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TESORO

Tesoro Refining & Marketing Company LLC
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Long Beach, California 90802
562 495 6800 Office
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February 28, 2013

Mr. Jerry Wickham, P.G.
Hazardous Materials Specialist
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

SUBJECT: Work Plan for Expanded ISCO Pilot Test
1619 1st Street, Livermore, California
Tesoro No. 67076 (Former Beacon 3604); ACEH Case No. RO0434

Dear Mr. Wickham:

Enclosed please find a copy of the ***Work Plan for Expanded ISCO Pilot Test*** for the subject site, dated February 28, 2013, prepared by Arctos Environmental on behalf of Tesoro Refining & Marketing Company LLC.

Based on my inquiry of the person or persons directly responsible for gathering the information contained in this report, I believe the information was prepared by qualified personnel who properly gathered and evaluated the information, and that the information submitted is, to the best of my knowledge and belief, true, correct, and complete. Please feel free to call me at 562/495-6916 or Scott Stromberg of Arctos Environmental at 510/525-2180 with questions.

Sincerely,

Paula M. Sime
Retail Remediation Supervisor
Tesoro Refining & Marketing Company LLC

Attachments

CC: Arctos – Scott Stromberg

Arctos Environmental
2703 7th Street, Mailbox 213 510 525-2180 PHONE
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28 February 2013
Project No. 01LV

Jerry Wickham
Hazardous Materials Specialist
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Subject: Work Plan for Expanded ISCO Pilot Test
1619 1st Street, Livermore, California
Tesoro No. 67076 (Former Beacon 3604); ACEH Case No. RO0000434

Dear Mr. Wickham:

Arctos Environmental (Arctos), on behalf of Tesoro Environmental Resources Company (Tesoro), is submitting this work plan for an expanded in situ chemical oxidation (ISCO) pilot test at the subject site (Figure 1). The pilot test will occur at onsite and offsite wells.

Executive Summary

During the third and fourth quarters 2011, Arctos conducted a pilot test injection of RegenOx™, an ISCO technology developed by Regenesis Bioremediation Products, Inc., of San Clemente, California, in onsite injection well IP-9. The pilot test was conducted after free product was detected in onsite injection well IP-8 and a membrane interface probe (MIP) investigation showed the highest onsite impacts were approximately 15 to 30 feet below the water table. Following the pilot test, concentrations of total petroleum hydrocarbons as gasoline (TPHg) decreased by over 70 percent in well IP-9 and over 60 percent in well DW-8, located approximately 26 feet downgradient.

In June 2012, Arctos drilled soil borings and installed two monitoring wells approximately 300 feet downgradient of the site. The results of soil and grab groundwater samples showed that the highest offsite impacts were approximately 50 to 65 feet below grade, or approximately 10 to 25 feet below the water table. This was consistent with conditions observed in the onsite source area.

Because RegenOx™ was effective at reducing hydrocarbon concentrations at the onsite source area Arctos is proposing an expanded ISCO pilot test to further evaluate alternative technologies to remediate the groundwater plume originating from the site. The injection activities would occur on site in three existing injection wells over three 1-week events and off site in seven proposed injection wells over two 2-week events.

Site Background

The site description and background are included in Arctos's ISCO Pilot Test Report dated 16 March 2012 (Arctos, 2012).

Previous Site Investigations

Onsite Investigation
Arctos performed a MIP investigation in January 2011 to assess the lateral and vertical extent of free product after it was detected at the site on 25 October 2010 in well IP-8. The highest impacts were generally encountered between 55 and 70 feet below grade in the southwest portion of the site near the underground storage tanks (USTs). These impacts were approximately 20 to 35 feet below the top of the current water table. The presence of submerged impacts appears to indicate that water levels at the time of the UST release were at least 20 feet below current water levels. Based on the results of the MIP borings, Arctos installed deep monitoring well DW-8 on 13 April 2011 downgradient of the USTs. The highest TPHg and benzene concentrations in groundwater at the site are currently reported at wells IP-8 and DW-8 (Figure 2).

Offsite Investigation
During June 2012, Arctos installed, developed, and sampled offsite downgradient monitoring wells MW-12 and DW-9. Three soil borings were also advanced off site and grab groundwater samples were attempted in each boring. The highest soil and groundwater impacts were encountered at depths of 50 to 65 feet below grade, which was consistent with the onsite source area. During the fourth quarter 2012, TPHg, benzene, methyl tert-butyl ether (MTBE), and tert-butyl alcohol (TBA) were detected in deep well DW-9 at concentrations of 10,000, 210, 28, and 94 micrograms per liter (µg/l), respectively. TPHg and benzene were detected in shallow well MW-12 at concentrations of 5,500 and 6.8 µg/l, respectively. MTBE and TBA were not detected in well MW-12.

