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Alameda County
Environmental Health

Stacie H. Frerichs
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Tel (925) 842-9655
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August 6, 2009
(date)

Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Re: Chevron Facility #_9-7127_______

Address:_Grant Line Road and Interstate 580, Tracy, California_________________________

I have reviewed the attached report titled *Work Plan for Groundwater Pumping Test*________________________________ and dated August 6, 2009.

I agree with the conclusions and recommendations presented in the referenced report. The information in this report is accurate to the best of my knowledge and all local Agency/Regional Board guidelines have been followed. This report was prepared by Conestoga-Rovers & Associates, upon whose assistance and advice I have relied.

This letter is submitted pursuant to the requirements of California Water Code Section 13267(b)(1) and the regulating implementation entitled Appendix A pertaining thereto.

I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

SH Frerichs

Stacie H. Frerichs
Project Manager

Enclosure: Report

CONESTOGA-ROVERS
& ASSOCIATES

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August 6, 2009

Reference No. 631656

Mr. Mark Detterman, PG, CEG
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Re: Work Plan for Groundwater Pumping Test
Former Chevron Service Station No. 9-7127
I-580 and Grant Line Road
Tracy, California
LOP Case #RO0000185

Dear Mr. Detterman:

Conestoga-Rovers & Associates (CRA) has prepared this *Work Plan for Groundwater Pumping Test* for review and approval by Alameda County Environmental Health (ACEH) on behalf of Chevron Environmental Management Company (Chevron) for the site referenced above. CRA previously prepared and submitted the December 2008 *Corrective Action Plan Addendum and Proposed Feasibility Study*, in which a groundwater pumping test was recommended to further evaluate the hydrogeologic conditions and behavior of groundwater beneath the site. The information obtained from the pumping test would then be used to further define the necessary scope of remediation, and to further evaluate available remedial options to address light non-aqueous phase liquid (LNAPL) at the site. As stated in the corrective action plan (CAP) addendum, upon ACEH approval, a work plan presenting the details of the pumping test would be prepared. Since a response has not been received from ACEH, CRA has prepared this work plan to expedite the process. Presented in the following sections are the site description and background, and the details of the proposed groundwater pumping test.

SITE DESCRIPTION AND BACKGROUND

The site is a vacant lot located on the east side of Grant Line Road, just south of Interstate 580 in rural Tracy, California (Figure 1). The site is situated in the rolling foothills at an elevation of approximately 320 feet above mean sea level (msl). The site is bounded by an on-ramp to Interstate 580 to the north, Grant Line Road to the west, and undeveloped (grazing) land to the south and east. Chevron operated a service station at the site from 1971 to 1986. In 1991, the station was demolished and all aboveground and belowground facilities were removed. Previous station facilities included two 10,000-gallon and one 6,000-gallon gasoline underground storage tanks (USTs), one 1,000-gallon used-oil UST, one 750-gallon heating oil UST, two dispenser islands, and a station building (Figure 2). The site has since remained vacant land. A former domestic water-supply well is present onsite that reportedly is currently used only for livestock.

Environmental investigation at the site has been ongoing since 1987. To date, nine exploratory borings (B-1 through B-7 in 1987; B-1 in 1992; and B-3 in 1993) have been drilled and eight monitoring wells (MW-1 through MW-8) have been installed both on- and offsite; and a soil vapor survey has been conducted. The wells are currently monitored on a semi-annual basis with the exception of MW-8, which was recently damaged by a vehicle. Remedial activities performed at the site have included soil over-excavation and aeration (1991), the placement of Oxygen Releasing Compound® (ORC) socks in wells MW-1, MW-2 and MW-4 (1998-2001), hydrogen peroxide injection in wells MW-1 and MW-3 (1999), hand bailing of LNAPL in well MW-1 (1993), use of a solar-powered passive skimmer in well MW-1 (1993 and 2001-2002), and batch groundwater extraction (2001, 2002, and 2007). A summary of the environmental work performed at the site is included as Attachment A. The approximate well and boring locations are shown on Figure 2.

Site Geology: Boring logs from previous site investigations indicate that soil beneath the site consists primarily of fill (combinations of sand, silt and clay), silty clay, clayey sand, silty sand and gravel to a maximum depth of approximately 19 feet below grade (fbg). Site soil is underlain by Franciscan Formation sediments, consisting primarily of sandstone that extends to the maximum explored depth of 40 fbg.

Site Hydrogeology: Groundwater has been monitored quarterly since 1994 and semi-annually since 1999. The depth to groundwater in the site wells has ranged from approximately 23 to 31 fbg onsite and 9 to 14 fbg offsite. The groundwater flow direction is generally to the north at an approximate gradient of 0.005 to 0.08.

