ARCO Products Company
Environmental Engineering
2155 South Bascom Avenue, Suite 202
Campbell, California 95008

Date: June 19, 1995

Re: ARCO Station # 2111

" I declare, that to the best of my knowledge at the present time, that the information and/or recommendations contained in the attached proposal or report are true and correct."

Submitted by:

Michael R. Whelan

Michael R. Whelan
Environmental Engineer

EMCON
1921 Ringwood Avenue • San Jose, California 95131-1721 • (408) 453-7300 • Fax (408) 437-9526

June 19, 1995
Project 0805-127.01

Mr. Michael Whelan
ARCO Products Company
P.O. Box 5811
San Mateo, California 94402

Re: Workplan for on- and off-site groundwater characterization, ARCO service station 2111, ~~Oakland,~~ California
San Leandro

Dear Mr. Whelan:

EMCON is pleased to submit this workplan for on- and off-site soil and groundwater investigation at ARCO Products Company (ARCO) service station 2111, 1156 Davis Street, San Leandro, California (Figure 1). Three phases of soil and groundwater investigation have been proposed as part of the site assessment. This workplan describes activities that will be performed during the first two phases. The initial phase (Phase A) will characterize soil and groundwater near the former waste-oil underground storage tank (UST) (Figure 2). If gasoline is detected in Phase A wells, the second phase (Phase B), will be implemented to characterize soil and groundwater in the vicinity of the gasoline USTs, dispenser islands, and downgradient off site. The final phase (additional on- and additional off-site groundwater characterization) will be described in a separate workplan, if warranted. EMCON will submit each workplan to the Alameda County Health Care Services Agency (ACHCSA) for review before beginning field activities.

BACKGROUND

In August 1993, a hydraulic hoist from one of the station service bays was removed. Geostrategies, Inc., (GSI) collected four soil samples from the bottom of the excavation. Total extractable petroleum hydrocarbons (TEPH) were detected in the soil samples at concentrations up to 27,000 milligrams per kilogram (mg/kg). In March 1994, GSI drilled and sampled two soil borings (B-1 and B-2) on the northwestern and northeastern sides of the former hydraulic hoist excavation. Soil samples from the borings detected hydraulic oil up to 11 mg/kg.

In August 1994, one 280-gallon waste oil UST was removed from the site. Several holes were observed on the top portion of the waste oil UST. Total petroleum hydrocarbons as motor oil, diesel (TPHD), gasoline (TPHG), and total recoverable petroleum hydrocarbons

(TRPH) were detected in the soil samples from the bottom of the excavation. Several metals were also detected at low concentrations. In September 1994, a new 600-gallon waste oil UST was installed in the same location as the former UST.

SCOPE OF WORK

EMCON proposes to drill a series of soil borings during phases A and B. During Phase A, four on-site borings will be drilled and converted to groundwater monitoring wells. During Phase B, one on-site and three off-site groundwater monitoring wells, four soil-vapor extraction (SVE) wells, and two air-sparge (AS) wells will be installed. The off-site groundwater monitoring wells will be located and installed following establishment of a groundwater flow direction based on four quarters of monitoring. The AS and SVE wells will be used in future testing, if needed, to determine whether air-sparging and vapor extraction are feasible remedial alternatives at the site.

Task 1. Prefield Activities: Workplan Preparation, Permitting, and Project Startup

Before beginning field activities, EMCON will submit this workplan to the ACHCSA. Upon gaining regulatory approval of the workplan, EMCON will obtain drilling permits from the Alameda County Flood Control and Water Conservation District (ACFCWCD). In addition, EMCON will obtain encroachment permits from the City of Oakland and the State of California Department of Transportation (Caltrans) for any off-site wells that may need to be installed in the public right-of-way. A health and safety plan will be prepared before beginning field activities to ensure safe work practices at the site.

EMCON will contract a private underground utility locating service to provide guidance in finding unobstructed locations for the off-site groundwater monitoring wells. In addition, we will notify Underground Services Alert. This task includes liaison with regulatory agencies, project planning, and scheduling.

Task 2. Field Investigation: Drilling, Soil Sampling, Well Installation, and Topographical Well Survey

EMCON will secure a licensed subcontractor to drill and install the wells. Procedures for drilling exploratory borings, installing groundwater monitoring wells, and sampling soil and groundwater will follow local guidelines, and are described in Appendix A, "Field and Laboratory Procedures."

