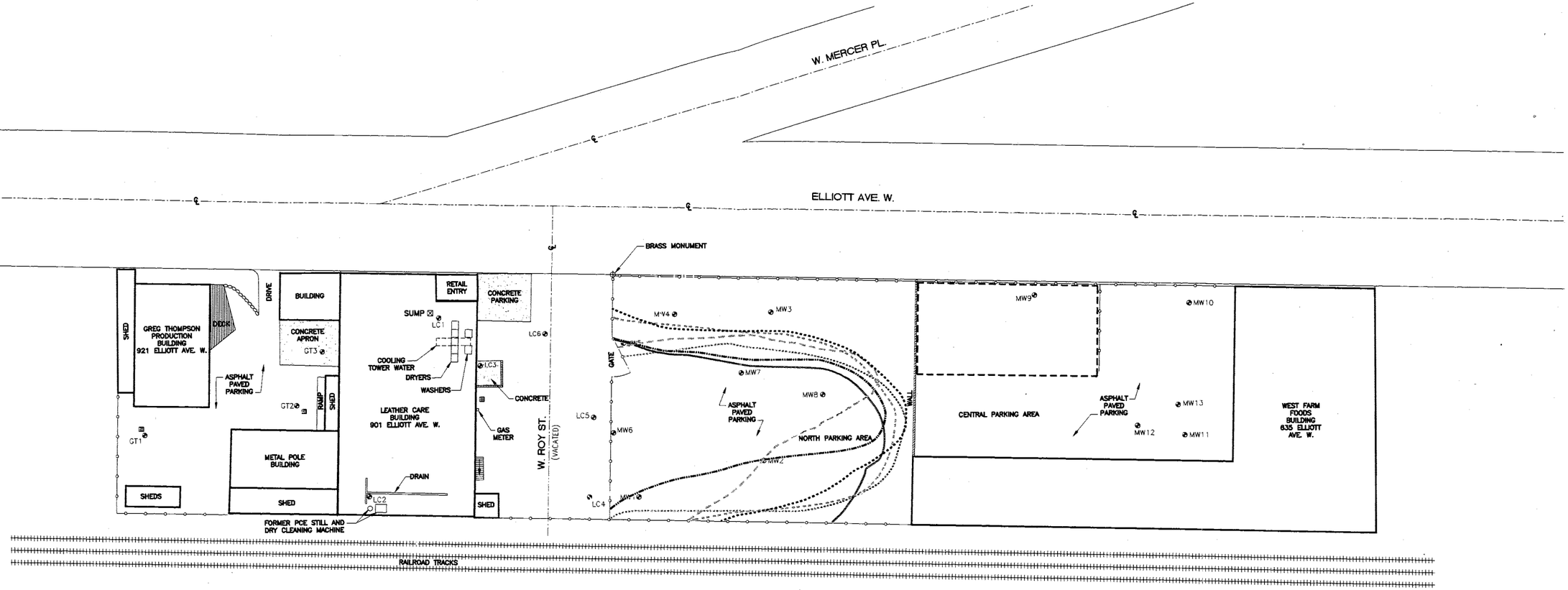
Figure 12
Vinyl Chloride
in MW-1 and MW-5

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- SANBORN MAP DATED 1950.
- POLK DIRECTORIES DATED 1938-1998

VERTICAL DATUM:

STAMPED ON BRASS MONUMENT NOT TIED TO CITY OF SEATTLE (NOT PUBLISHED)

BASIS OF BEARING:

BASIS OF BEARING ASSUMED DUE WEST

SITE PLAN

N

1" = 80'

40 0 80

LEGEND:

- MW1 ⊕ MONITORING WELL LOCATION AND DESIGNATION AND ELEVATION IN FEET
- FENCE
- RAILROAD TRACKS
- CB CATCH BASIN
- HISTORICAL FEATURES
- SURVEY MONUMENT
- APPROXIMATE EDGE OF PLUME 10-03
- APPROXIMATE EDGE OF PLUME 11-04
- APPROXIMATE EDGE OF PLUME 10-05
- APPROXIMATE EDGE OF PLUME 5-06
- APPROXIMATE EDGE OF PLUME 9-06
- APPROXIMATE EDGE OF PLUME 2-07