Initial ISCO Pilot Test (2011)

RegenOx™ is an ISCO technology that includes a two-phase injection process involving a solid oxidant complex (sodium percarbonate) and an activator complex (ferrous iron sulfate). The published benefits of RegenOx™ include subsurface longevity ranging from weeks to months and a relatively low increase in groundwater temperature due to the oxidation reaction (Regenesis, 2007).

During the third and fourth quarter 2011, Arctos performed a pilot test injection of RegenOx™ in injection well IP-9 which included three injection events followed by groundwater extraction after each injection. The objective of the pilot test was to evaluate the effectiveness of RegenOx™ in destroying hydrocarbons and desorbing hydrocarbons for removal by groundwater extraction. RegenOx™ was effective at desorbing petroleum hydrocarbon mass from soil with a radius of influence of approximately 20 feet. The ISCO radius of influence for hydrocarbon destruction was approximately 10 feet because of the high oxidant demand surrounding the injection well (Figure 2). An estimated 130 pounds of TPHg were destroyed by chemical oxidation during the pilot test. Groundwater was extracted from the injection well and surrounding monitoring wells IP-8 and DW-8 to remove high TPHg concentrations after desorption. During the pilot test, 7,300 gallons of groundwater were extracted with an average TPHg concentration of 55,000 µg/l, resulting in an estimated 3.7 pounds of TPHg removed from three wells. ISCO destroyed approximately 35 times the amount of mass removed by groundwater extraction during the pilot test.

From the first RegenOx injection to the fourth quarter 2012, groundwater concentrations of TPHg and benzene decreased by over 74 percent in injection well IP-9 (Figure 3A). During the same period, groundwater concentrations of TPHg and benzene decreased by over 67 percent in downgradient well DW-8 (Figure 3B).

Objective and Scope of Work

The objective of the planned activities is to further assess the effectiveness of remediating hydrocarbon-impacted soil and groundwater in the source area and downgradient of the site using the RegenOx™ ISCO technology. To meet this objective, Arctos will perform the following scope of work:

- ☐ Obtain Alameda County Environmental Health (ACEH) approval of this work plan
- ☐ Shut down the oxygen injection and soil vapor extraction systems
- ☐ Obtain well permits from Zone 7 Water Agency
- ☐ Install and develop seven offsite injection wells (Figures 4 and 5)
- ☐ Collect baseline groundwater samples
- ☐ Inject RegenOx™ solutions into onsite and offsite injection wells
- ☐ Collect post-injection groundwater samples from monitoring wells surrounding the injection wells after approximately 2 to 4 weeks
- ☐ Repeat injection for up to three events based on monitoring results

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- Conduct final performance groundwater monitoring
- Evaluate the pilot test results and prepare a summary report.

Arctos's field procedures for well installation are described in Attachment A.

Expanded Pilot Test Design

Arctos will mix the two RegenOx™ components with water to form separate 5-percent concentration solutions. The activator complex (ferrous iron sulfate) will be injected first at approximately 2 gallons per minute (gpm) into three onsite injection wells and seven offsite injection wells (Figure 5). Approximately 5 casing volumes of clean water will then be injected to flush each well casing and surrounding well pack. The oxidant complex (sodium percarbonate) will be injected next at a rate of approximately 2 gpm followed by another clean water injection to flush the casings and well packs. Because mass removal through groundwater extraction was much less than through ISCO in the 2011 pilot test, groundwater extraction events will not be conducted during the expanded pilot test. The following table summarizes the pilot test design parameters for typical onsite and offsite injection wells based on existing soil and groundwater data in the areas.

Design Parameters	Units	Onsite Value	Offsite Value
Assumed radius of influence	feet (ft)	10	15
Assumed saturated thickness affected by injection well	ft	10	15
Assumed porosity	percent	30	30
Volume of water within treatment zone	gallons	7,050	23,800
Mass of TPHg in groundwater	pounds (lbs)	5.4	1.7
Mass of TPHg in soil	lbs	126	106
Total TPHg mass within treatment zone	lbs	131	108
RegenOx™ mass required (assumes 20 lbs RegenOx™ to 1 lb TPHg)*	lbs	2,933	3,211
Proposed mass of RegenOx™ (oxidant complex) per injection	lbs	900	1,500
Proposed total mass of RegenOx™ for pilot test	lbs	2,700	3,000

*Note – The estimated oxidant requirement does not include natural soil oxidant demand.

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Monitoring and Analytical Program

RegenOx™ will be injected into existing onsite injection wells IP-2, IP-8, and IP-9. The new offsite injection wells will be labeled IP-11 through IP-17. The effects of RegenOx™ will be monitored at surrounding monitoring wells to measure and track changes in general groundwater quality and reduction/rebound in petroleum hydrocarbon concentrations compared to background values.