Phase A: Install Four On-Site Groundwater Monitoring Wells. Depth to groundwater at the site has been reported to be approximately 19 feet below grade (fbg). During this initial phase of investigation, four on-site borings will be drilled and completed as groundwater monitoring wells using 8-inch-diameter, hollow-stem auger drilling equipment. The borings will be drilled and sampled to a depth of approximately 40 fbg and completed as groundwater monitoring wells using 4-inch-diameter polyvinylchloride (PVC) casing and screen. The proposed drilling locations are shown in Figure 2.

Phase B: Install Additional On- And Off-Site Monitoring Wells, Vapor Extraction Wells, and Air-Sparge Wells. The second phase of investigation will include installing six on-and off-site borings, which will be drilled and sampled to approximately 40 fbg. The borings will be completed as either groundwater monitoring wells or AS wells using 8- or 10-inch-diameter, hollow-stem auger drilling equipment. The on-site wells will be completed using 4-inch diameter PVC screen and casing. The off-site groundwater and AS wells will be completed using 2-inch diameter PVC screen and casing. Also during Phase B, four additional onsite borings will be drilled to approximately 20 fbg and completed as 4-inch-diameter SVE wells. The proposed drilling locations are shown in Figure 2.

Soil Sampling. Soil samples for lithologic description will be collected from the borings at 5-foot-depth intervals. Representative soil samples will be collected from the borings and screened for petroleum-hydrocarbon content with a portable photo-ionization detector (PID).

Drill cuttings will be temporarily stockpiled on site and covered with plastic sheeting. A composite soil sample will be collected from below the pile surface and submitted for laboratory analysis. Once the cuttings are characterized, EMCON will make recommendations for appropriate disposal.

Topographic Well Survey. The new groundwater monitoring and AS wells will be surveyed for elevation (relative to mean sea level) and location using a City of Oakland benchmark. The SVE wells will be surveyed for location.

Task 3. Well Development and Groundwater Sampling

After installation, EMCON will develop groundwater monitoring and AS wells in accordance with local guidelines. Depth to water will be measured and the well will be checked for floating product with a clear Teflon® bailer. If there is floating product in the well, its thickness will be measured with an interface probe. If no product is observed, the well will be sampled as described in Appendix A.

Task 4. Laboratory Analysis of Soil and Groundwater

Phase A: Investigation. Selected soil samples and the groundwater sample from the well nearest the waste oil UST and the stockpile sample will be submitted to a state-certified laboratory and analyzed for TPHG; TPHD; benzene, toluene, ethylbenzene, and total xylenes (BTEX); oil and grease (O&G); volatile organic compounds (VOCs); and the metals cadmium, chromium, lead, zinc, and nickel. Selected soil samples and the groundwater samples from the three remaining wells will be analyzed for TPHG and BTEX only.

Soil and groundwater samples will be prepared for analysis by U.S. Environmental Protection Agency (USEPA) method 5030 (purge and trap). Soil will be analyzed for TPHG by the methods accepted by the Department of Toxic Substances Control (DTSC) and referenced in the *Leaking Underground Fuel Tank (LUFT) Field Manual* (State Water Resources Control Board, October 1989). Samples will be analyzed for BTEX by USEPA method 8020, described in *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (USEPA, SW-846, November 1986, 3rd edition). These methods are recommended for use at petroleum-hydrocarbon-impacted sites in the *Tri-Regional Board Staff Recommendations for Preliminary Evaluation and Investigation of Underground Tank Sites* (August 10, 1990). Laboratory procedures are detailed in Appendix A. A sieve analysis will be performed on one sample from the site by American Society of Tests and Measures (ASTM) method D422.

Phase B: Investigation. Selected soil samples from the AS, SVE, and well borings and the groundwater samples from the wells will be submitted to a state-certified laboratory and analyzed for TPHG and BTEX. Additional waste oil related analyses will be performed based on the findings of the Phase A investigation.