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SEATTLE, WASHINGTON

Figure No. 13
Vinyl Chloride Plume On The Darigold Property Over Time

CDM

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# Appendix A
## Memo: Reevaluation of Field Measured Dissolved Oxygen Readings

# Appendix A

# Memorandum

*To:* *Ms. Jo Flannery*

*From:* *Pam Morrill*

*Date:* *March 1, 2007*

*Subject:* *Reevaluation of Field Measured Dissolved Oxygen Readings*

On February 12, through 14, 2007 ENTRIX purged and sampled existing monitoring wells on the LeatherCare and Darigold sites. CDM oversaw sampling activities and collected split samples. Upon reviewing the field data, CDM became concerned regarding the accuracy of the dissolved oxygen (DO) concentrations. A Horiba U-22, rented from Instrumentation Northwest (INW) in Bellevue, Washington, had been used for field measured parameters. This is the same supplier that CDM uses; however, CDM has only ever used the YSI 556 (YSI) while sampling this site. On February 20, 2007, CDM retested the performance of the Horiba U-22 (Horiba).

To perform this test, CDM attempted to procure a YSI with a flow through cell and the same Horiba that ENTRIX had used. However, at the time we went to pick up the instruments, CDM was informed that they had no YSI with a flow through cell. CDM then initially procured another Horiba, which INW had just calibrated and also the Horiba from ENTRIX, which had not yet been returned to INW. The scope of work was to purge three monitoring wells in W Roy Street and to observe the differences in field measured parameters. Upon purging the first monitoring well, it was evident that both Horiba meters were measuring high DO readings (i.e., 5 to 7 milligrams per liter [mg/L]), so thereafter, only the recently rented meter was used. At CDM's request, INW then brought out a YSI used for down-well readings. CDM proceeded to purge LC4, LC5, and LC6 and measured the field parameters using the Horiba. Afterwards, the YSI was extended down into the monitoring well and the readings were recorded from the water inside the monitoring well.

Five field parameter measurements (temperature, conductivity, pH, dissolved oxygen, and oxidation-reduction potential (ORP)) were compared. Following are a comparison of values for the five parameters listed above for these three wells.

# Appendix A

**LC4**

| Parameter | Horiba Meter Reading | YSI Meter Reading |
|---|---|---|
| Temp (Celsius) | 10.1 | 9.49 |
| Conductivity (µS/cm) | 546 | 395 |
| DO (mg/L) | 5.1 | 1.14 |
| pH | 6.78 | 7.21 |
| ORP (mV) | 67 | 39.2 |

Note: YSI readings taken a few hours after Horiba.

**LC5**

| Parameter | Horiba Meter Reading | YSI Meter Reading |
|---|---|---|
| Temp (Celsius) | 9.9 | 9.91 |
| Conductivity (µS/cm) | 745 | 752 |
| DO (mg/L) | 4.4 | 0.14 |
| pH | 6.81 | 7.09 |
| ORP (mV) | -53 | -97.1 |

**LC6**

| Parameter | Horiba Meter Reading | YSI Meter Reading |
|---|---|---|
| Temp (Celsius) | 11 | 11.54 |
| Conductivity (µS/cm) | 910 | 875 |
| DO (mg/L) | 4.2 | 0.28 |
| pH | 6.81 | 6.82 |
| ORP (mV) | -1 | 66.4 |

The YSI meter probe was also lowered into three other wells without prior purging (LC3, GT1, and GT2), to obtain readings. The DO values in these three wells were 1.18, 0.31 and 0.13 mg/L, respectively

The results of this test showed significant differences in DO readings between the two meters. The YSI DO readings are reasonably consistent with the previous two sets of groundwater data for the site (if not slightly higher).

CDM's findings were discussed with Jon Cory at INW. Mr. Corey noted that they perform the recommended maintenance from the manual as often as recommended, or more frequently. For the DO, they use an Autocal solution, which is a saturated DO solution that should read about 9 or 10 mg/L. The manual calibration procedure described in the manual for the instrument provides instructions for preparing a zero

calibration solution and a saturated solution for a span calibration. INW does not perform manual calibrations for the DO analysis or a zero-calibration solution with the Horiba. Consequently, the low end of the calibration for DO is never checked.

An EPA memo regarding the calibration of dissolved oxygen meters states that the loss of the low end of the calibration will not be detected if the meter is calibrated with a saturated solution only and no zero-solution is run as a check. For this reason, the EPA recommends that if DO readings are critical that either a two-point calibration (zero-oxygen and saturated) or a zero-oxygen check be performed.