Groundwater monitoring will be conducted before, during, and after the pilot test. Before the application of RegenOx™, a monitoring event will be conducted to establish baseline groundwater conditions. Groundwater samples will be collected following the procedures in Arctos's approved Interim Remedial Action Plan (IRAP) dated 21 March 2008 (Arctos, 2008). The following table summarizes the parameters and sampling frequency during monitoring to assess the effectiveness of the pilot test.

Monitoring Wells	Sampling Frequency	Parameter	Laboratory Analytical Method
On site MW-2, MW-7, MW-11, DW-1, DW-8, IP-1, IP-5, IP-10 *Off site* MW-6, MW-8, MW-9, MW-10, MW-12, DW-2, DW-3, DW-5, DW-6, DW-7, DW-9	Baseline, 2 to 4 weeks after each injection, and quarterly thereafter	*Field parameters* Temperature, conductivity, pH, and oxidation reduction potential (ORP)	NA[a]
		Dissolved petroleum hydrocarbons TPHg, benzene, toluene, ethylbenzene, xylenes, MTBE, di-isopropyl ether, ethyl tert-butyl ether, tert-amyl methyl ether, and TBA	U.S. Environmental Protection Agency (EPA) Method 8260B
		Water quality parameters Nitrate, sulfate	EPA Method 300.0
		Arsenic, chromium, total iron, manganese, and sodium	EPA Method 6010B
		Hexavalent chromium	EPA Method 7199
		Ferrous iron	Standard Method 3500-Fe D
		Carbon dioxide	Standard Method 4500C
		Methane	EPA Method RSK-175M
		Total alkalinity as calcium carbonate	Standard Method 2320B
		Total dissolved solids	Standard Method 2540C

[a] NA – Not applicable.

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A summary report will be submitted to ACEH after completing the expanded ISCO pilot test. The summary report will include the following:

- Evaluation of the monitoring results
- Estimate of mass removed for oxidant injected
- Recommendations for a continued monitoring schedule and analytical list.

Schedule

Arctos is requesting approval to conduct the RegenOx™ injection pilot test starting in May 2013. The pilot test will be completed by November 2013.

If you have questions or comments, please call Mike Purchase or Scott Stromberg at 510/525-2180.

Very truly yours,

ARCTOS ENVIRONMENTAL

REGISTERED PROFESSIONAL ENGINEER
MICHAEL P. PURCHASE
NO. C71230
Exp. 6/30/13
CIVIL
STATE OF CALIFORNIA

Scott Stromberg
Senior Staff Geologist

Michael P. Purchase, P.E.
Principal Engineer

Copy: Paula M. Sime – Tesoro Refining & Marketing Company LLC
Colleen Winey – Zone 7 Water Agency