CRA previously prepared and submitted the May 15, 2007 *Corrective Action Plan* (CAP) that proposed surfactant injection followed by groundwater extraction for LNAPL removal. In a letter dated August 22, 2007, ACEH provided several technical comments regarding the proposed remedial action. CRA subsequently prepared and submitted the October 19, 2007 *Additional Assessment and Revised Interim Remedial Action Plan* (IRAP) that proposed additional subsurface investigation to further evaluate the potential effectiveness of surfactant injection. In a letter dated August 20, 2008, ACEH did not concur with the proposed surfactant injection prior to the performance of a bench-scale treatability study, and requested a bench-scale study and revised CAP. After further evaluation of the site conditions, and as presented in the CAP addendum, CRA no longer recommended surfactant injection as a remedial alternative at the site, and alternatively proposed a groundwater pumping test.

PROPOSED GROUNDWATER PUMPING TEST

As stated above, CRA recommends a groundwater pumping test to further evaluate hydrogeologic conditions beneath the site to aid in screening potential remedial options. The details of the proposed pumping test are presented below.

Test Procedures: Well MW-1 (4-inch diameter) will be used as the pumping (extraction) well; surrounding wells MW-2, MW-3, and MW-4 will be used as observation wells. Wells MW-1 through MW-4 are all screened in approximately the same depth interval (approximately 22 to 36 fbg); therefore the data gathered from these wells should be representative of subsurface conditions. Groundwater extraction will be performed using a submersible pump temporarily installed into well MW-1 approximately 1 foot from the bottom of the well. All extracted groundwater will be pumped directly into a holding tank with an approximate 8,000- to 10,000–gallon capacity. The extracted groundwater will be temporarily stored onsite in the storage tank and subsequently transported to a recycling or disposal facility.

The test consists of four steps: 1) a step-discharge test, 2) recovery period, 3) a constant-discharge test, and 4) a second recovery period. The step-discharge test will first be performed to determine the rate of change in drawdown in well MW-1. During the test, at least three different pumping rates will be used to determine the most effective rate. The duration of the step-discharge test will be approximately 4 hours, depending on site conditions. The water-bearing zone will be allowed to recover after the step-discharge test for approximately 12 hours, or until well MW-1 has recovered at least 80 percent of its maximum drawdown. The constant-discharge test will use the optimum pumping rate determined from the step-discharge test, and will be performed for approximately 8 hours, depending on site conditions, or once the holding tank is at or close to capacity. After completion of the constant-discharge test, the water-bearing zone will be allowed to recover as before.

Data loggers/transducers will be placed in well MW-1 and the observation wells to monitor the water levels in the wells throughout the test. The LNAPL thickness in well MW-1, if present, will also be monitored. CRA's standard procedures for groundwater pumping tests are included as Attachment B.

Groundwater Sampling and Laboratory Analysis: Groundwater samples will be collected from well MW-1 prior to and following completion of the pumping test to evaluate any effect on groundwater quality. If LNAPL is present, samples will not be collected from the well for analysis. Grab samples of the extracted groundwater will also be collected throughout the groundwater pumping test to evaluate potential hydrocarbon mass removal from the subsurface. Standard field procedures for groundwater sampling are included in Attachment B.

The groundwater samples will be analyzed for the following constituents:

- Total petroleum hydrocarbons as gasoline (TPHg) by EPA Method 8015
- Benzene, toluene, ethylbenzene and xylenes (BTEX), and methyl tertiary butyl ether (MTBE) by EPA Method 8260

Data Analysis: The data obtained from the test will be used to estimate subsurface parameters, including transmissivity, hydraulic conductivity, and storativity. The results of the test may indicate the general orientation of the primary bedrock fractures beneath the site.

Reporting: Upon completion of the groundwater pumping test, CRA will prepare a report documenting the activities. Included in the report will be the data collected from the loggers/tranducers, the volume of groundwater extracted, laboratory analytical results, our interpretation of the data, and CRA's conclusions and recommendations.

SCHEDULE AND CLOSING

CRA will implement the proposed scope of work upon receipt of written approval from ACEH or 60 days following submittal of this work plan. We will submit our investigation report approximately six weeks after completion of field activities.

We appreciate your assistance on this project and look forward to your reply. Please contact Mr. James Kiernan if you have any questions or require any additional information.