**Conclusion:** All of the field measured DO reading from the last (February 2007) sampling round at the LeatherCare site are inaccurate and were not used.

**Proposed Action:** CDM will work with INW to ensure that any instruments that measure DO which we rent from them (or any other supplier) will be appropriately calibrated.

Attachment: USEPA. 2006. QA Bulletin, Calibration of Dissolved Oxygen Meters.

# QA BULLETIN
# CALIBRATION OF DISSOLVED OXYGEN METERS

Office of Environmental Measurement and Evaluation
Quality Assurance Unit
United States Environmental Protection Agency
New England
11 Technology Drive
North Chelmsford, MA 01863-2431



Prepared for: The Office of Environmental Measurement and Evaluation (OEME), U.S. EPA New England

Prepared by: _____
Charles Porfert, Quality Assurance Chemist, QA Unit Date

Approved by: _____
Gerard Sotolongo, QA Unit Manager Effective Date

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**NEW ENGLAND**
**OFFICE OF ENVIRONMENTAL MEASUREMENT & EVALUATION**
**11 TECHNOLOGY DRIVE**
**NORTH CHELMSFORD, MA 01863-2431**

# FINAL QA BULLETIN
# CALIBRATION OF DISSOLVED OXYGEN METERS

February 2006, Revision 0

**ISSUE**: Dissolved oxygen (DO) measurements at low oxygen levels may be inaccurate when DO membrane electrode meters are calibrated only at 100 percent saturated air.

**BACKGROUND**: As stated in *Standard Methods for the Examination of Water and Wastewater*, 20th ed., 4500-O G, the electrode method for measuring dissolved oxygen is extremely useful for *in situ* measurements for a variety of waters. One of the problems with the method includes unknowingly altering the characteristics of the DO probe's membrane. The probe's oxygen-permeable plastic membrane can be compromised by being punctured or by a coating adhering to it which may not be visible upon inspection. It is EPA NE's experience that these situations result in high DO measurements when the probe is placed in waters with low DO levels. This problem cannot be detected when the DO meter is calibrated only at the 100 percent saturated air level (approximately 10 mg/L at 15° C, 760 mm Hg).

**RECOMMENDATION**: If DO is a critical parameter for an investigation, EPA NE recommends a two point calibration using 100 percent saturated air and a zero DO solution. These two points define the measurement range.

*Standard Methods for the Examination of Water and Wastewater*, 20th ed., 4500-O G states that the DO meter should be calibrated following the manufacturer's instructions. Four common manufacturer* manuals, YSI, Hydrolab, In-Situ and Horiba, instruct users to calibrate the DO meter at 100 percent saturated air. In-situ and Horiba also instruct users to calibrate using a zero DO solution. The zero DO solution consists of a saturated solution of sodium sulfite with a trace of cobalt chloride. EPA NE has found that cobalt chloride can be omitted from the zero DO solution; however, the reaction time is slower. This solution should have a measured DO of less than 0.5 mg/L. If DO is a critical analytical parameter, EPA NE recommends calibration at 100 percent saturated air or using a known dissolved oxygen concentration (determined by the iodometric method) for the upper limit and with a zero DO solution (even if it is not explicitly stated in a particular manufacturer's manual) for the lower limit. If the DO meter does not allow for a second calibration point, the zero DO solution can be used as a check standard when the DO meter is set to the measurement mode. The DO meter should read less than 0.5 mg/L (or to the accuracy of the DO meter). If the DO meter does not read less than 0.5 mg/L, then there may be a problem with the DO membrane.

If it is determined that the DO membrane needs to be replaced, consult the manufacturer's manual on conditioning the new membrane before use. It is also possible that other maintenance may need to be performed on the DO meter or the zero DO solution may need to be replaced. Other factors that affect the accuracy of DO measurements include: improper calibration, not verifying calibration after use, not correcting for ambient barometric pressure/altitude, and instrument drift.

**SUMMARY:** If DO is a critical parameter, EPA New England (EPA NE) recommends a second calibration point using the zero DO solution or a check of low DO accuracy with a zero DO solution.

* The use of specific manufacturers' names does not constitute endorsement, recommendation, or approval of any manufacturer's equipment by EPA NE.