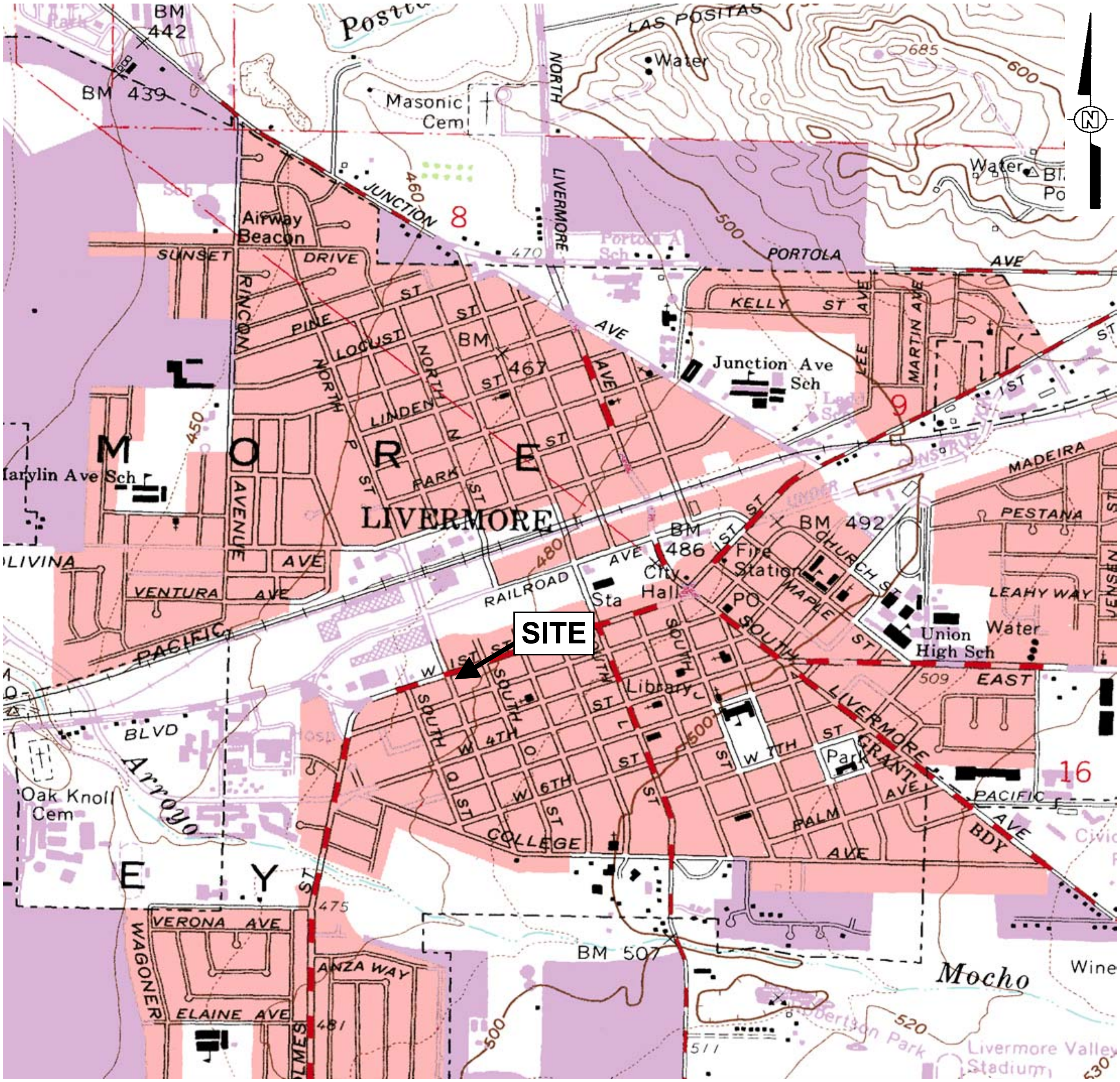
Attachments: Figure 1 – Site Location Map
Figure 2 – Site Plan with ISCO Pilot Test Radius of Influence
Figure 3A – IP-9 Hydrocarbon Concentration Graph
Figure 3B – DW-8 Hydrocarbon Concentration Graph
Figure 4 – Injection Well Construction Diagram
Figure 5 – Expanded ISCO Pilot Test Injection Wells
Attachment A – Well Installation Quality Assurance/Quality Control (QA/QC) Procedures

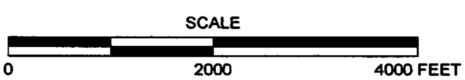
References

Arctos Environmental, 2012. "In Situ Chemical Oxidation (ISCO) Pilot Test Report, Tesoro Site No. 67076 (Former Beacon 3604), 1619 1st Street, Livermore, California," 16 March.

Arctos Environmental, 2008. "Interim Remedial Action Plan for Groundwater, 1619 1st Street, Livermore, California, Tesoro Station No. 67076, Former Beacon Station No. 3604, ACEH Case No. RO0434," 21 March.

Regenesis Bioremediation Products, 2007. "Principles of Chemical Oxidation Technology for the Remediation of Groundwater and Soil: RegenOx™ Design and Application Manual," 7 April.





REFERENCE

7.5 MINUTE USGS TOPOGRAPHIC MAP OF
LIVERMORE, CALIFORNIA QUADRANGLE
DATE: 1961, PHOTOREVISED 1980
SCALE = 1:24,000

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TESORO - LIVERMORE			
SITE LOCATION MAP			
PROJECT NO. 01LV	DRAWN BY MP	CHECKED BY MP	APPROVED BY JG
FILE NO. Site Map.xls		FIGURE 1	

Legend

MW-1 Groundwater Monitoring Well
DW-1 Deep Groundwater Monitoring Well
IP-1 Injection Well
IP-6 Angled Injection Well Screen Location
VW-3 Vapor Extraction Well (Not Connected to System)
TP-2 Monitoring Well/Vapor Extraction Well
MIP-1 January 2011 Membrane Interface Probe (MIP) Boring

Flame Ionization Detector (FID) Response Contours from January 2011 MIP Borings

1.0E6 - 5.0E6
>5.0E6

Injection Radius of Influence at 65 PSI

>pH 2 Increase During Injection of RegenOx™ Activator Complex

Oxidation Radius of Influence at 75 PSI

>50% Reduction in TPHg Concentration from First to Third RegenOx™ Injection

REVISION	NO.	BY	DATE	DESCRIPTION
	0	MY	2/15/12	Fourth Quarter 2011 Monitoring Report
1	1	MY	10/15/12	Work Plan for Expanded ISCO Pilot Test

