REVISED CORRECTIVE ACTION PLAN

AND RESULTS OF ADDITIONAL SITE ASSESSMENT

76 Service Station No. 3713
1503 Carlson Boulevard
RICHMOND, CALIFORNIA

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CERTIFICATION

The following report was prepared under the supervision and direction of the undersigned California Professional Geologist.

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1.0 INTRODUCTION

Delta Consultants (Delta), on behalf of ConocoPhillips (COP), has prepared this Revised Corrective Action Plan and Results of Additional Site Assessment in response to directives from the California San Francisco Bay Regional Water Quality Control Board (letters dated July 8, 2008, and January 12, 2009). This document supersedes/replaces the *Corrective Action Plan and Report of Findings for Vertical Delineation* dated October 31, 2008, received by the Regional Water Quality Control Board (RWQCB) on November 4, 2008.

This report describes proposed Corrective Action for remediation of gasoline in soils and groundwater at the site. In addition, this report details additional assessment consisting of the installation of two groundwater monitoring wells, the attempt to install a third groundwater monitoring well, the installation of one CPT boring, installation of subsurface vapor probes, and collection of soil vapor samples.

The site location is a 76-branded Service Station (No. 3713), located at 1503 Carlson Boulevard, Richmond, California (site) (**Figure 1**). The report includes the following:

- Site conceptual model (SCM) that provides a working hypothesis regarding the current and future distribution of petroleum hydrocarbons detected in soil and groundwater beneath the site
- Details of the installation of one CPT boring and groundwater monitoring wells MW-15 and MW-16 including drilling method, soil sampling method and intervals, well design, well development, and groundwater sampling. In addition, the rationale for why a third proposed well was not installed will be discussed.

- Details and evaluation of a soil vapor sampling event performed in October 2008
- Corrective Action Plan for remediation of soil and groundwater

2.0 SITE LOCATION AND DESCRIPTION

The following sections provide a description of the site and surrounding area.

2.1 Site Location

The site is located on a square shaped property on the southeast corner of the intersection of Carlson Boulevard and Imperial Avenue in Richmond, California (**Figures 1 and 2**). The site is located approximately 1,500 feet east of wetlands along the edge of San Francisco Bay. The elevation of the site is approximately 15 feet above mean sea-level (msl).

2.2 Site Description

The site is currently an active 76-branded service station. The properties in the site vicinity are a mixture of commercial buildings and residences. The site is bounded on the north by Carlson Boulevard, on the west by Imperial Avenue, on the east by Forty Flags Motel, and on the south by private residences. **Figure 2** shows the location of the station facilities including a small station building, two gasoline underground storage tanks (USTs) and four fuel dispensers located on two dispenser islands. The two fuel dispenser islands are covered by a single canopy.

3.0 SITE SETTING

The following sections provide a summary of the regional geologic and hydrogeologic setting.

3.1 Regional Geologic Setting

The site is located near the western edge of the East Bay Plain, a gently sloping surface extending from the foothills on the east towards the edge of San Francisco Bay on the west. The site area is underlain by Holocene-age estuarine muds and alluvial deposits consisting of silt and clay with a few thin beds of coarse sand and gravel. The estuarine muds are locally referred to as Bay Mud. A geologic map of Quaternary deposits in the site area is provided as **Figure 3**.

3.2 Regional Hydrogeologic Conditions

The site is located on East Bay Plain Richmond Subbasin. The following is an excerpt from the *East Bay Plain Groundwater Basin Beneficial Use Evaluation Report (RWQCB, June 1999)*.

> The East Bay Plain is an elongated, northwest trending flat alluvial plain encompassing about 115 square miles. The East Bay Plain, as defined by DWR (1980), is bounded on the west by San Francisco Bay, by San Pablo Bay to the north, and by the Hayward Fault to the east.

Groundwater is found both in shallow and deep deposits. Groundwater flow is generally from east to west toward San Francisco Bay. Groundwater along the edge of San Francisco Bay has typically been impacted by salt water intrusion. The East Bay Plain report states that "Historically, there were well fields in the Richmond area that likely tapped significant gravel deposits that occur 100 to 150 feet below ground surface. The historical wells were only operated for 12 to 16 years before they were shut down due to saltwater intrusion."

3.3 Site Hydrogeologic Conditions

The site is underlain by clay with thin sand layers. Surficial clay has generally been classified as fat clay (CH) using the Unified Soil Classification System (USCS). Fat clay is typical of Bay Mud deposits. Sand is present as thin layers in the upper ten feet of the soil profile. Groundwater is first encountered in borings at depths of 5 to

10 feet below ground surface (bgs) within the sand layers. Initial site monitoring wells, screened from 5 to 15 feet bgs, were installed to monitor this shallow groundwater zone. Equilibrated depth to groundwater in wells on July 11, 2008 ranged from 5 to 6 feet below top of casing (toc). The predominant groundwater flow direction has been to the south-southeast. A flow direction rose diagram is provided as **Figure 4**.

Sand and scattered gravel layers have been encountered by deeper borings at depths ranging from 18 to 51 feet bgs. Historic boring logs are provided in **Appendix A**. Geologic cross sections are provided as **Figures 5 and 6**. The computer-generated log from the cone penetrometer test (CPT) boring B-1 indicated sand layers within clay deposits at depths of 8 to 10 feet, 30 to 34 feet, and 44 to the bottom of the boring at 48 feet bgs. Permeable sand and gravel (USCS symbols SP, GP, and GW) were encountered in the recent boring for well MW-15 at depths of 18 to 23 feet and 29 to 31 feet (bottom of boring) and in the boring for well MW-16 at from 28.5 to the bottom of the boring at 31 feet bgs.

Wells MW-15 and MW-16 are screened in the coarse-grained deposits in 29- to 30-foot depth interval (See Section 6.2 for details).

3.4 Site-Specific Hydrogeologic Parameters (Sustainable Extraction Rate, Groundwater Flow Rate)

The following sections describe the hydrogeologic parameters of the upper saturated zone.

3.4.1 Step-Drawdown Testing

In November 2007, Delta performed step-drawdown tests on monitoring wells MW-3, MW-4, and MW-5. Step drawdown tests were conducted to determine the maximum sustainable pumping rates from the monitoring wells. Water levels in the wells were measured during pumping using an electronic water level meter.

The target drawdown value was 60% of available drawdown (the difference between the initial water level and the top of the submersible pump). At each well, extraction rates were "stepped" at values ranging between 0.25 and 1 gallons per minute (gpm), applied for time periods of about 30 to 50 minutes at each extraction rate. Observation wells, used to determine the approximate radius of influence, were located from between 19 to 80 feet from pumping wells during the test.

Results indicated 60% of available drawdown was attained at extraction rates ranging between 0.25 to 0.58 gpm. The only observation well which demonstrated any change during the pump test was MW-7, located 19 feet from monitoring well MW-5. This well exhibited 0.17 feet of drawdown.

Water level data from the step drawdown test was analyzed using the AquiferTest software produced by Waterloo Hydrogeologic. The data was analyzed by the Theis Recovery Method.

Hydraulic conductivities of between 8.08 x 10^{-4} to 6.85 x 10^{-5} centimeters per second (cm/sec) were calculated using average pumping rates during the test ranging between 0.25 to 0.58 gpm. These values are typical of clayey sands (Fetter, 1988) and are consistent with the description of soils on boring logs.

3.4.2 Hydraulic Conductivities

As described above hydraulic conductivities (K) were calculated for each well based on the pumping tests. The K values were 1.05 x 10^{-4} cm/sec, 6.85 x 10^{-5} cm/sec, and 8.08 x 10^{-4} cm/sec for the three wells (equivalent to 0.30 feet/day, 0.19 feet/day, and 2.5 feet/day, respectively). These values are typical of low-permeability soils.