Sincerely,

CONESTOGA-ROVERS & ASSOCIATES

Kelly M. Rider

James P. Kiernan, P.E. #C68498

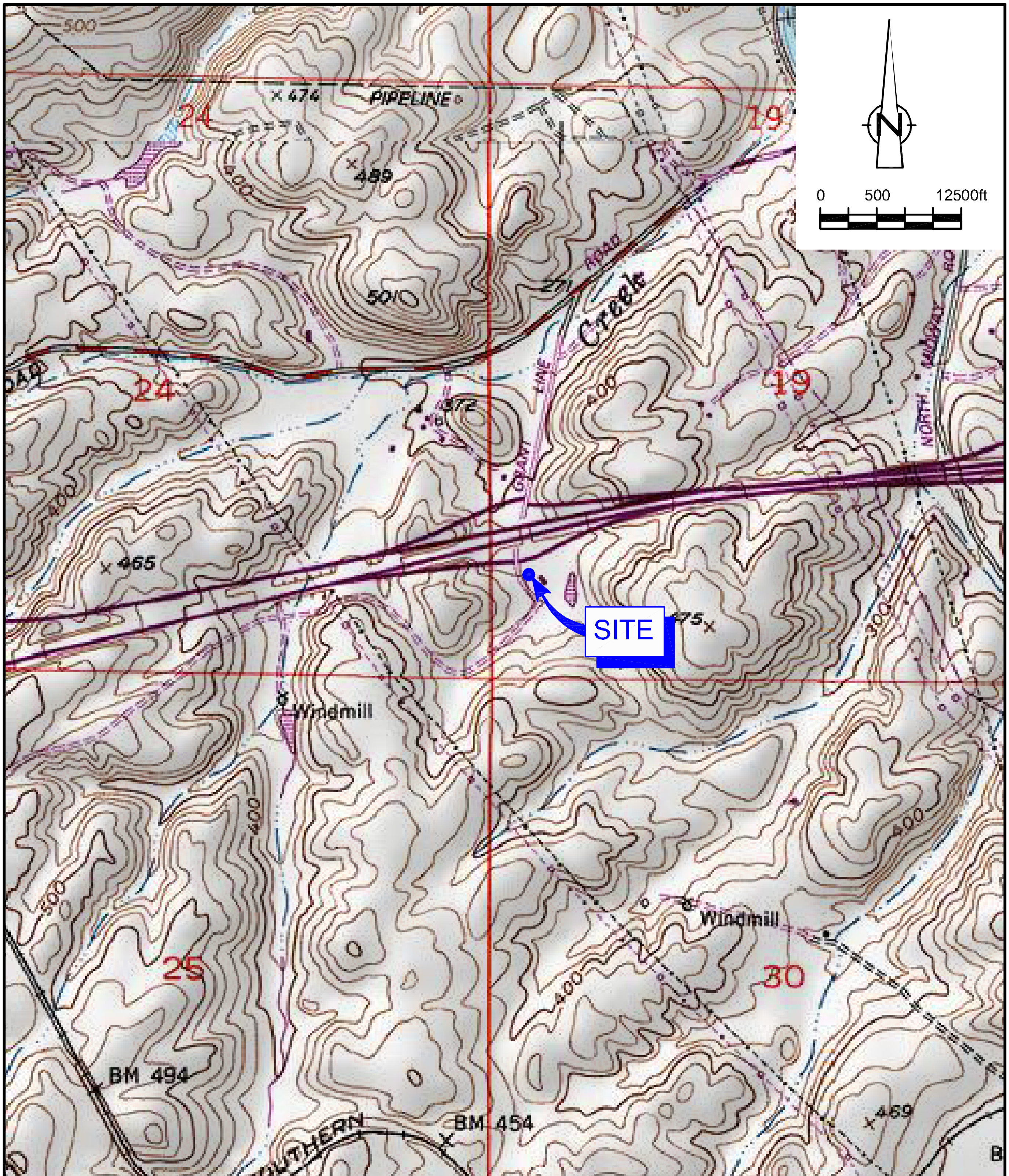
REGISTERED PROFESSIONAL ENGINEER
JAMES P. KIERNAN
No. 68498
Exp. 9/30/09
CIVIL
STATE OF CALIFORNIA

KR/kw/3
Encl.

Figure 1	Vicinity Map
Figure 2	Site Plan
Attachment A	Summary of Previous Environmental Work
Attachment B	Standard Field Procedures

cc: Ms. Stacie Frerichs, Chevron Environmental Management Company
Mr. Ardavan Onsori

FIGURES



SOURCE: TOPO! MAPS.