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TESORO - LIVERMORE

SITE PLAN WITH ISCO PILOT TEST RADIUS OF INFLUENCE

PROJECT NO.	DRAWN BY	CHECKED BY	APPROVED BY
01LV	MY	MN	JPG

FILE NO. 01LV11B1301.DWG

FIGURE 2

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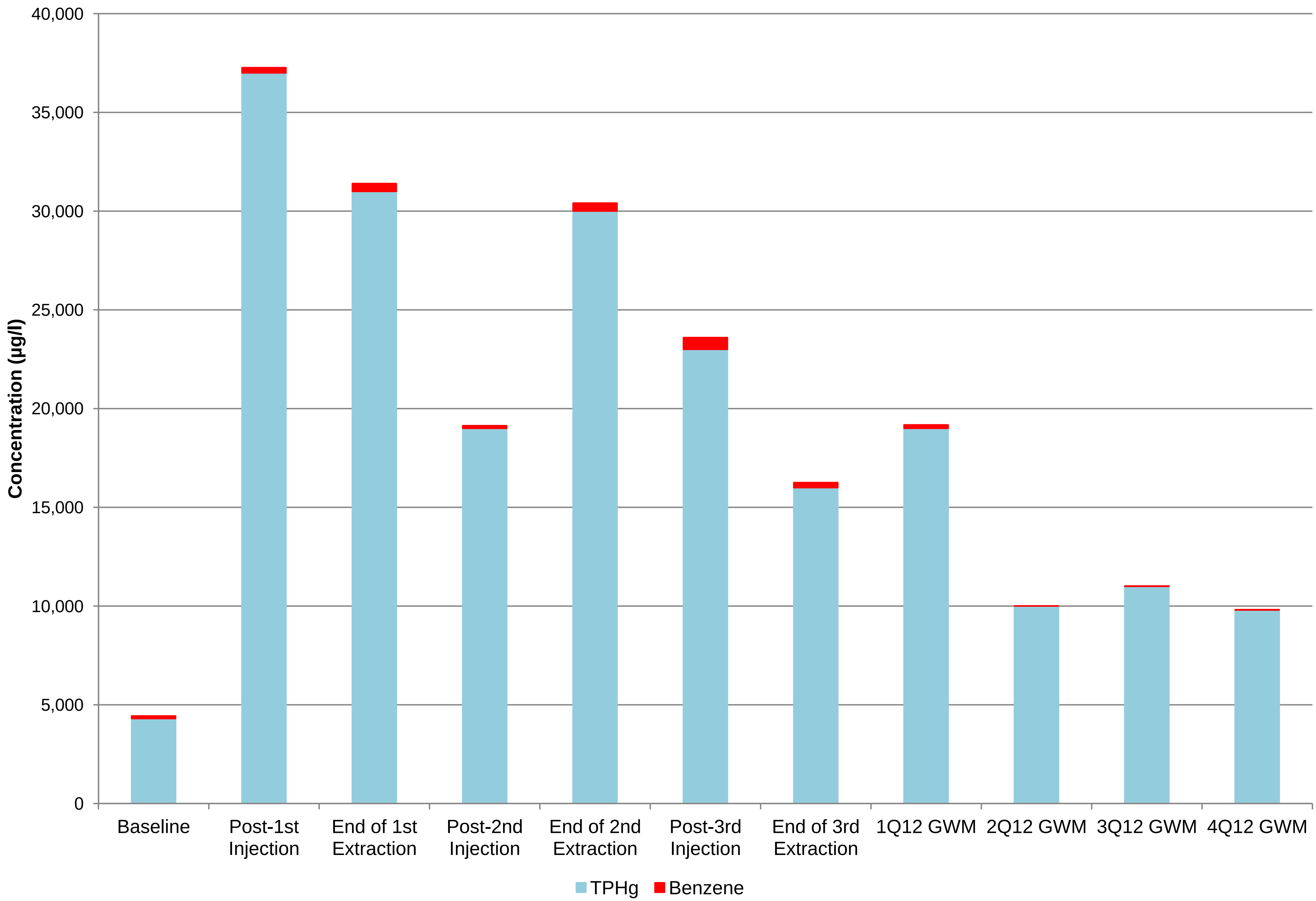
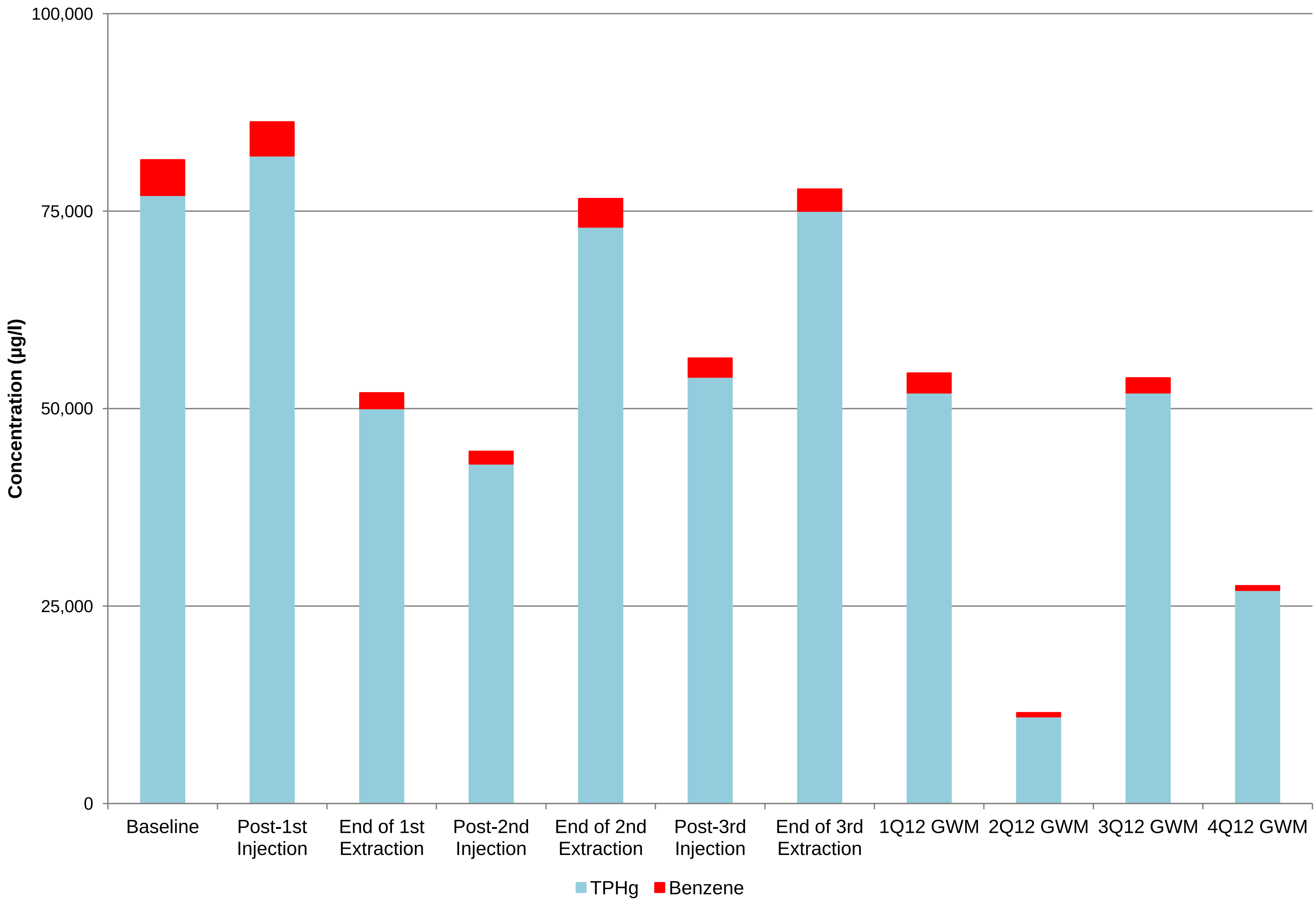
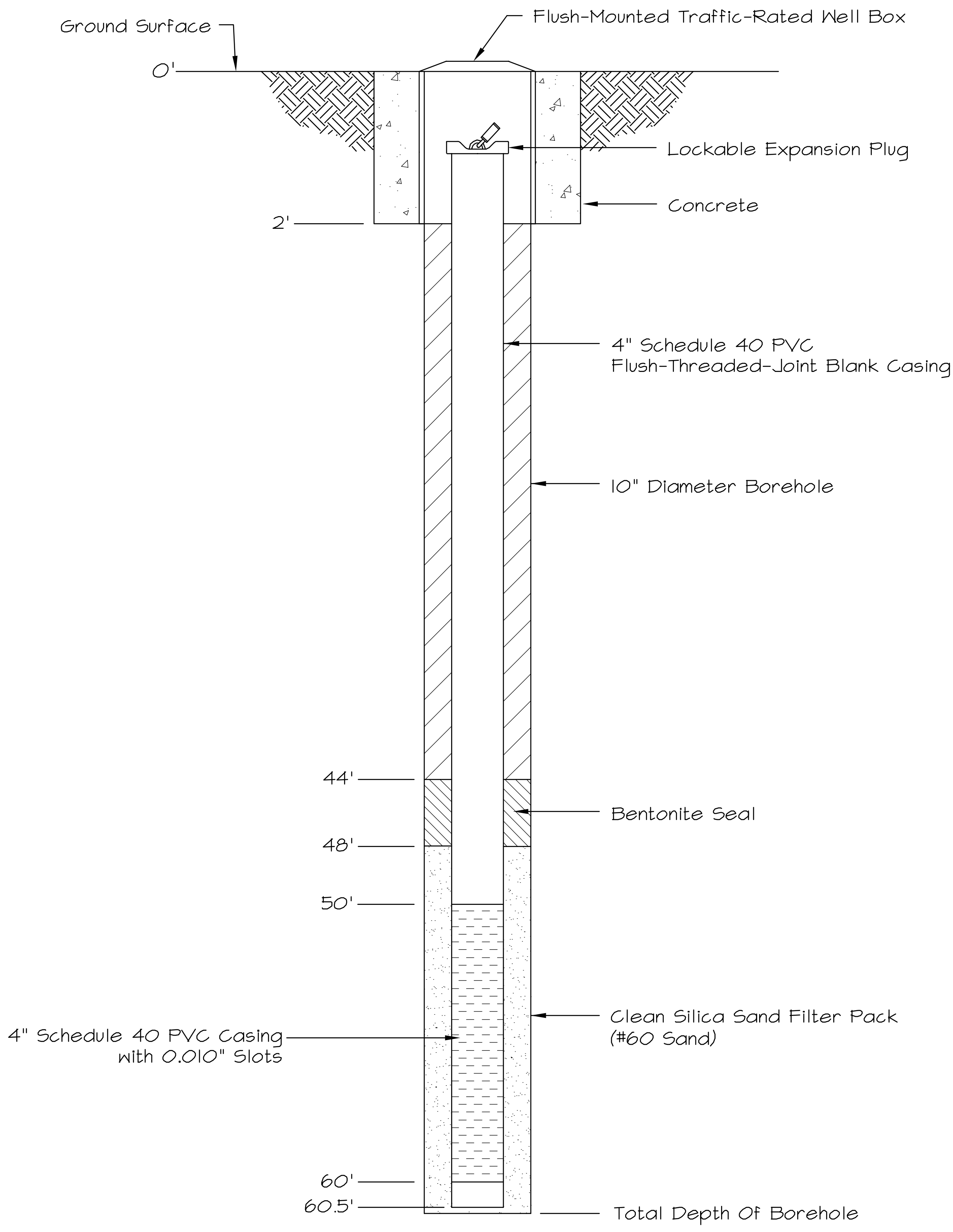