Task 5. Data Evaluation and Report Preparation

Upon completion of field and laboratory activities, EMCON will prepare **one report for all phases of work**, which will include the following:

- Results of an off-site source identification survey
- Results of a one-half mile radius well survey
- Description of drilling, well installation, sampling, and analytical techniques

- Exploratory boring logs, well construction details, and a site map
- Two geologic cross sections
- One groundwater contour map with analytical data
- Certified analytical reports, water sample field data sheets, and chain-of-custody documentation
- Discussion of the findings and conclusions

SCHEDULE

Figure 3 breaks down the project schedule by weeks for completion of each task. This schedule represents EMCON's best judgment, but may vary depending on conditions encountered, ease of access, and other circumstances beyond EMCON's control. EMCON will initiate the project upon receiving ARCO's authorization to proceed and approval of the workplan by ACHCSA. If this schedule needs revision, the ACHCSA will be notified of any changes.

Please call if you have questions.

Sincerely,

EMCON

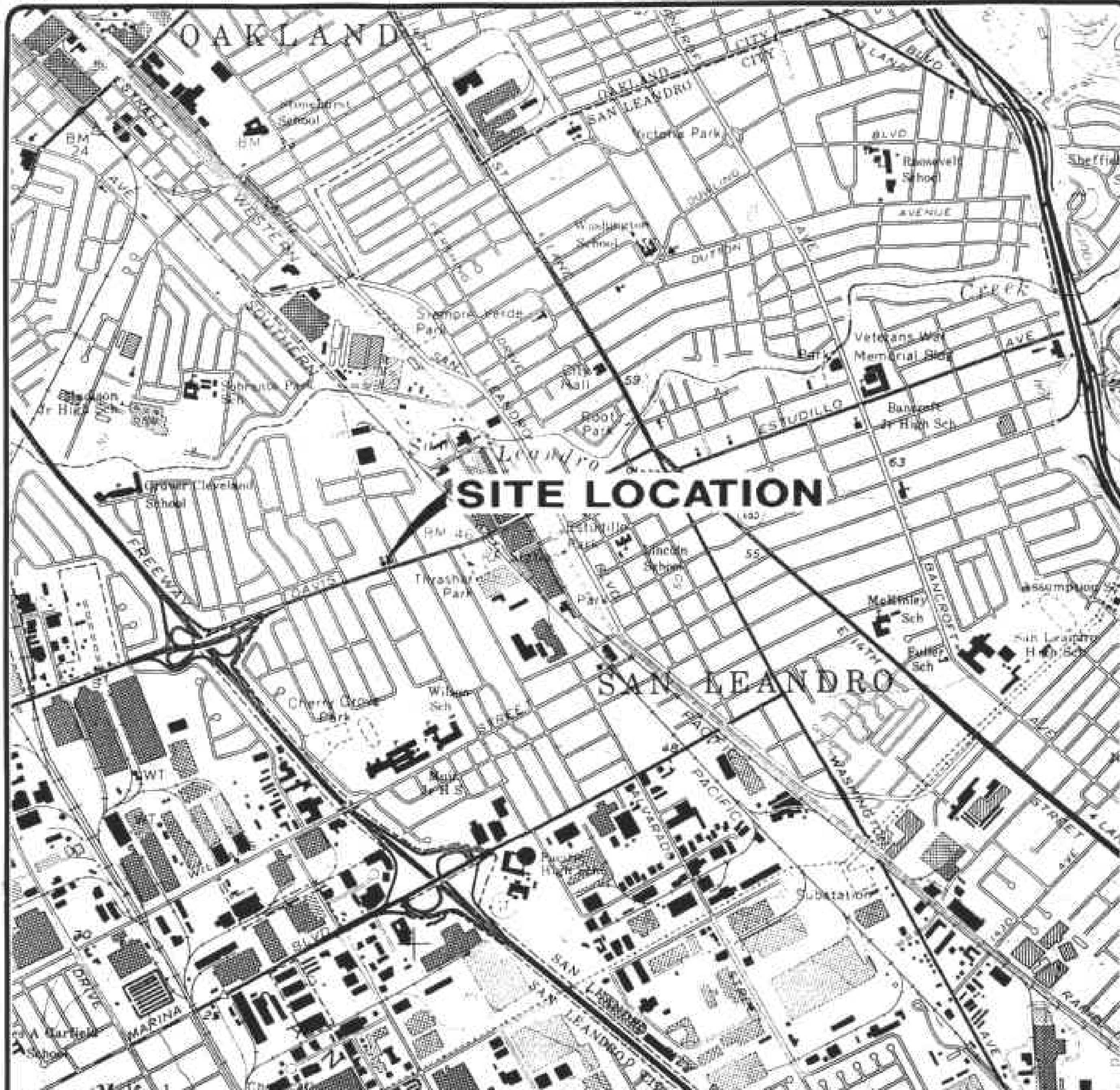
Peter T. Christianson
Project Geologist

John C. Young
Project Manager

Attachments: Figure 1 - Site Location
Figure 2 - Proposed Well Locations
Figure 3 - Project Schedule
Appendix A - Field and Laboratory Procedures

cc: Scott Seery - ACHCSA
Kevin Graves - RWQCB

152753



Base map from USGS 7.5' Quad. Map:
San Leandro, California. (PR 1980).

Scale : 0 2000 4000 Feet

N

EMCON Associates

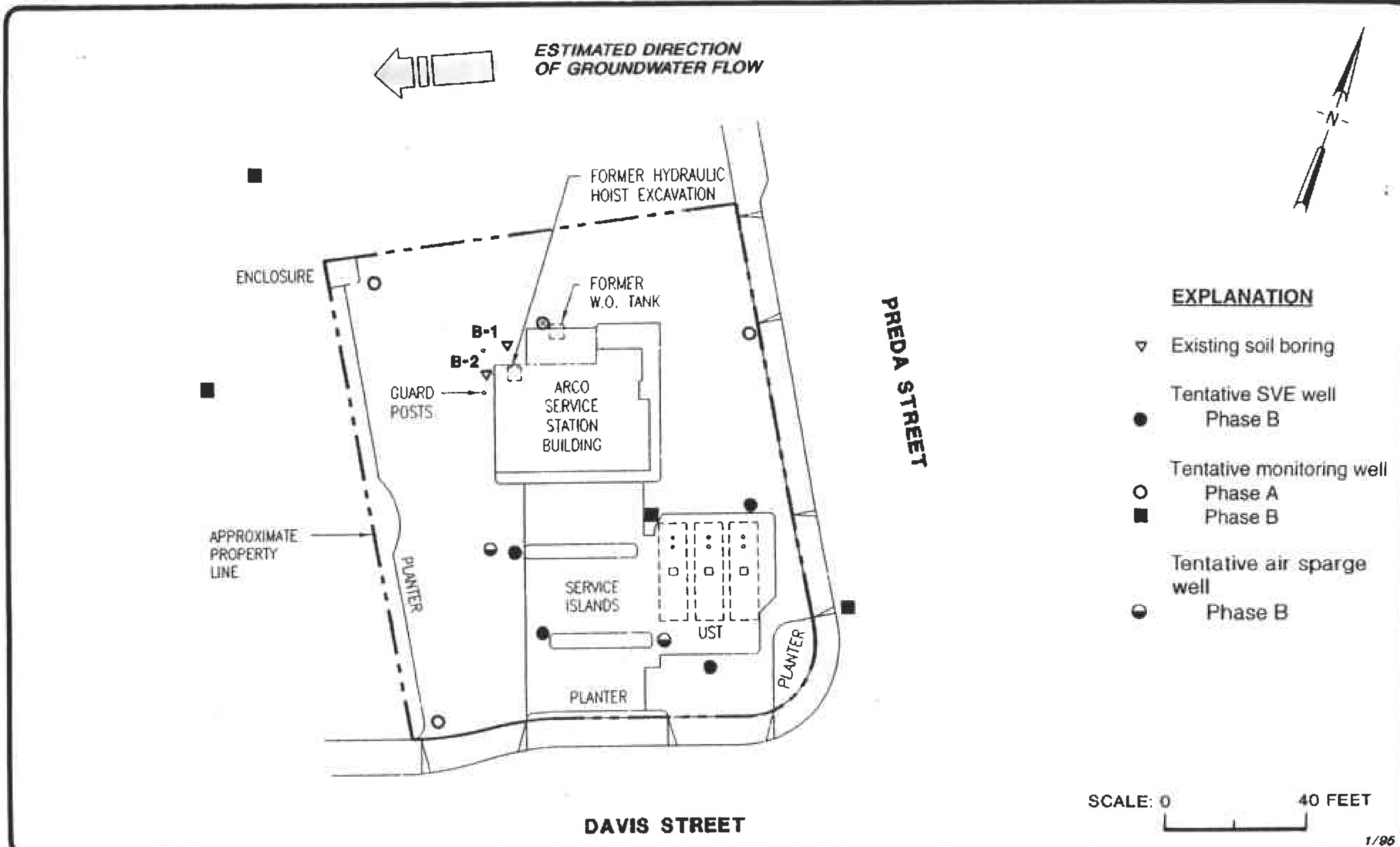
ARCO PRODUCTS COMPANY
SERVICE STATION 2111, 1156 DAVIS STREET
QUARTERLY GROUNDWATER MONITORING
SAN LEANDRO, CALIFORNIA