3.4.3 Groundwater Flow Velocity

The groundwater flow rate beneath the site can be approximated based on the hydraulic conductivity of the soil (K), groundwater flow gradient (I), and effective soil porosity (N). The linear groundwater flow rate or velocity (V) can be calculated from the formula:

$$V = (K \times I)/N$$

where K = soil coefficient of hydraulic conductivity
I = groundwater gradient
N = effective soil porosity

The predominant soil type beneath the site, at the depth of shallow groundwater, is clay with thin sand layers. The average K for from site tests was 1.0 feet per day (ft/d) and is used to approximate the bulk K of clay and fine sand. The effective porosity of fine sand is estimated at 25%. A groundwater gradient of 0.02 is used based on historic site data. Using the above estimated parameters, a groundwater velocity of approximately 29 feet per year is calculated. Using the lower K from the field test of 0.19 ft/d, a groundwater velocity of approximately 5.5 feet per year is calculated. Based on the current distribution of petroleum hydrocarbons and MtBE, the lower velocity appears to be consistent with the current distribution of petroleum hydrocarbons and MtBE in groundwater.

4.0 SUMMARY OF PREVIOUS SITE ASSESSMENT DATA

The following sections provide a description of previous site assessment activities and associated data.

4.1 Underground Storage Tank Removal

A used oil tank was removed from the site on July 20, 1993. Analytical data from the soil sample collected beneath the tank indicated that benzene was present at 0.53 milligrams per kilogram (mg/kg).

As part of a facility upgrade, the underground fuel storage tank (UST) system was removed on March 21, 1997 and replaced with new fiberglass tanks along with new product piping and dispensers. Analytical data from the soil samples collected from the UST excavation indicated that the soil was impacted by petroleum hydrocarbons. Maximum concentrations of petroleum hydrocarbons were as follows: benzene (8.5 mg/kg, SW4 at 10 feet bgs), MtBE (4.9 mg/kg, P2 at 4.5 feet bgs), and total petroleum hydrocarbons as gasoline (TPH-G) (1,100 mg/kg, SW4 at 10 feet bgs). No directive was issued by the Contra Costa Department of Environmental Health.

4.2 Baseline Site Assessment

A Baseline Site Assessment was conducted at the site in November 2003. Four soil borings (SB-1 through SB-4) were advanced and soil and groundwater samples were collected (**Figure 2**). Maximum concentrations of petroleum hydrocarbon constituents in soil samples collected from the soil borings were as follows: benzene (0.20 mg/kg, SB-3 at 5 feet bgs), MtBE (0.12 mg/kg, SB-2 at 15 feet bgs), and TPH-G (45 mg/kg, SB-3 at 15 bgs). Soil analytical data is summarized on **Table 1**.

Groundwater samples were collected from the soil borings and from tank pit observation wells MW-1 and MW-2. Analytical data indicated that total purgeable petroleum hydrocarbons (TPPH) were present in the groundwater samples collected from SB-2, SB-3, and SB-4 at concentrations ranging from 500 micrograms per liter (µg/L) (SB-2) to 120,000 µg/L (SB-4). Analytical data indicated that benzene was present in the groundwater samples collected from SB-2, SB-3, and SB-4 at concentrations ranging from 0.69 µg/L (SB-2) to 10,000 µg/L (SB-4). Analytical data indicated that MtBE was present in the groundwater samples collected from SB-2, SB-3, and SB-4, and monitor wells MW-1 and MW-2 at concentrations ranging from 2.9 µg/L (MW-2) to <2,000 µg/L (SB-4). Groundwater analytical data is summarized on **Table 2**.

4.3 Boring and Monitoring Well Installations

The RWQCB issued a directive in October 2004 requiring the property owner submit a work plan to assess and evaluate petroleum hydrocarbon impact and groundwater conditions at the subject site. In response to this directive, a subsurface investigation was conducted at the site in May 2005 which included drilling and construction of four additional monitoring wells (MW-3 through MW-6), each to a total depth of 15 feet bgs and screened from 5 to 15 feet bgs. Analytical data indicated that TPH-G was present in soil samples collected for analysis ranging from less than the laboratory's indicated reporting limit of 1.0 mg/kg to 540 mg/kg (MW-3, 5.5 feet bgs). Analytical data indicated that benzene was present in two soil samples collected for analysis at 1.8 mg/kg (MW-3, 5.5 feet bgs) and 0.2 mg/kg (MW-4, 5.5 feet bgs). Analytical data indicated that MtBE was present in one soil sample collected for analysis at 0.0055 mg/kg (MW-4, 5.5 feet bgs).

Initial groundwater monitoring and sampling at the site was conducted on May 16, 2005. Groundwater samples were collected from monitoring wells MW-3 through MW-6 and submitted for analysis of TPH-G, benzene, toluene, ethyl-benzene, total xylenes (BTEX), and MtBE. Analytical data indicated that TPH-G concentrations in groundwater ranged from 2,300 µg/L (MW-6) to 73,000 µg/L (MW-5); benzene ranged from 2.0 µg/L (MW-6) to 8,400 µg/L (MW-5); and MtBE ranged from below the laboratory's indicated reporting limit of 1.0 µg/L (MW-6) to 870 µg/L (MW-5).

On October 27, 2006, January 25, 2007, and February 8-9, 2007 Delta observed the installation of eight additional monitoring wells by a C-57 licensed contractor, two on-site and six off-site. The details of this investigation were presented in the *Subsurface Assessment Report* prepared by Delta and submitted to the RWQCB on February 26, 2007.

On September 25, 2007, Gregg Drilling (Gregg), under supervision of a Delta field geologist, advanced one exploratory boring (IW-1) to a depth of approximately 40 feet bgs using a truck mounted drill-rig equipped with 8-inch diameter hollow-stem augers. The boring was located between monitoring wells MW-5 and MW-7 east-southeast of the fuel dispenser islands. Groundwater was first encountered in the boring at a depth of approximately 22 feet bgs. Soil samples collected at depths of 20, 25, 30, 35, and 40 feet bgs from the boring were retained for laboratory analysis. Groundwater samples were collected at depths of 30 and 40 feet bgs. Groundwater samples were collected using the hydro-punch sampling method. Details of this work are included in Delta's February 25, 2008, *Site Investigation and Feasibility Testing Report*. Soil and groundwater data are summarized in **Tables 1 and 2**.

4.4 Initial Soil Vapor Investigation

A soil vapor monitoring investigation using passive soil vapor collection points (GoreSorber) was completed and submitted in August 2006. Gasoline range petroleum hydrocarbons (GRPH) were reported in each of the 15 sampled soil vapor points with a maximum concentration of 112,669 $\mu g/m^3$ in soil vapor point SV-7. Benzene was reported in 11 of the 15 sampled soil vapor points with a maximum concentration of 930 $\mu g/m^3$ in soil vapor point SV-7. MtBE was reported in 8 of the 15 sampled soil vapor points with a maximum concentration of 115 $\mu g/m^3$ in soil vapor point SV-14.