figure 1

VICINITY MAP
FORMER CHEVRON SERVICE STATION 9-7127
GRANT LINE ROAD AND INTERSTATE 580
Tracy, California

CRA

631656-122(004)GN-WA001 JUN 25/2009

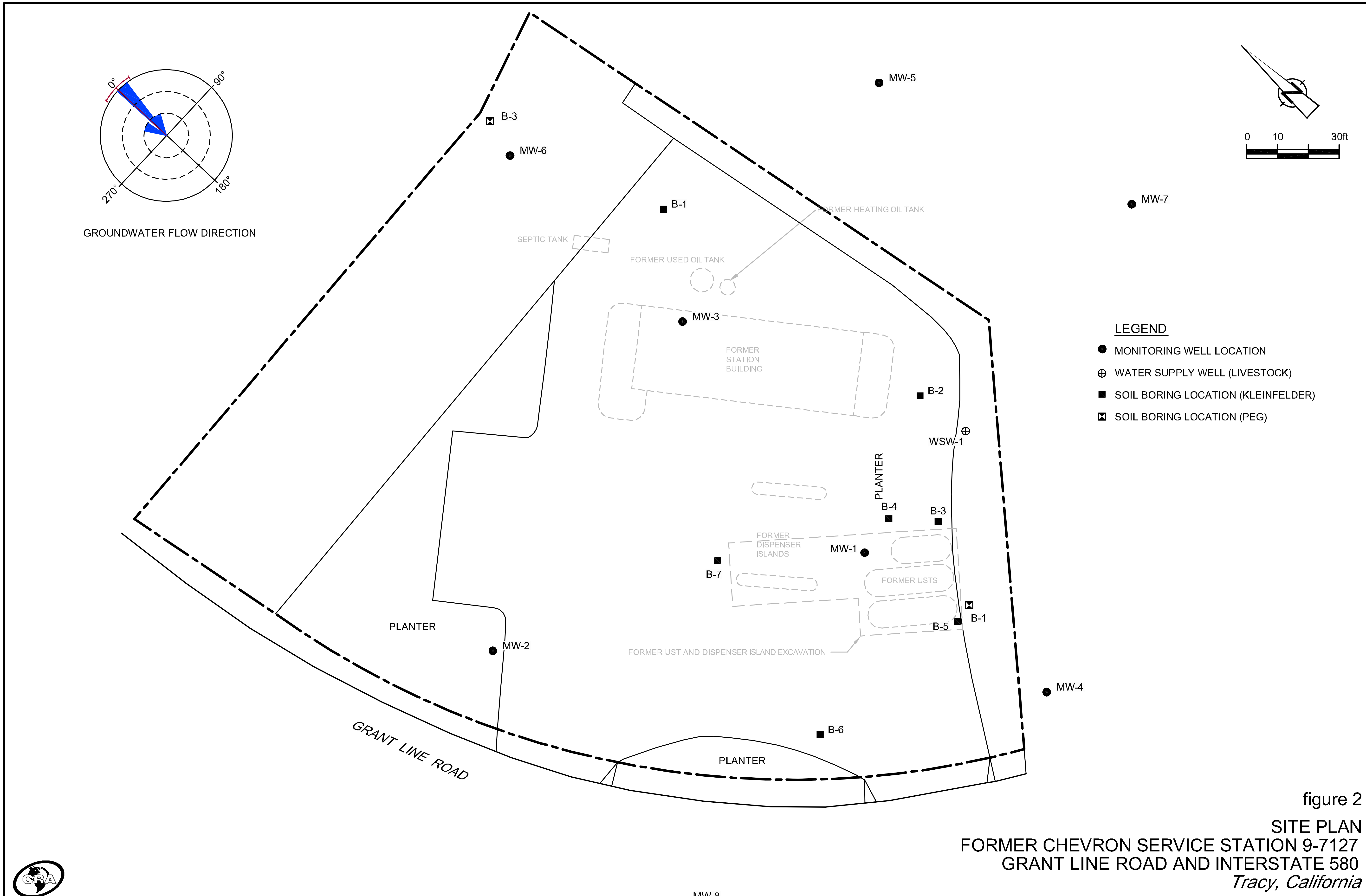


figure 2

SITE PLAN
FORMER CHEVRON SERVICE STATION 9-7127
GRANT LINE ROAD AND INTERSTATE 580
Tracy, California

631656-601(PRES001)GN-WA002 JAN 23/2009

ATTACHMENT A

SUMMARY OF PREVIOUS ENVIRONMENTAL WORK

SUMMARY OF PREVIOUS ENVIRONMENTAL WORK

October 1987 Soil Vapor Investigation: In October 1987, EA Engineering, Science, and Technology, Inc. (EA) conducted a soil vapor investigation at the site. Soil vapor samples were collected from 13 onsite (V1 through V12, and V-14) and two offsite (V13 and V15) locations at depths ranging from 3 to 12 feet below grade (fbg). Petroleum hydrocarbons were detected in several of the samples at concentrations ranging from 10 (V9 at 8 fbg) to 28,500 parts per million (ppm) (V4 at 3 fbg). Benzene was detected in several of the samples at concentrations ranging from 1.0 (V3 at 5 fbg) to 3,200 ppm (V4 at 3 fbg). Toluene was detected in several of the samples at concentrations ranging from 10 (V3 at 3 and 5 fbg) to 5,200 ppm (V4 at 3 fbg). Based on the results of the investigation, it was concluded that light non-aqueous phase liquid (LNAPL) may be present in the area of the tank field and pump island. Details of this investigation were presented in EA's November 13, 1987 *Report of Investigation*.