SITE LOCATION

FIGURE 1

PROJECT NO.
805-127.01

155812



EMCON

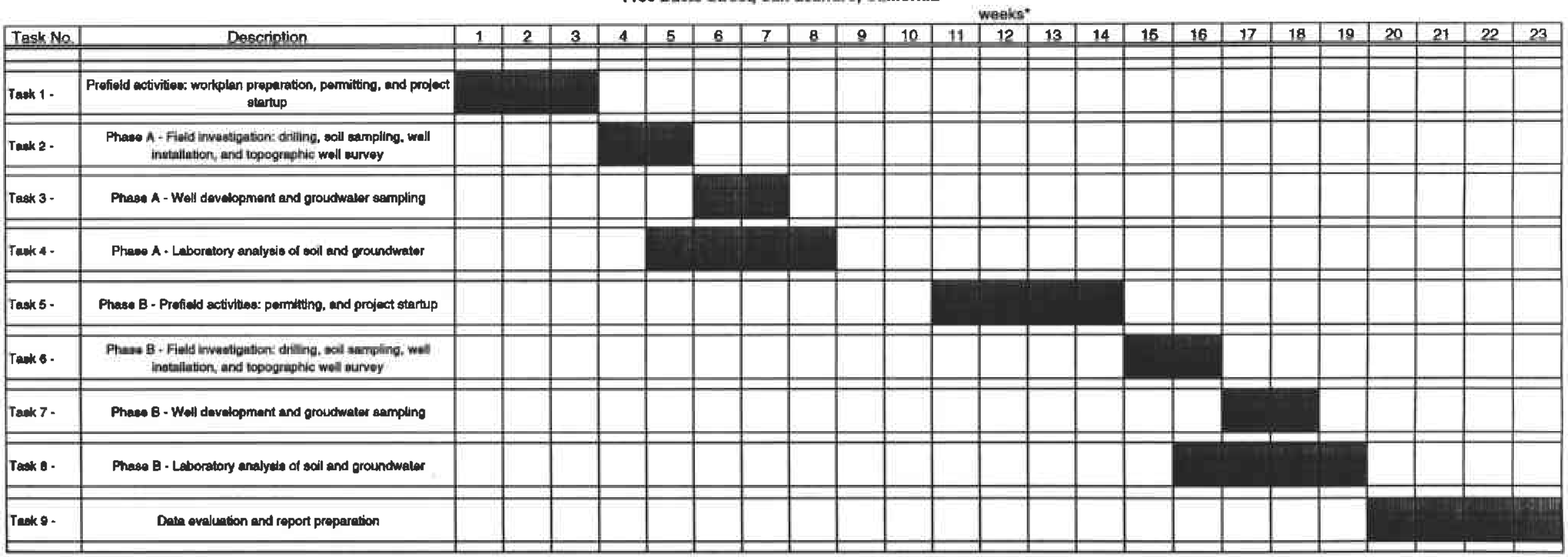
ARCO PRODUCTS COMPANY
SERVICE STATION 2111, 1156 DAVIS STREET
QUARTERLY GROUNDWATER MONITORING
SAN LEANDRO, CALIFORNIA

PROPOSED WELL LOCATIONS

FIGURE
2

PROJECT NO.
805-127.01

FIGURE 3
Proposed Project Schedule
ARCO Service Station 2111
1156 Davis Street, San Leandro, California



* Tasks are in weeks following review of workplan and receipt of approval letter from ACHCSA

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APPENDIX A

FIELD AND LABORATORY PROCEDURES

EXPLORATORY BORING AND SOIL SAMPLING

EXPLORATORY BORING AND SOIL SAMPLING

General procedures for drilling and sampling exploratory borings are discussed below.