4.5 Installation of Ozone Injection Well

On December 6, 2007, Gregg, under supervision of a Delta field geologist, advanced one boring (OZ-1) to a depth of 12 feet bgs using a truck mounted drill-rig equipped with 8-inch diameter hollow-stem augers. The boring was located east of the boring IW-1 described above and between monitoring wells MW-5 and MW-7 east-southeast of the fuel dispenser islands. Groundwater was first encountered in the boring at a depth of approximately 6.5 feet bgs. The construction depth of this well was based on the lithology encountered in the IW-1 boring. The ozone injection well was constructed with 1-inch interior diameter, Schedule 80 PVC connected to a 1.5-inch diameter by 18-inch-long sparge point. The sparge point was placed from 9.5 to 11 feet bgs with a #2/16 sand pack placed from the total depth of the boring (12 feet bgs) to 2 feet above the sparge point (7.5 feet bgs). Three feet of bentonite chips were placed above the sand and hydrated in place. A neat cement grout seal was placed from the top of the bentonite chips to approximately two feet bgs. A wellhead connection was placed on top of the riser pipe, and a traffic-rated, flush-mounted well box was installed over the well and cemented in place. Details of this work are included in Delta's February 25, 2008, *Site Investigation and Feasibility Testing Report*.

Historic soil data is included on **Table 1**. Historic groundwater data is included in **Table 2**. Boring and well locations are shown on **Figure 2.**

5.0 NATURE AND EXTENT OF SOURCE AREAS

The following sections describe the source(s) of the petroleum hydrocarbons and MtBE that have been detected in soil and groundwater beneath the site.

In March 21, 1997, as part of a facility upgrade, the fuel system was removed and replaced with new fiberglass tanks along with new product piping and dispensers. Soil samples were collected from the base and sidewalls of the UST pit and from beneath the product line trenches. A sample location map and summary of analytical data is contained in **Appendix B**. TPH-G was detected at concentrations as high as 1,100 milligrams per kilogram (mg/kg) in the UST pit sidewall samples at a depth of 10 feet bgs. TPH-G was below the laboratory detection limit in soil samples from the base of the tank pit at a depth of 18 feet bgs. Soil analytical data is summarized on **Table 1**.

Soil samples were collected at three locations along product piping. Samples were collected at between 3.5 and 4.5 feet bgs. The highest concentration of TPH-G was detected at 330 mg/kg at location P1 adjacent to the southern dispenser island. MtBE was detected in product piping samples at concentrations ranging from 0.93 mg/kg to 4.9 mg/kg.

A soil sample was collected from beneath each of the four fuel dispensers. TPH-G was detected at a maximum concentration of 180 mg/kg. MtBE was detected at a maximum concentration of 2.7 mg/kg.

In May 2005, TPH-G was detected in groundwater wells MW-3 at 9,300 µg/L, MW-4 at 19,000 µg/L, MW-5 at 73,000 µg/L, and MW-6 at 2,300 µg/L. Well MW-5, with the highest TPH-G concentration, is located southeast (downgradient) of the fuel dispenser islands. Benzene and MtBE were detected in the sample from MW-5 at 8,400 µg/L and 870 µg/L, respectively. Historic soil data is included on **Table 1**. Selected historic groundwater data is included in **Table 2** and **Appendix C**. Boring and well locations are shown on **Figure 2.**

Based on these data, the area of highest concentrations of TPH-G, benzene, and MtBE in groundwater are located downgradient of the fuel dispenser islands, and the predominant source of the release is most likely the dispenser islands and/or fuel lines.

6.0 ADDITIONAL SITE ASSESSMENT

The following sections describe the drilling of cone penetrometer test (CPT) boring B-1 on September 11, 2008 and the installation of on-site wells MW-15 and MW-16 in October 2008. Locations are shown on **Figure 2**.

6.1 Cone Penetrometer Test (CPT) Boring B-1

Boring B-1 was advanced on September 11, 2008 using CPT equipment. The purpose of the boring was to determine the soil types beneath the site to a depth of approximately 48 feet bgs, and to collect discrete groundwater samples below the upper saturated zone (5 to 15 feet bgs).

6.1.1 Soil Profile

Two borings were advanced at the B-1 location. The first boring was used to establish the soil stratigraphy using a computerized CPT program to generate a detailed boring log. The boring log indicated primarily clay and silt to the total depth of the boring. Three sand layers were indicated at depths of 8 to 10 feet, 30 to 34 feet, and 44 to the bottom of the boring at 48 feet bgs. The boring log is found in **Appendix A**. A pore pressure dissipation test was performed at a depth of approximately 44 feet bgs. The test indicated rapid pore pressure dissipation typical of a permeable sand/gravel.

6.1.2 Collection of Groundwater Samples

The second boring was used to collect groundwater samples at depths targeted based on the adjacent boring log.

Groundwater was collected using the hydro-punch sampling method at depths of approximately 10 feet and 33 feet bgs. A sealed, stainless steel 1.75 inch hollow push rod was advanced to the desired sampling depth. The push rod was then retracted, exposing the inlet screen which allowed groundwater to hydrostatically flow into the sampler. A sample was collect by a stainless steel sampler lowered through the push rods. The groundwater samples were decanted into hydrochloric acid (HCl) preserved 40-milliliter glass vials and immediately placed on ice. An attempt was made to collect a groundwater sample from a depth of approximately 47 feet bgs. The sampler was opened to allow groundwater to enter. However, after approximately 90 minutes, the sampler remained dry and no sample could be collected.

Following sample collection, a Portland cement mixture was placed into the borehole using a tremie pipe to 0.5 feet below grade. Grouting was performed under the supervision of a county well inspector.

The groundwater from the upper 10-foot sample contained TPH-G at 74,000 µg/L, benzene at 4,400 µg/L and MtBE at 480 µg/L. In comparison, the deeper groundwater sample from 33 feet contained benzene at only 0.51 µg/L and MtBE at 3.3 µg/L. TPH-G was below the laboratory detection limit (**Table 2**).

6.2 Wells MW-15 and MW-16

The following sections describe the installation, development, sampling, surveying of on-site wells MW-15 and MW-16. The wells were installed to allow sampling of groundwater in the sand layer indicated on the CPT log for boring B-1 at a depth of approximately 30 to 34 feet bgs. Analytical data from the groundwater samples were used to evaluate the vertical extent of dissolved petroleum hydrocarbons and MtBE detected in shallow groundwater.

6.2.1 Borings

The borings for wells MW-15 and MW-16 were advanced using the mud rotary drilling method. The RWQCB in its letter to COP dated July 8, 2008, required a drilling method be used that prevented cross contamination between separate water bearing zones. The mud rotary drilling method was selected to provide a sufficient diameter borehole to install a conductor casing to a depth of approximately 21 feet bgs and provide stability of the borehole wall in the upper soft Bay Mud during installation of the conductor casing. The conductor casing was used to isolate the upper saturated zone containing dissolved petroleum hydrocarbons and MtBE during installation of the well screen and surrounding sand pack. The borehole diameter was 14-inches from the ground surface to 21 feet for installation of an 8-inch diameter steel conductor casing and 8-inches from 21 feet to bottom of the boring at 31 feet bgs for installation of the 2-inch diameter well casing and screen.

6.2.2 Soil Sampling

For each well, soil samples were collected at five-foot intervals from 10 to 20 feet bgs and continuously from 20 to 31 feet bgs using a modified California split spoon sampler with brass liner inserts. A pre-calibrated photo-ionization detector (PID) was used to field screen soil samples for the presence of organic vapors. PID data is recorded on the boring logs contained in **Appendix A**.

6.2.3 Well Construction

For each well, the 8-inch diameter conductor casing was cemented in place with concrete grout in the annular space between the borehole wall and the casing. Drilling mud was then pumped from the inside of the conductor casing until nearly dry. The conductor casing seal was allowed to set for approximately 24 hours in accordance with requirements of the Contra Costa County inspector before further drilling activities proceeded. An eight-inch diameter boring was then advanced through the conductor casing to a depth of approximately 31 feet bgs by mud rotary. The borehole was converted to a well by the installation of 2-inch diameter PVC well casing and screen. A two foot long 0.010-inch well screen was set from 29 to 31 feet bgs. A #2/12 sand was placed from 27 to 31 feet followed by bentonite from 25 to 27 feet bgs. A cement grout was then placed from 25 feet bgs to the ground surface. All well construction activities were supervised by a Contra Costa

County well inspector. Well details are illustrated on the boring logs contained in **Appendix A**.