December 1987 Subsurface Investigation: In December 1987, Kleinfelder, Inc. (Kleinfelder) advanced seven onsite exploratory borings (B-1 through B-7). One soil sample was collected from each boring (sample depths ranging from 5 to 20 fbg) and analyzed for total petroleum hydrocarbons as gasoline (TPHg), benzene, toluene, ethylbenzene and xylenes (BTEX). Low concentrations of TPHg (up to 76 milligrams per kilogram [mg/kg]) and BTEX (up to 2.0 mg/kg) were detected in the samples collected from borings B-2, B-3, B-5, and B-7. Elevated concentrations of TPHg (2,300 mg/kg) and BTEX (up to 140 mg/kg) were detected in the sample collected from boring B-4. Water samples were also collected from taps supplied by an onsite water well in December 1987 and January 1988. The samples were analyzed for purgeable aromatics; which were not detected with the exception of benzene at 2 micrograms per liter (μg/L) and 4 μg/L. Details of this investigation were presented in Kleinfelder's January 6, 1988 *Final Report: Subsurface Environmental Investigation at Chevron Service Station #7127*.

January 1988 through March 1991 Domestic Well Monitoring: In January 1988, groundwater samples were collected from a tap and the onsite water supply well; benzene was detected in the tap samples at 1.0 μg/L and 1.1 μg/L. Benzene was not detected in the well sample. In February 1989, samples collected from a tap and the well did not contain TPH or BTEX. Benzene concentrations detected in tap and well samples collected in March and April 1989 ranged from 1.4 to 7 μg/L. In May 1989, Gettler-Ryan Inc. (G-R) installed a carbon adsorption treatment system on the wellhead and began weekly sampling. Samples collected from the well and treatment system influent, mid, and effluent samples in August 1989 did not contain TPH or BTEX. From August 1989 to March 1991, 26 samples were collected from the well. TPHg and benzene generally were not detected in the samples with the exception of TPHg in one sample at 320 μg/L and benzene in one sample at 0.07 μg/L. Details of this work were presented in Kleinfelder's March 8, 1988 *Summary of Domestic Water Sampling Activities and Analytical Results* and August 2, 1989 *Domestic Water Contaminant Source Evaluation*, and Pacific Environmental Group's (PEG's) March 22, 1993 untitled report.

April 1991 Tank, Product Piping, and Dispenser Island Removal: In April 1991, the station was demolished and all aboveground and underground facilities were removed. Blaine Tech Services, Inc. (Blaine Tech) supervised the removal of two 10,000 gallon and one 6,000-gallon gasoline underground storage tanks (USTs), one 1,000-gallon used-oil UST, one 750-gallon heating oil UST, two dispenser islands, and associated product piping. No holes were observed in the fiberglass tanks upon removal. Ten soil samples were collected from the gasoline UST excavation (sample depths of 12.5 to 15 fbg) and beneath the product piping and the dispenser island (sample depths of 2.5 to 4 fbg); several of the samples contained elevated concentrations of TPHg (up to 5,700 mg/kg), benzene (up to 30 mg/kg), and lead (up to 80 mg/kg). Therefore, over-excavation of the gasoline UST pit and product piping trenches was conducted. The final confirmation soil samples contained TPHg and benzene up to 710 mg/kg and 0.085 mg/kg, respectively. Soil samples were also collected at 11 fbg beneath the used-oil and heating oil USTs. TPHg, BTEX, TPH as diesel (TPHd), total oil and grease (TOG), and volatile organic compounds (VOCs) were not detected in the sample collected beneath the used-oil UST; the detected metals concentrations were consistent with background levels. Only low concentrations of TPHg (170 mg/kg) and xylenes (2.7 mg/kg) were detected in the sample collected beneath the heating oil UST; the detected metals concentrations were consistent with background levels. The excavated soil was aerated onsite until detected TPHg concentrations did not exceed 10 mg/kg; the soil was then used to backfill the excavations. Details of this investigation were presented in Blaine Tech's June 24, 1991 *Multiple Event Sampling Report.*

December 1992 Monitoring Well Installation and January through March 1993 Water-Supply Well Sampling: In December 1992, PEG advanced exploratory boring B-1 and installed monitoring wells MW-1 through MW-3. The borings were advanced to total depths ranging from 22 to 40 fbg. The wells were screened at intervals of 22 to 37 fbg (MW-1), 21 to 36 fbg (MW-2), and 22 to 37.5 fbg (MW-3). A total of nine soil samples were collected at various depths from borings B-1 and MW-1 and analyzed for TPHg and BTEX. TPHg was detected in three samples at concentrations of 4.0 mg/kg (B-1 at 12.5 fbg), 2,600 mg/kg (MW-1 at 24 fbg), and 8,100 mg/kg (MW-1 at 29 fbg). Benzene was only detected in the sample collected from boring MW-1 at 29 fbg (21 mg/kg). Toluene (up to 560 mg/kg), ethylbenzene (up to 150 mg/kg), and xylenes (up to 840 mg/kg) were also detected in several of the soil samples. Groundwater samples were collected from wells MW-2 and MW-3 and analyzed for TPHg and BTEX. TPHg and BTEX were detected in well MW-3 at concentrations of 19,000 μg/L, 8,900 μg/L, 660 μg/L, 380 μg/L, and 720 μg/L, respectively. Xylenes (0.6 μg/L) were the only analyte detected in the groundwater sample collected from well MW-2. Well MW-1 was not sampled due to the presence of LNAPL. PEG performed weekly sampling of the water-supply well from January through March 1993; TPHg and BTEX generally were not detected in the samples with the exception of low concentrations of toluene (3 μg/L) and xylenes (2 μg/L) in January 1993. Details of this work were presented in PEG's March 22, 1993 untitled report.