ARCTOS Arctos Environmental		Tesoro - Livermore	IP-9 HYDROCARBON CONCENTRATION GRAPH	Figure 3A
ISCO Graphs.xlsx	2/15/2013			



ARCTOS Arctos Environmental		Tesoro - Livermore	DW-8 HYDROCARBON CONCENTRATION GRAPH	Figure 3B
ISCO Graphs.xlsx	2/15/2013			



Notes:

1. Drawing not to scale.

2. Actual well construction may vary based on field investigation.

REVISION	NO.	BY	DATE	DESCRIPTION
0	0	MY	10/1/12	Work Plan for Expanded ISCO Pilot Test

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TESORO - LIVERMORE

INJECTION WELL
CONSTRUCTION DIAGRAM

PROJECT NO.	DRAWN BY	CHECKED BY	APPROVED BY
02HAW	MY	SS	MP

FILE NO. 01LV11B1500.dwg

FIGURE 4

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Legend

MW-7	Groundwater Monitoring Well
DW-1	Deep Groundwater Monitoring Well
IP-1	Injection Well
IP-6	Angled Injection Well Screen
VW-2	Vapor Extraction Well
TP-2	Monitoring Well/Vapor Extraction Well
(ND<50/110)	3Q12/4Q12 Total Petroleum Hydrocarbons as Gasoline (TPHg) Results in μg/L
1,000	TPHg Concentration Contour (μg/L), Queried Where Uncertain
ND	Not Detected
NS	Not Sampled
DB-8 [ND]	Soil Boring with 55-Foot Grab Groundwater Sample TPHg Results in μg/L
IP-2	Expanded ISCO Pilot Test Onsite Injection Well
IP-11	Proposed Offsite Injection Well

0 30' 60'
SCALE

REVISION	NO.	BY	DATE	DESCRIPTION
	0	MY	10/1/12	Work Plan for Expanded ISCO Pilot Test
	1	MY	2/19/13	Work Plan for Expanded ISCO Pilot Test

ARCTOS ENVIRONMENTAL

TESORO - LIVERMORE

EXPANDED ISCO PILOT TEST
INJECTION WELLS

PROJECT NO.	DRAWN BY	CHECKED BY	APPROVED BY
01LV	MY	MP	JPG

FILE NO. 01LV11B1601.DWG — FIGURE 5

2/20/2013 11:42AM 01LV11B1601.dwg

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ATTACHMENT A

WELL INSTALLATION QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PROCEDURES

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ATTACHMENT A
WELL INSTALLATION QA/QC PROCEDURES

Health and Safety

Arctos will modify the site-specific Health and Safety Plan (HSP) for the field program outlined in this work plan. The HSP presents procedures for personnel and equipment safety, medical surveillance, personal protection, air-quality monitoring, exposure control, emergency response procedures, and general work practices.