6.2.4 Well Development

Wells MW-15 and MW-16 were developed on October 15, 2008 by Gregg Drilling. Field notes and Monitoring Well Development Logs are contained in **Appendix D.** Approximately 2 to 3 gallons of water were bailed from each well, followed by surging and removal of another 9 gallons of water also by bailing. Approximately 3 casing volumes were removed from each well. Final turbidity of development water was approximately 750 NTU. pH and electrical conductivity values were monitored during purging and are recorded on the Well Development Logs.

6.2.5 Well Sampling

Monitoring wells 15 and 16 were developed on October 15, 2008. Approximately 22 gallons were purged from MW-15; approximately 22 gallons were purged from MW-16. Both wells were purged utilizing a pre-cleaned stainless steel bailer. Recordings of pH, EC, turbidity, temperature and salinity were recorded at approximately 10 gallons purged, and at end of purge operations in both wells. Purge water was contained in DOT approved 55 gallon drums that were sealed, labeled, and stored securely on-site pending disposal at a COP approved facility.

Sampling purge data sheets are contained in **Appendix E**.

6.2.6 Well Location and Elevation Survey

Well locations and top of casing elevations were established for wells MW-15 and MW-16 by Morrow Survey on November 11, 2008. Survey data is contained in **Appendix F**.

6.3 Explanation of Non-Installation, Well MW-17

A third well (MW-17) was proposed in Delta's work plan dated June 9, 2008 and approved by the RWQCB in a letter to COP dated July 8, 2008. The proposed location of the well was along the southern boundary of the site (**Figure 2**).

Well installation was initiated, but could not be completed due to drilling difficulties. The MW-17 borehole was advanced to a depth of approximately 21 feet using the mud-rotary drilling method. At a depth of 21 feet, drilling mud was observed seeping out of the pavement approximately 10 feet north of the boring. The location of the seepage was near an underground PG&E electrical utility trench trending east-west just south of the site building. PG&E was notified and a representative came to the site to examine the site conditions. PG&E determined that no action was required. It was decided to terminate the boring in order to avoid any further impact to underground utilities. The boring was filled with concrete grout under the supervision of a Contra Costa County well inspector. An alternative location could not be established based on the close spacing of underground utilities in the area.

6.4 Vertical Delineation

Vertical delineation of gasoline has been completed based on the data from boring B-1 and wells MW-15 and MW-16. Groundwater samples were collected from CPT boring B-1 at depths of 10 feet (upper zone) and 33 feet bgs (first saturated sand and gravel). The upper sample contained TPH-G at 74,000 µg/L, benzene at 4,400 µg/L and MtBE at 480 µg/L. In comparison, the deeper groundwater sample contained benzene at only 0.51 µg/L and MtBE at 3.3 µg/L. TPH-G was below the laboratory detection limit (**Table 2**).

Results from wells MW-15 and MW-16 also showed the effectiveness of clay layers to prevent vertical migration of petroleum hydrocarbons and MtBE. Recent deep wells MW-15 and MW-16 were sampled on October 17, 2008. The groundwater samples were analyzed for TPH-G, benzene, toluene, ethylbenzene, xylene (BTEX compounds), and fuel oxygenates. TPH-G, BTEX, and fuel oxygenates were not detected in either sample. A laboratory analytical report is contained in **Appendix G**.

Dissolved gasoline sample data collected from IMW-1 is considered anomalous, especially considering soil analytical data from installation of this boring. The results are considered non-representative, likely due to inadvertent cross-contamination in the field.

Review of soil analytical data verifies that detections below about 20 feet below grade are largely non-detectable.

Based on the summary of soil and groundwater analytical data, the base of the plume lies at a depth of about 20 feet bgs.

7.0 ADDITIONAL SOIL GAS SAMPLING

The following sections describe the collection and analysis of additional soil gas/vapor samples from beneath the site.

7.1 Additional Soil Gas Sampling

Additional soil vapor sampling was conducted at the site in December 2007. Delta supervised the sampling of SG-1 through SG-12 on December 17, 2007, by Transglobal Environmental Geochemistry (TEG) (see map in **Appendix H**).

The soil vapor samples were obtained by using Strataprobe™ direct-push technology to push a 1-inch outer diameter steel probe equipped with a steel drop-off tip into the sand layer at each sampling location. For each of the sample point locations, the tip was pushed down to 4.5 feet bgs to collect a shallow soil gas sample. Soil vapor sampling was attempted in the SG-1, SG-2, SG-4, SG-6, SG-10, SG-11, and SV-12 borings, however due to excessive moisture in the borings during sample collection, no samples were collected at these locations.

A total of eight soil vapor samples were collected and analyzed from borings SG-3, SG-5, SG-7, SG-8, and SG-9 by the on-site California state-certified mobile laboratory. A laboratory analytical report is contained in **Appendix H**. Soil vapor data is included in **Table 3.**

After sampling, probe locations were backfilled with Portland cement and capped with color-matching neat cement.

Soil vapor results are shown on a series of maps and summarized in **Appendix H.** It was concluded, based on the depth of samples and analytical data, that the soil vapor readings represented saturated conditions in the capillary fringe above the groundwater rather than the vadose zone.

Additional soil gas samples were collected in October, 2008. Soil vapor was collected at eight locations (SV-1B through SV-8B) shown on a map in Appendix H. Samples were collected at depths of 0.5 and 3.0 feet bgs to assure that they were representative of the vadose zone and not saturated conditions. Samples were collected by Transgolobal Environmental Geochemistry (TEG) under the direction of Delta. The TEG soil vapor sampling protocol is provided in Appendix H. Soil vapor analytical results are included in Table 3. The laboratory report is included in Appendix H.

TPH-G was detected in four samples; SV-2B at 3 feet, SV-3B at 3 feet, SV-4B, SV-5B at three feet, and SV-8B at 3 feet. TPH-G was not detected in any samples from 0.5 feet bgs. Benzene was detected in two samples; SV-3B at 3 feet and SV-4B at 3 feet. Benzene was not detected in any samples from 0.5 feet bgs. MtBE was not detected in any soil vapor samples. The leak detection compound 1,1-difluormethane was detected in the sample SV-4B at 0.5 feet bgs.

7.2 Subslab Vapor Sample

The analytical data collected from the soil vapor assessment conducted in December 2007 indicated TPH-G was above the Environmental Screening Levels (ESLs) established by the RWQCB in two sample locations (SG-3 and SG-8) and benzene was above the ESLs in one location (SG-8). Sample locations are shown on **Figure 2**. The SG-3 location is along the eastern property boundary and the SG-8 location is located south, immediately behind the station building. Therefore, Delta proposed the collection of one subslab vapor sample be collected from beneath the station building.

An attempt was made to drill a boring through the floor slab within the building. The very limited space within the small building allowed for only a hand operated drill. The drill was unable to penetrate the floor slab. Delta selected a location immediately outside the building as an alternative location for collection of a soil vapor sample (SV-SB, **Figure 2**). The soil vapor sampling procedure and results are included in **Table 3** and **Appendix H**. Xylene (m,p) was detected at 210 ug/m^3 at 0.5 feet bgs at this location. All other compounds of concern were not detected above the laboratory reporting limits.

<u>8.0 FATE AND TRANSPORT CHARACTERISTICS</u>

The following sections describe potential contaminant migration pathways for petroleum hydrocarbons and MtBE. Plume migration and contaminant concentration trends are discussed.