1993 LNAPL Removal: In 1993, weekly bailing of well MW-1 to remove LNAPL was performed by PEG; a passive skimmer was also installed in the well. As of March 1993, approximately 2 gallons of product had been removed. The bailing frequency was then reduced to monthly.

May 1993 Monitoring Well Installation: In May 1993, PEG advanced exploratory boring B-3 and installed wells MW-4 and MW-5 to investigate groundwater conditions upgradient, crossgradient, and downgradient of the site. Wells MW-4 and MW-5 were screened at depths of 22 to 36.5 fbg and 5 to 24.5 fbg, respectively. Soil samples were collected at depths of 10 fbg and 15 fbg from the boring for well MW-5 and analyzed for TPHg and BTEX; which were not detected. A grab-groundwater sample was collected from boring B-3 and analyzed for TPHg and BTEX; TPHg, benzene, and toluene were detected at 96 μg/L, 1 μg/L, and 0.5 μg/L, respectively. The initial groundwater sample collected from well MW-4 contained TPHg and benzene at 300 μg/L and 56 μg/L, respectively. TPHg and BTEX were not detected in the initial groundwater sample collected from well MW-5. Details of this investigation were presented in PEG's December 3, 1993 untitled report.

October 1994 Comprehensive Site Evaluation: In October 1994, Weiss Associates (WA) conducted a comprehensive site evaluation. Based on historical soil and groundwater data, WA concluded that the hydrocarbon source areas had been removed from the site and that the plume was primarily contained onsite. However, to determine the full extent of the hydrocarbon plume beneath the site, WA recommended the installation of an additional offsite monitoring well north of the site. Details of this investigation were presented in WA's October 13, 1994 *Comprehensive Site Evaluation and Proposed Future Action Plan.*

October 1995 Monitoring Well Installation: In October 1995, PEG installed monitoring wells MW-6 through MW-8 to further evaluate the offsite extent of impacted groundwater. Wells MW-6, MW-7, and MW-8 were screened at intervals of 6.5 to 30 fbg, 4.5 to 25 fbg, and 20 to 40 fbg, respectively. A total of nine soil samples were collected at various depths from the well borings and analyzed for TPHg and BTEX; which were not detected in any of the samples. TPHg and BTEX were also not detected in the initial groundwater samples collected from the wells. Details of this investigation were presented in PEG's January 25, 1996 *Groundwater Investigation Report*.

June 1997 Risk-Based Assessment: In June 1997, a Risk-Based Corrective Action (RBCA) Tier 2 Assessment was completed for the site. Results of the assessment indicated that groundwater ingestion could pose a risk to human health due to the elevated TPHg and benzene concentrations in wells MW-1, MW-3, and MW-4. The assessment also indicated that the onsite water supply well was a potential receptor for residual concentrations of petroleum hydrocarbons in the subsurface. Details of this investigation were presented in PEG's June 27, 1997 *Risk-Based Corrective Action-Tier 2* report.

1998-2001 Bioremediation: In August 1998, Oxygen Releasing Compound® (ORC) socks were installed in wells MW-1, MW-2 and MW-4 to attempt to reduce hydrocarbon concentrations via enhanced biodegradation. In July 2001, the ORC sock in well MW-1 was removed so that a passive product skimmer could be installed. No data is available as to when the ORC socks in the remaining two wells were removed.

December 1999 Hydrogen Peroxide Injection: In December 1999, Cambria Environmental Technology, Inc. (Cambria; now CRA) injected hydrogen peroxide into wells MW-1 and MW-3 to attempt to reduce hydrocarbon concentrations in groundwater beneath the site. Various concentrations of hydrogen peroxide were injected in the wells. Details of the work were documented in Cambria's March 30, 2000 *Hydrogen Peroxide Injection* report.

May 2001 Corrective Action Plan: In May 2001, Delta Environmental Consultants, Inc. (Delta) submitted an interim corrective action plan (CAP). Delta recommended that the onsite supply well be destroyed and that LNAPL be hand bailed from MW-1 on a monthly basis for two quarters, after which the thickness of the LNAPL would be re-evaluated. Details of this investigation were presented in Delta's May 7, 2001 *Interim Corrective Action Plan*.

2001-2002 Remedial Activities: In July 2001, a passive product skimmer was again installed in MW-1 to attempt to remove LNAPL from this well and seven groundwater vacuum extraction events were conducted from July 2001 through April 2002. Approximately 8,300 gallons of groundwater and 2.19 gallons of LNAPL were extracted from MW-1 during this time. In July 2002, vacuum extraction of impacted groundwater from MW-3 was initiated. Due to an increase in LNAPL thickness in MW-1, vacuum extractions from MW-1 and MW-3 were terminated in October 2002.