Before beginning work at the site, a site safety meeting will be conducted. Field personnel will review the HSP and sign the accompanying acknowledgment form. Field personnel will be required to comply with the HSP throughout performance of site assessment activities.

Based on the site history and potential chemicals of concern, field activities will be initiated in Level D personal protective equipment (PPE). During field activities, the breathing zone of field personnel will be monitored using a field photoionization detector (PID). If breathing zone PID readings indicate elevated levels of organic vapors, PPE will be upgraded accordingly. Breathing zone readings will be recorded on the boring log.

The following sections provide a description of Arctos's proposed drilling, soil sampling, and well installation program.

Drilling Procedures

Before initiating drilling activities, Arctos will mark the well locations and contact Underground Service Alert to clear the area of subsurface lines and utilities. Arctos will also obtain boring and well permits from Zone 7 Water Agency.

The soil borings for the installation of the injection wells will be drilled with 10-inch-diameter hollow-stem continuous-flight augers. Soil samples will not be collected.

Injection Well Installation

Arctos personnel will oversee well construction and installation. Each injection well will be installed with a casing with total depth of approximately 60.5 feet below grade and screened from 50 to 60 feet below grade as shown on the well construction diagram (Figure 4). Field personnel may adjust actual well depth and screen placement as required by the field conditions encountered.

The wells will be constructed using new 4-inch-diameter, flush-threaded, Schedule 40 polyvinyl chloride casings. In order to decrease the amount of fine sediment buildup in the casings due to injection activities, Monterey #60 sand will be used as filter pack. The annular space around the wells will be filled with filter pack to about 2 feet above the top of the screens. A drawing showing the as-built well construction will be included on the boring/well installation log.

An approximately 4-foot-thick layer of bentonite will be placed above the well screen filter packs to provide an annular seal. The wells will be surged before placing the annular seal to allow for filter pack settlement. After placement, the seals will be hydrated with potable water. The remainder of the annulus to near ground surface will be filled with cement. Locking caps and traffic-rated covers will be installed at the surface.

The wells will be developed at least 72 hours after installation by surging and bailing to remove fines from the filter packs and well screens to reduce sediment in the groundwater. Development will be considered complete when at least 5 to 10 casing volumes are removed or until the pH, temperature, and specific conductivity measurements of the evacuated groundwater stabilize to within 10 percent of the previous readings.

General Field QA/QC Procedures

Equipment Decontamination Procedures
Field equipment will be decontaminated between borings using the following procedures:

1. Rinse with water using a brush to remove soil and mud.
2. Wash with non-phosphate detergent and water using a brush.
3. Rinse with deionized or distilled water.
4. Rinse again with deionized or distilled water.
5. Air dry.

Personal Decontamination Procedures
At a minimum, field personnel will follow the following decontamination procedures:

1. Wear appropriate gloves.
2. Wash hands thoroughly with soap and water.
3. Avoid unnecessary contact with groundwater.

The site HSP will be reviewed for site-specific personal decontamination procedures.

Wastewater and Solid Waste Storage and Disposal
Small volumes of used wash and rinse solutions will be collected during field work and transported to a central decontamination area. This wastewater will be stored in a holding tank. The Project Manager will determine the appropriate disposal method for this wastewater.

Solid wastes such as used personal protective equipment, paper towels, trash bags, and any other solid debris will be collected for disposal. If the sampled groundwater is not a hazardous waste, the solid wastes will be disposed with the onsite trash.

Field Investigation Documentation Procedures
Field personnel will follow documentation procedures developed for site investigation work. The procedures serve to (1) provide a record of the activities performed in the field and (2) permit identification of samples and tracking of their status in the field, during shipment, and at the laboratory. All documentation will be recorded with waterproof ink. Groundwater sampling activities will be documented on daily field reports and on well purge and sample logs.

Health and Safety
Arctos will use a site-specific HSP with procedures that will be followed by field personnel for equipment safety, medical surveillance, personal protection, air quality monitoring, exposure control, emergency response, and general work practices during field activities. Before beginning work at the site, a site safety meeting will be conducted. Field personnel will review the HSP and sign the accompanying acknowledgment form before initiating field activities. Field personnel are required to comply with the HSP throughout performance of site assessment activities.