8.1 Underground Utility Conduits

The exact location and depth of utility trenches both on-site and in the site vicinity has not been determined. Based on a review of site related files, a survey of nearby utilities for the purpose of a preferential pathway evaluation has not been performed. A utility survey will be performed as part of proposed tasks.

8.2 Soil Migration Pathways

Migration of petroleum hydrocarbons and MtBE through soil is limited by the fine grained nature of clay deposits. Soil beneath the site is primarily clay (see Geologic Sections, **Figures 5 and 6**). The first layer of coarse sand/gravel is at a depth of approximately 30 feet bgs.

8.3 Hydrogeologic Pathways

The vertical and lateral migration of dissolved petroleum-hydrocarbons is limited by fine-grained low permeability clay soils.

Lateral groundwater migration occurs through thin (less than one-foot thick) fine sand layers within surficial clay. As described in Section 3.4.3, a groundwater velocity of less than 10 feet per year is calculated.

MtBE is very soluble in water and migrates at nearly the same rate as the groundwater in which it is dissolved. Site isoconcentration maps indicate that MtBE has migrated with shallow groundwater approximately 200 feet downgradient (south) of the fuel dispensers and USTs. Assuming a release occurred during the 1980s when MtBE usage was highest, a horizontal flow rate of 10 feet or less per year is calculated given a travel time of approximately 20 years.

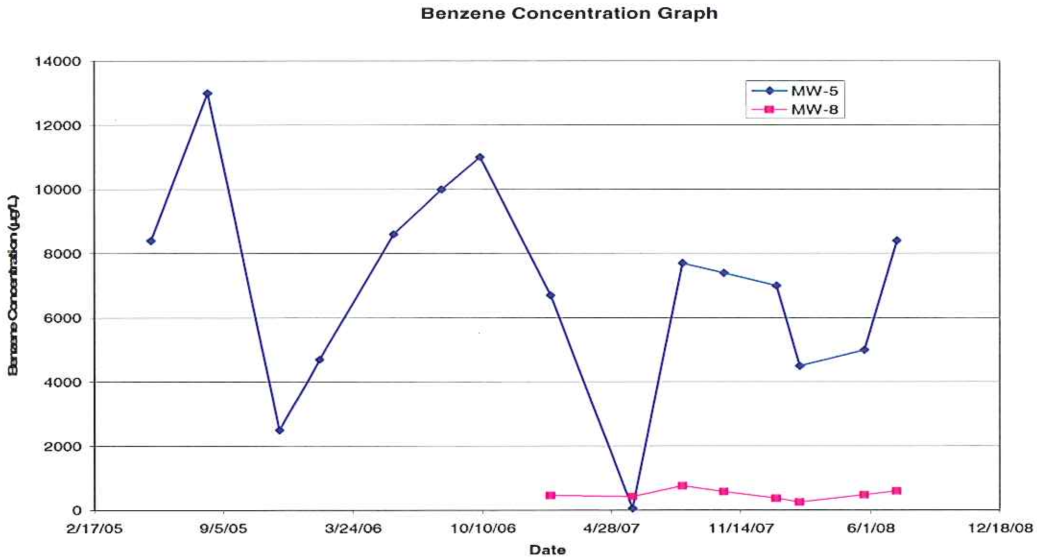
The vertical migration of groundwater is restricted by extensive clay layers. Groundwater quality data from boring B-1 and wells MW-15 and MW-16 confirm that petroleum hydrocarbons and MtBE are confined to the shallow upper saturated zone at depths of 5 to 15 feet bgs. The See Section 6.4 for a complete discussion of data related to vertical migration.

8.4 Contaminant Migration Model

It appears that a petroleum hydrocarbon release occurred at some undetermined time prior to the removal and replacement of the former fuel USTs, product lines, and dispensers in 1997. The USTs were submerged in groundwater. Depth to groundwater in 1997 is anticipated to have been approximately 5 to 10 feet bgs. The distance from the bottom of the product piping trenches to groundwater was approximately 5 feet. Petroleum hydrocarbons and MtBE moved rapidly into the shallow groundwater. TPH-G, benzene, and MtBE dissolved into the groundwater and began to move slowly to the south through thin sand layers within predominantly clay deposits. Impacted soils are concentrated in the 5- to 15-foot depth interval correlating with the capillary fringe and upper portion of the zone of saturation. The highest soil PID concentrations were typically between 5 and 10 feet bgs (see logs, **Appendix A**). Chemicals of concern (COCs), TPH-G, benzene, and MtBE, have migrated horizontally approximately 100 feet off-site to the south. Isoconcentration maps showing the current TPH-G, benzene, and MtBE plume configurations are shown on **Figures 7** through **9**.

8.5 Concentration Trends

The petroleum hydrocarbon plume and MtBE dissolved groundwater plumes appear to be stable. The graph below shows the concentrations of benzene in well MW-5 (in the area of highest site concentrations) and in well MW-8 (located in the downgradient southern corner of the site).



9.0 SITE REMEDIATION AND FEASIBILILTY TEST RESULTS

Historic remediation activities are described below. Remediation alternatives have been evaluated through feasibility tests and are also described below.

9.1 UST Removals

A used oil tank was removed from the site on July 20, 1993. As part of a facility upgrade, the fuel underground storage tank (UST) system was removed on March 21, 1997 and replaced with new fiberglass tanks along with new product piping and dispensers. It is possible that impacted soil was removed during the UST removals. Regardless, fuel system upgrades have removed older subsurface features that presumably were the origin of the release. There has been no documentation to suggest that existing newer fueling facilities are contributing to the release gasoline in the subsurface. Fuel system component replacement has therefore removed the direct source of the release.

9.2 Feasibility Test for Groundwater Extraction

Groundwater extraction feasibility testing was performed in November 2007. Step drawdown tests were performed on three monitoring wells (MW-3, MW-4, and MW-5) along with short term pumping tests. Details of the feasibility testing are contained in Section 3.4.

The results of the testing indicated that groundwater extraction was not a viable remediation methodology due the dominance of clay in the upper saturated zone. Average sustainable yields were less than 0.5 gpm, and the area of influence was less than approximately 20 feet. This value is low for this type of remedial method.

9.3 Feasibility Test for Ozone Injection

On December 6, 2007, Delta installed an ozone injection well (OZ-1) to a depth of 12 feet bgs using a truck mounted drill-rig equipped with 8-inch diameter hollow-stem augers (**Figure 2)**.

The ozone injection test was performed using a Calcon HiPro Jr. ozone system, capable of producing approximately 0.5 pounds of ozone per day and injecting an air/ozone mixture into the subsurface at a flow rate of approximately 2.0 standard cubic feet per minute (scfm) at a pressure up to 30 pounds per square inch (psi). The ozone system was connected to the injection well using 1/2-inch outside diameter (3/8-inch inside diameter) high density polyethylene (HDPE) tubing.

The system was started on January 8, 2008. The system was run an average of eight hours per day (480 minutes), Monday through Friday, for the duration of the test.

During the injection event system readings (system operating pressures) were recorded and leaks in the OZ-1 well head and tubing were checked by routinely scanning an ozone sensor over the tubing from the connection at the ozone system to the sparge point. An approximately 2.28 pounds of ozone was injected into well OZ-1 well during the 137.8 hours time (0.016 pounds/hr).

Post-injection results include:

- TPH-G concentrations in monitoring well MW-3 increased over 300 percent from 2,500 µg/L to 8,800 µg/L. Benzene, ethyl-benzene, and total xylenes concentrations increased while toluene concentrations decreased. MtBE concentrations decreased by 25 percent from 52 µg/L to 39 µg/L. The remaining fuel oxygenates and lead scavengers remained below laboratory's indicated reporting limits.