April 2003 Remedial Action Plan and Feasibility Study: In April 2003, Delta submitted a remedial action plan (RAP) and feasibility study for the site. Data from the study indicated that groundwater beneath the site is in a perched zone at approximately 10 to 40 fbg, with underlying confining bedrock. The impacted soil appeared to be confined to just above the groundwater table, within the capillary fringe approximately 25 to 30 fbg, in the vicinity of the former USTs. Potential remedial technologies evaluated included soil excavation, soil vapor extraction (SVE), groundwater extraction, and natural attenuation. Due to the depth of the source and site lithology, soil excavation and SVE were not considered viable options for the site. Delta recommended removal of LNAPL from MW-1 using an active mechanical skimmer in conjunction with natural attenuation as the most feasible remedial options for the site. Details of this investigation were presented in Delta's April 30, 2003 *Remedial Action Plan and Feasibility Study*.

2007 Groundwater Extraction: In March and April 2007, CRA conducted three additional batch groundwater extraction events in well MW-1, and a total of approximately 5,100 gallons of groundwater were extracted. The LNAPL thickness in MW-1 was measured prior to each batch extraction event; the results were 0.5 feet, 0.36 feet and 0.39 feet.

May 2007 Corrective Action Plan: In May 2007, CRA submitted a CAP which evaluated three remedial alternatives for the site: oxygen injection, batch groundwater extraction, and surfactant injection. The recommended alternative was surfactant injection followed by groundwater extraction. Details were presented in CRA's May 15, 2007 *Corrective Action Plan.*

October 2007 Interim Remedial Action Plan (IRAP): In October 2007, CRA submitted a revised IRAP that proposed the installation of three additional groundwater monitoring wells around MW-1 to better evaluate hydrocarbon distribution, hydrogeologic characteristics, and potentially facilitate the remediation of groundwater and vapors from fractures in the bedrock beneath the site. In addition, CRA proposed injection of a surfactant solution to emulsify LNAPL found in formation pore spaces. Emulsification of the LNAPL would increase the ability to remove it using enhanced vacuum fluid recovery (EVFR). Details were presented in CRA's October 19, 2007 *Additional Assessment and Revised Interim Remedial Action Plan.*

ATTACHMENT B

STANDARD FIELD PROCEDURES

STANDARD FIELD PROCEDURES FOR GROUNDWATER PUMPING TESTS

This document describes Conestoga-Rovers & Associates standard methods for performing groundwater pump testing using existing groundwater monitoring or extraction wells. These procedures are designed to comply with Federal, State and local regulatory guidelines. Specific procedures are summarized below.

Prefield Activities

Review existing site data, including boring logs, regional hydrogeologic setting, well elevation information, and site layout. Determine if pumping tests are feasible under site conditions.

Coordinate with site owner and/or manager to determine timing of testing. Conduct site visit to assess logistics and accessibility. Develop plan to handle and/or dispose of extracted groundwater. Secure permits for groundwater discharge, if needed.

Determine which wells are going to be pumped and monitored, and develop estimates of pumping rates and test length.

Field Activities

The field activities include setup, a step-discharge test, recovery period, a constant-discharge test, and a second recovery period.

The initial setup includes measuring static water levels and total well depths, installing water level probes and/or dataloggers, and testing, field calibration, and programming of depth measurement and logging equipment. After setup, wait for groundwater to equilibrate to static conditions before the testing begins.

The step-discharge test will be performed for approximately 4 hours, depending on the site conditions. The extraction well will be pumped at least three different pumping rates. Water levels in the pumping well and observation wells and pumping rate will be monitored over time. The duration of a step will be determined by the rate of change in drawdown in the extraction well. Steps will typically last approximately 60 minutes.

The water-bearing zone will be allowed to recover before the constant-discharge test is started. The depth to water in the pumping and observation wells will be recorded during the recovery period.

The constant-discharge test will be performed for approximately 8 hours, depending on the site conditions. The pumping rate will be determined from the information gathered during the step-discharge test. Water levels in the pumping well and observation wells and pumping rate will be monitored over time. Drawdown data in the pumping and observations wells will be plotted in the field to monitor the progress of the test. Barometric pressure, tidal changes (if applicable), and changes in weather will be recorded during the test.

The depth to water in the pumping and observation wells will be observed during the recovery period for a period of approximately 12 hours, or until the pumping well has recovered at least 80% of its maximum drawdown. Depth to water measurements will be plotted in the field to determine when to stop monitoring the recovery.

Data Analysis and Reporting

Data analysis will be performed to estimate subsurface parameters, including transmissivity, hydraulic conductivity, and storativity. The analytical methods will be determined by the type of test performed and the characteristics of the site subsurface.

STANDARD FIELD PROCEDURES FOR GROUNDWATER MONITORING AND SAMPLING

This document presents standard field methods for groundwater monitoring, purging and sampling, and well development. These procedures are designed to comply with Federal, State and local regulatory guidelines. CRA's specific field procedures are summarized below.