- TPH-G concentrations in monitoring well MW-4 increased over 200 percent from 9,200 µg/L to 21,000 µg/L. Benzene, toluene, ethyl-benzene, and total xylenes concentrations also increased. MtBE concentrations increased 23 percent from 600 µg/L to 780 µg/L. TBA was reported at 160 µg/L on February 13, 2008 and was below the laboratory's indicated reporting limit of 200 on January 8, 2008. All other petroleum hydrocarbon constituents tested were below the laboratory's indicated reporting limits.

- TPH-G concentrations in monitoring well MW-5 decreased 13 percent from 67,000 µg/L to 58,000 µg/L. Benzene concentrations decreased 36 percent from 7,000 µg/L to 4,500 µg/L. Toluene concentrations decreased 10 percent from 8,900 µg/L to 8,000 µg/L. Ethyl-benzene concentrations decreased 27 percent from 2,600 µg/L to 1,900 µg/L. Total xylenes concentrations decreased 17 percent from 12,000 µg/L to 10,000 µg/L. MtBE concentrations decreased 10 percent from 500 µg/L to 450 µg/L. All other petroleum hydrocarbon constituents tested were below the laboratory's indicated reporting limits. This is the monitoring well closest to the OZ-1 injection well.

- TPH-G concentrations in monitoring well MW-7 decreased 29 percent from 8,700 μg/L to 6,200 μg/L. Benzene, toluene, ethyl-benzene, and total xylenes concentrations increased. MtBE concentrations increased 42 percent from 36 μg/L to 62 μg/L. All other petroleum hydrocarbon constituents tested were below the laboratory's indicated reporting limits.

- TPH-G concentrations in monitoring well MW-8 decreased 13 percent from 9,100 μg/L to 7,400 μg/L. Benzene concentrations decreased 32 percent from 370 μg/L to 250 μg/L. Toluene concentrations remained below the laboratory's indicated reporting limit. Ethyl-benzene concentrations decreased 6 percent from 660 μg/L to 620 μg/L. Total xylenes concentrations increased 20 percent from 400 μg/L to 500 μg/L. MtBE concentrations decreased 34 percent from 410 μg/L to 270 μg/L. All other petroleum hydrocarbon constituents tested were below the laboratory's indicated reporting limits.

Ozone feasibility testing indicated that ozone injection is likely to be a successful method for groundwater remediation. Localized increases in dissolved gasoline concentrations throughout the course of the test likely indicate desorption of gasoline (mass transfer) from the soil to groundwater. Sustained injection trends will likely show continued "spikes" in these areas as the mass transfer process is completed, followed by gradual declines as the dissolved mass is sequentially oxidized by the ozone. Further declines are expected to result from a synergistic process, whereby excess unreacted ozone degrading to oxygen supports growth of natural aerobic bacterial populations.

Feasibility testing indicated a lateral injection radius of influence of approximately 15 to 20 feet, which is considered adequate for this form of remediation. The vertical zone of influence is dictated by lithology, and attenuates upward from the point of injection. The vertical zone of influence is harder to measure, but at the most is likely comparable to the lateral radius of influence.

10.0 RISK ANALYSIS

The following sections evaluate the various potential impacts to sensitive receptors from petroleum hydrocarbons and MtBE detected in soil and groundwater.

10.1 Inhalation of Soil Vapors/ Evaluation of October 2008 Data

The October 2008 investigation provided detailed data on soil vapor conditions in the vadose zone along the downgradient boundaries of the site. The highest benzene concentration 520 ug/m^3 was found in sample SV-4B located in the southern corner of the site. However, the soil vapor concentration found in sample SV-3B-3' was used to calculate incremental risk and hazard quotient from vapor intrusion to indoor air because SV-3B-3' was the sample point located closest to identified potential receptor.

The California Department of Toxic Substances Control (DTSC) soil vapor model was used to evaluate the potential for impact to off-site residences. A benzene soil vapor concentration of 230 ug/m^3 was used. The concentration is considered a conservative value as concentrations beneath off-site buildings will be considerably less that at the downgradient boundary of the site. The benzene concentration was applied to a depth of 3 feet bgs within sandy soil. This is a worst case scenario as borings have consistently shown near surface soil to be low permeability clay. An 8-hour per day exposure time was used (the number of exposure years was reduced from 25 to 8.25 in cell G47). The DTSC commercial default ventilation rate of one exchange per hour was used.

The calculated incremental risk from vapor intrusion to indoor air for benzene (a carcinogen) was 4.5E-07 (unitless). This value is less than the standard 1.0E-06 risk standard. The calculated hazard quotient (HI) for this scenario is 1.2E-03 (unitless). This value is less than 1, the HI risk standard.

The analysis indicates that soil vapors from shallow impacted groundwater do not pose a threat to off-site structures. Model input and output sheets are contained in **Appendix I**.

10.2 Estuarine Environments

The San Francisco Bay fringe is located approximately 1500 feet south/southeast of the site. The US Geological Survey topographical quadrangle (**Figure 1**) indicates wetlands and estuaries along the edge of the Bay. Groundwater monitoring data indicates that the TPH-G, benzene, MtBE has traveled a maximum of approximately 200 feet off-site to the south/southeast. The threat of impacted groundwater discharging to the Bay fringe is deemed very low.

10.3 Ingestion of Impacted Groundwater

A well survey was performed by Delta in 2006. Survey data was obtained from the California Department of Water Resources (DWR) office in Sacramento. The DWR survey located records for 12 wells within a one-mile radius of the site. Survey data is summarized on a map and table in **Appendix J**. The nearest wells were indicated as located approximately 0.5 miles west of the site. Four wells were recorded as located approximately 0.5 miles west of the site; two domestic well (map codes #1 and #4), two industrial (# 3 and #9), and two wells associated with a Chevron service station (#7 and #8). It appears that the site groundwater plume does not pose a threat to any drinking water supply wells.

<u>11.0 CORRECTIVE ACTION PLAN</u>

The following sections provide a corrective action plan (CAP) for residual petroleum hydrocarbons and MtBE in soil and water beneath the site.

11.1 Remediation Goals

The primary remediation goals are;

- Reduction of petroleum hydrocarbon mass in soil in order to allow cleanup of shallow groundwater

- Reduction of TPH-G, benzene, and MtBE concentrations in shallow groundwater to levels at which the agency will consider case closure.

- Continued protection of off-site downgradient residential and commercial structures from soil vapor impacts to indoor air.

These goals are considered to be very conservative, as soil gas data within site boundaries has shown there to be no to low risk to nearby residents due to vapor migration. Also, there are no nearby drinking water receptors at risk due to groundwater at the site, and no likelihood of the site groundwater being used for drinking purposes. Drinking water Maximum Contaminant Levels (MCLs) are not considered appropriate for this site under the specific circumstances.

11.2 Remediation Alternatives – Soil

Delta has evaluated three soil remediation alternatives; excavation, soil vapor extraction, and dual phase extraction.

11.2.1 Excavation

Impacted soil is concentrated in the 5- to 15-foot depth interval, primarily in the area of the islands and lines. Soil could be removed by standard excavation techniques. Removal of soil in the eastern portion of the site would expedite groundwater cleanup by removing the primary source petroleum hydrocarbons and MtBE.

However, the property is the location of an active service station, and is no longer owned or operated by ConocoPhillips. Soil excavation would mean full closure of the station and removal of all of the underground features in the area of impact so that excavation beneath them could occur. The property owner is unlikely to agree to such measures.

11.2.2 Soil Vapor Extraction

Soil vapor extraction (SVE) is a commonly used methodology for soil cleanup. Petroleum hydrocarbons are removed from soil by vapor extraction and treatment.

Traditional SVE methods use wells to extract soil vapors. Traditional SVE is not effective in clay soil such as found beneath the site. Clay prevents the movement of soil vapor toward extraction wells. In addition, groundwater beneath the site at less than 10 feet bgs, results in a negligible vadose zone from which to extract vapor. This method is not considered viable for this site for these reasons.

11.2.3 Dual Phase Extraction

Dual Phase Extraction (DPE) is a common methodology for soil cleanup involving extraction of both groundwater and soil vapors. Groundwater is pumped from wells lowering the water table to expose petroleum hydrocarbon "smear" zones. SVE is used in combination with groundwater extraction to remove hydrocarbons from the exposed soil.

DPE is not anticipated to be effective at this site due to the predominance of low permeability clay that inhibits movement of both soil vapor and groundwater. Groundwater extraction results during the pump test show a low capacity for extraction with a limited area of influence. Drawdown is likely to be insufficient to expose much of the vadose zone, and even with the exposure of additional vadose zone, the intrinsic soil properties will continue to inhibit SVE which is a required component of this remediation method.

11.3 Remediation Alternatives – Groundwater

Delta has evaluated three groundwater remediation alternatives; groundwater extraction and treatment, ozone injection, and a trench application for air sparge/SVE.

11.3.1 Groundwater Extraction and Treatment

Groundwater extraction is performed by pumping of wells screened in the impacted aquifer. Extracted water is treated on site by carbon filtration or discharged under permit to the sanitary sewer. Site groundwater extraction (GWE) feasibility tests (Section 3.4) showed that this methodology would not be effective due to very low extraction rates in clay and a limited area of influence.

11.3.2 Ozone Injection

Delta initially proposed ozone injection for remediation of groundwater. The radius of influence has been calculated at 15 to 20 feet, but these data may not be fully representative of all site conditions due to the predominance of clay.

For remedial design purposes, a more conservative value of 10 feet can be applied to account for localized soil heterogeneity and predominance of low-permeability soil types. If in the field the radius of injection influence approaches 15 to 20 feet or more, areas of overlap between wells will exist that may further expedite cleanup.

11.3.3 Trench Application - Air Sparge/SVE

Delta has successfully used air sparging in remediation of fine-grained soil by installing a trench to artificially increase subsurface permeability. Air is pumped into the saturated zone via piping in the trench to maximize the area of aquifer contact. Petroleum hydrocarbons dissolved in groundwater pass through/collect in the trench filled with permeable material. The permeable material in the trench allows for effective air-sparging and off-gases are collected in the upper portion of the trench by SVE. Extracted soil gas is treated before being discharged to the atmosphere.

11.4 Recommendations

Delta recommends the use of a combination of ozone and air sparge/SVE for site remediation. If an opportunity arises for remedial excavation to be conducted during any future station upgrades or land use changes, plans to pursue soil excavation will be submitted as addendums to the Corrective Action Plan.

11.4.1 Sensitive Receptor Survey – Underground Utilities

Prior to initiating remediation, Delta will evaluate the potential for nearby utilities to be preferential pathways for contaminant migration.

11.4.2 Soil Vapor Extraction/Sparging Using Permeable Trench

Due to the shallow groundwater and clay soil types, vapor extraction in general is not feasible at the site in native soils. However, soil vapor extraction to control vapor migration as a stand alone remedial process and in conjunction with any sparging activity is important to protect nearby residential property from the potential for vapor migration. In addition, groundwater extraction feasibility testing has also demonstrated the low potential for effective remediation by traditional pump and treat methods, and by inference dual-phase extraction, due to the low soil permeability.

The proposed solution to address these conflicting issues is to install a shallow permeable trench, containing horizontal injection/vapor recovery lines. The trench is filled with permeable materials to allow for air (and/or ozone) circulation during the remedial process. The positioning of the trench allows it to act as a barrier to further off-property migration of gasoline-containing groundwater and/or vapors. The depth of the trench will intersect the depth at which most of the plume resides.

Delta will install one horizontal SVE well (SVE-1H) and one horizontal sparge well (AS-1H) in a 15-foot deep trench. **Figure 10** presents the site map with proposed horizontal well locations. **Figure 11** presents the trench details.

The 15-foot deep trench will be approximately 100 feet in length and 2 feet in width along the southern property line. The trench will be backfilled with sand. Both SVE and sparge wells are proposed to be screened horizontally along the entire length of the trench. Water passing through the trench will be sparged with air to strip off the volatile hydrocarbons and oxygenate the water. Vapors stripped from the water will be captured in the soil vapor extraction piping and treated with a thermal or catalytic oxidizer. The oxidizer will be permitted in accordance with the air quality management districts regulations. Ozone addition to the air stream may be considered as a contingency measure for the future to increase the rate of gasoline destruction/removal, and if proposed will be submitted as an addendum to the Corrective Action Plan.

11.4.2.1 SVE/ Air Sparge System

The above-ground equipment will consist of a small AS blower capable of 50 cubic feet per minute (cfm) and 12 pounds per square inch (psi) which will be utilized to inject air below the water table through the air sparge (AS) well placed horizontally at 14 feet below grade. The SVE system will consist of a thermal or catalytic oxidizer capable of treating 100 cfm of soil vapors. The AS vapors will be captured by the SVE and treated in the thermal oxidizer which will be permitted in accordance with air district requirements.

11.4.2.2 Pre-field Activities

Upon approval of the work plan, Delta will visit the site to mark the well locations, contact Underground Services Alert at least 48 hours prior to hand digging, arrange the schedule and coordinate mobilization of equipment and materials. Prior to trench construction, a utility locator contractor will perform a geophysical survey of the proposed trench. Notifications regarding the field activities will be made in advance to the appropriate agencies and the property owner, and any necessary permits will be obtained.

11.4.2.3 Air Sparge and SVE Installation Procedures

The trench will be excavated to approximately 15 feet bgs in depth, 100 feet in length and 2 foot in width. The lithology will be logged using the Unified Soil

Classification System during the excavation. If necessary, the trench will be dewatered using a sump pump and water pumped will be temporarily stored on-site, pending transport and disposal at appropriate treatment facility. The trench will be backfilled with #2/16 Monterey sand approximately one foot above the bottom of it. Proposed horizontal AS well location (AS-1H) will be constructed of 2-inch diameter Schedule 40 PVC screened approximately 100 feet along the trench. Based on existing site data, the AS well will be constructed of 0.010-inch slotted screen.

The AS well will be placed in the trench at approximately 14 feet bgs, covered with #2/16 Monterey sand. The proposed horizontal SVE well (SVE-1H) will be constructed of 4-inch diameter Schedule 40 PVC screened approximately 100 feet along the trench. Based on existing site data, the SVE well will be constructed of 0.010-inch slotted screen. The SVE well will be placed in the trench at approximately 5 feet bgs, followed 2-feet of #2/16 Monterey sand and 2-foot hydrated bentonite chip seal. Excavated material will be backfilled above the bentonite chip sealed zone to the surface in the trench. A riser from each horizontal well will bring the well to a locking cap placed at the wellhead, which will be enclosed in a flush-mounted traffic-rated vault.

During well installation activities, soil will be field screened for the presence of volatile organic compounds (VOCs) by headspace analysis using a PID calibrated to 100 parts per million by volume (ppmv) of isobutylene. PID readings will be recorded on the air monitoring forms.