Groundwater Elevation Monitoring

Prior to performing monitoring activities, the historical monitoring and analytical data of each monitoring well shall be reviewed to determine if any of the wells are likely to contain non-aqueous phase liquid (NAPL) and to determine the order in which the wells will be monitored (i.e. cleanest to dirtiest). Groundwater monitoring should not be performed when the potential exists for surface water to enter the well (i.e. flooding during a rainstorm).

Prior to monitoring, each well shall be opened and the well cap removed to allow water levels to stabilize and equilibrate. The condition of the well box and well cap shall be observed and recommended repairs noted. Any surface water that may have entered and flooded the well box should be evacuated prior to removing the well cap. In wells with no history of NAPL, the static water level and total well depth shall be measured to the nearest 0.01 foot with an electronic water level meter. Wells with the highest contaminant concentrations shall be measured last. In wells with a history of NAPL, the NAPL level/thickness and static water level shall be measured to the nearest 0.01 foot using an electronic interface probe. The water level meter and/or interface probe shall be thoroughly cleaned and decontaminated at the beginning of the monitoring event and between each well. Monitoring equipment shall be washed using soapy water consisting of Liqui-nox™ or Alconox™ followed by one rinse of clean tap water and then two rinses of distilled water.

Groundwater Purging and Sampling

Prior to groundwater purging and sampling, the historical analytical data of each monitoring well shall be reviewed to determine the order in which the wells should be purged and sampled (i.e. cleanest to dirtiest). No purging or groundwater sampling shall be performed on wells with a measurable thickness of NAPL or floating NAPL globules. If a sheen is observed, the well should be purged and a groundwater sample collected only if no NAPL is present. Wells shall be purged either by hand using a disposal or PVC bailer or by using an aboveground pump (e.g. peristaltic or Wattera™) or down-hole pump (e.g. Grundfos™ or DC Purger pump).

Groundwater wells shall be purged approximately three to ten well-casing volumes (depending on the regulatory agency requirements) or until groundwater parameters of temperature, pH, and conductivity have stabilized to within 10% for three consecutive readings. Temperature, pH, and conductivity shall be measured and recorded at least once per well casing volume removed. The total volume of groundwater removed shall be recorded along with any other notable physical characteristic such as color and odor. If required, field parameters such as turbidity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) shall also be measured prior to collection of each groundwater sample.

Groundwater samples shall be collected after the well has been purged. If the well is slow to recharge, a sample shall be collected after the water column is allowed to recharge to 80% of the pre-purging static water level. If the well does not recover to 80% in 2 hours, a sample shall be collected once there is enough groundwater in the well. Groundwater samples shall be collected using clean disposable bailers or pumps (if an operating remediation system exists on site and the project manager approves of its use for sampling) and shall be decanted into clean containers supplied by the analytical laboratory. New latex gloves and disposable tubing or bailers shall be used for sampling each well. If a PVC bailer or down-hole pump is used for groundwater purging, it shall be decontaminated before purging each well by using soapy water consisting of Liqui-nox™ or Alconox™ followed by one rinse of clean tap water and then two rinses of distilled water. If a submersible pump with non-dedicated discharge tubing is used for groundwater purging, both the inside and outside of pump and discharge tubing shall be decontaminated as described above.

Sample Handling

Except for samples that will be tested in the field, or that require special handling or preservation, samples shall be stored in coolers chilled to 4° C for shipment to the analytical laboratory. Samples shall be labeled, placed in protective foam sleeves or bubble wrap as needed, stored on crushed ice at or below 4° C, and submitted under chain-of-custody (COC) to the laboratory. The laboratory shall be notified of the sample shipment schedule and arrival time. Samples shall be shipped to the laboratory within a time frame to allow for extraction and analysis to be performed within the standard sample holding times.

Sample labels shall be filled out using indelible ink and must contain the site name; field identification number; the date, time, and location of sample collection; notation of the type of sample; identification of preservatives used; remarks; and the signature of the sampler. Field identification must be sufficient to allow easy cross-reference with the field datasheet.

All samples submitted to the laboratory shall be accompanied by a COC record to ensure adequate documentation. A copy of the COC shall be retained in the project file. Information on the COC shall consist of the project name and number; project location; sample numbers; sampler/recorder's signature; date and time of collection of each sample; sample type; analyses requested; name of person receiving the sample; and date of receipt of sample.

Laboratory-supplied trip blanks shall accompany the samples and be analyzed to check for cross-contamination, if requested by the project manager.

Waste Handling and Disposal

Groundwater extracted during sampling shall be stored onsite in sealed U.S. DOT H17 55-gallon drums and shall be labeled with the contents, date of generation, generator identification, and consultant contact. Extracted groundwater may be disposed offsite by a licensed waste handler or may be treated and discharged via an operating onsite groundwater extraction/treatment system.