Soil cuttings and rinseate generated during air-knifing activities will be placed in DOT-approved 55-gallon drums or roll off bins. The drums or roll off bin will be sealed and labeled in accordance with the appropriate protocols and will be identified on a waste inventory form. The waste will be temporarily stored on-site, pending transport and disposal at appropriate disposal or recycling facilities.

11.4.3 Low-Flow Ozone Injection

Feasibility testing was conducted in February 2008. This study included the injection of 2.28 pounds of ozone into ozone well OZ-1 over 137.8 hours for a rate of 0.016 pounds/hr. From the test radius of influence (ROI) of the ozone injection well was estimated to be approximately 15 to 20 feet based on pressure reading in the MW-5. Dissolved oxygen (DO) concentrations, however, did not show a significant response during the pilot test, indicating the ROI is likely less than the pressure reading ROI. Combining both Pressure and DO factors into the ROI estimate results in a total estimated ROI of about 10 feet. This smaller ROI is conservative, as any areas with a larger ROI will be areas of overlap.

Delta therefore recommends to install between 5 and 7 ozone injection points along the eastern property boundary, spaced between 15 to 20 feet apart (**Figure 10**). Well construction will consist of 1-inch ID, Schedule 80 PVC connected to a 1.5-inch diameter by 18-inch-long sparge point. The sparge points will be placed from 25 to 23.5 bgs with a #2/16 sand pack placed from the total depth of the boring (25 feet bgs) to 2 feet above the sparge point (21.5 feet bgs). Three feet of bentonite chips will be placed above the sand and hydrated in place. A neat cement grout seal will be placed from the top of the bentonite chips to approximately two feet bgs. A wellhead connection will be placed on top of the riser pipe, and a traffic-rated, flush-mounted well box will be installed over the well and cemented in place. Wells will be connected by trenching to the equipment compound common with the equipment for the permeable interceptor trench.

Ozone sparging uses relatively low flow and volumes, reducing the risk of groundwater displacement/movement during sparging. During the initiation of ozone/air injection into a sparge point, groundwater displacement results in mounding of the groundwater surface near the injection point. The magnitude of this mounding diminishes with distance from the injection point. With continuous sparging, mounding reaches an initial maximum peak and then dissipates. Once sparging stops, the air-filled voids collapse (fill with water). During this transient collapse the groundwater surface near the sparging point may show a depression. Pulsed sparging therefore generally results in localized mixing of the groundwater within the zone of influence. Ozone sparging uses flow rates from less than 1 to 4 SCFM per well, resulting in less mounding and groundwater displacement.

Enhanced aerobic bioremediation is a remedial technique which stimulates aerobic microbial degradation of contaminants by increasing the dissolved oxygen concentration available to microbes. Enhanced aerobic bioremediation can be accomplished by injecting air or oxygen into the subsurface at a low flow rate (3 to 4 cfm). Injection of ozone and other oxidants such as hydrogen peroxide often have a synergistic enhanced aerobic biodegradation effect, as ozone not consumed directly by reaction with organic substances such as gasoline converts to oxygen after a short period of time. Petroleum hydrocarbons are sufficiently biodegradable for enhanced aerobic bioremediation to be effective (EPA 2004). Monitoring the effectiveness of enhanced aerobic bioremediation includes establishing concentration distribution, trends, and monitoring dissolved oxygen concentrations.

11.5 Cost Estimates

Delta has estimated the installation and operation costs for the remediation system described above:

- Equipment $70,000 (assumes pre-capitalized equipment will be available)
- Trench Installation $75,000
- Well Installation $40,000
- System and Conveyance Piping Installation $75,000 to $100,000

11.5.1 Annual Operation and Maintenance Costs

- Operation $30,000 per year

- Expected Duration: 3 – 5 years

11.5.2 Life Cycle Cost

- Total Cost: Approximately $300,000 - $400,000

11.6 Schedule

An installation schedule will be submitted to the RWQCB after review and approval of this Corrective Action Plan. The agency will be contacted for a meeting to discuss the schedule and any additional details requested upon submittal of this document.

11.7 Progress Monitoring and Remediation Completion

Remediation progress monitoring will be accomplished by comparing pre-remediation quarterly groundwater monitoring data with groundwater data to be collected during the remediation process. In addition, remedial progress will be tracked by evaluating extracted vapor levels over time from the interceptor trench.

All data collected during the remediation process will be reported in the Quarterly Summary Status report and any reports prepared by ConocoPhillips' remediation contractor.

Remediation will be deemed complete upon approval by the RWQCB to terminate. Criteria for completion may include, but not be limited to:

Extracted vapor level decline over time to stable minimum levels
Dissolved concentration decline over time to stable minimum levels

Recommendations for either continued remediation or review for shutdown will be included in quarterly submittals, along with evaluation of the effect of remediation on the plume for each quarterly period.

When applicable, a request for remediation system shut down will be submitted, with supporting documentation, to the RWQCB. The remediation system will continue to operate until such a time as the Board approves shut down.

Any changes to the remedial process which may be indicated based on progress monitoring data will be submitted as Addendums to this document.

12.0 LIMITATIONS

The recommendations contained in this report represent Delta's professional opinions based upon the currently available information and are arrived at in accordance with currently acceptable professional standards. This report is based upon a specific scope of work requested by the client. The Contract between Delta and its client outlines the scope of work, and only those tasks specifically authorized by that contract or outlined in this report were performed. This report is intended only for the use of Delta's Client and anyone else specifically listed on this report. Delta will not and cannot be liable for unauthorized reliance by any other third party. Other than as contained in this paragraph, Delta makes no express or implied warranty as to the contents of this report.

13.0 REFERENCES

ATC Associates, *Subsurface Investigation Report, 76 Station No. 3713 WNO #4642, 1503 Carlson Boulevard, Richmond, California*, July 21, 2005

Delta Consultants, *(Interim) Subsurface Assessment Report, 76 Service Station No. 3713, Delta Project No. C103713061, Regional Board File No. 07-0522 (BGS), 1503 Carlson Boulevard, Richmond, California,* February 26, 2007

Delta Consultants, *Work Plan – Off-Site Subsurface Investigation Activity, 76 Service Station No. 3713, Delta Project No. C103713021, 1503 Carlson Boulevard, Richmond, California*, March 14, 2006

Delta Consultants, *Passive Soil Vapor Monitoring Investigation Report, 76 Service Station No. 3713, Delta Project No. C103713061, Regional Board File No. 07-0522 (BGS), 1503 Carlson Boulevard, Richmond, California*, August 26, 2006

Delta Consultants, *Subsurface Assessment Report, 76 Service Station No. 3713, Delta Project No. C103713061, Regional Board File No. 07-0522 (BGS), 1503 Carlson Boulevard, Richmond, California*, February 26, 2007

Delta Consultants, *Site Investigation and Feasibility Testing Report, 76 Station No. 3713, 1503 Carlson Boulevard, Richmond, California*, February 27, 2008

California Regional Water Quality Control Board, *San Francisco Bay Region, East Bay Plain Groundwater Basin Beneficial Use Evaluation Report, Alameda and Contra Costa Counties, CA*, June 1999

Delta Consultants, *Work Plan – Vertical Delineation and Additional Soil Vapor Sampling, File No. 07-0522*, June 9, 2008

Delta Consultants, *Corrective Action Plan (CAP) and Report of Findings for Vertical Delineation, 76 Station No. 3713, 1503 Carlson Boulevard, Richmond, California, File No. 07-0522*, October 31, 2008

TEG Northern California, Inc., *Delta Consultants Project #C103713, 1503 Carlson Boulevard, Richmond, California*, November 24, 2008

TRC Solutions, *Quarterly Monitoring Report, October through December 2008, 76 Station 3713, 1503 Carlson Boulevard, Richmond, California*, January 8, 2009