Before a drilling rig is mobilized, access issues with private property owners are resolved and an underground utility locating service contracted to investigate proposed boring sites and arrange for site visits by public and private utility companies. The utility companies locate their installations with the aid of maps and the locating service verifies and marks the locations. Final boring locations are determined after these assessments are made. To confirm that no subsurface utilities will obstruct drilling, field personnel excavate the upper four feet of soil from each boring location with a posthole digger.

For sites characterized by relatively shallow (less than 100-feet-deep) groundwater, exploratory borings are drilled with 8- to 12-inch hollow-stem auger drilling equipment. The augers are steam-cleaned to prevent possible cross-contamination between boreholes. Where chemical analysis of samples is indicated, sampling equipment is also steam-cleaned between each sampling event.

Soil samples are collected at depths no farther apart than 5 feet using a modified California split-spoon sampler which is fitted with stainless-steel liners. As the sampler is driven into undisturbed soil ahead of the auger tip, soil accumulates in the liners. The sampler is retrieved from the ground and the liners are removed, sealed with Teflon® tape and polypropylene end-caps, and stored on dry ice pending selection for analysis and transport to the laboratory. Chain-of-custody documentation accompanies samples to the laboratory.

Field characterization of contamination is based on visual and olfactory observations and on the results of a headspace analysis, in which a soil sample is removed from the liner, sealed in a mason jar, and exposed to direct sunlight for 10 to 15 minutes. The jar is shaken to release volatile hydrocarbons into the headspace between the soil and the jar cover. The headspace is probed by a tube attached to a portable photoionization detector (PID), by which volatile hydrocarbon content is measured. A minimum of one sample, typically that having the highest PID reading from a boring, is submitted for chemical analysis.

A detailed boring log is maintained for each exploratory boring from auger-return material and representative soil samples. Soil is logged in the field according to the Unified Soil Classification System, and the logging supervised by a state-registered geologist. Borings not completed as wells are backfilled with a neat-cement slurry by the tremie method.

Drill cuttings are stockpiled on site and covered with plastic sheeting until the results of chemical analyses are known. The petroleum hydrocarbon content of the stockpile is determined by analysis of a composite formed from samples collected from the subsurface of the stockpile. Recommendations for disposal of the cuttings are made on the basis of the analysis, and the cuttings are disposed of by the client.

Sampling and Analysis Procedures

EMCON's sampling and analysis procedures for soils provide consistent and reproducible results and ensure that the objectives of the sampling program are met.

The following publications were used as guidelines for developing these procedures:

- *Leaking Underground Fuel Tank (LUFT) Field Manual* (State Water Resources Control Board, May 1988, revised October 1989)

- *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA, SW-846, 3rd edition, November 1986)

Sample Handling

Sample containers are labeled immediately after sample collection, and are kept in ice chests with dry ice which is replaced daily until the containers are received at the laboratory. As a sample is collected, it is logged on the chain-of-custody record that accompanies samples to the laboratory.

Samples are transferred from the site to EMCON's laboratory by EMCON field personnel. Laboratory personnel assign a different number to each sample container and the number is recorded on the chain-of-custody record and used to identify the sample on all subsequent internal chain-of-custody and analytical records. Within 24 hours of sample receipt, samples are routinely shipped from EMCON to laboratories performing the selected analyses. EMCON's laboratory manager ensures that the holding times for requested analyses are not exceeded.

Sample Documentation

The procedures for sample handling provide chain-of-custody control from collection through storage. Sample documentation includes the following:

- Labels for identifying individual samples

- Chain-of-custody records for documenting possession and transfer of samples

- Laboratory analysis requests for documenting analyses to be performed

Labels

Sample labels contain the following information:

- Project number
- Sample number (i.e., boring designation)
- Sampler's initials
- Date and time of collection

Sampling and Analysis Chain-of-Custody Record

The sampling and analysis chain-of-custody record, initiated at the time of sampling, includes the boring number, sample type, analytical request, date of sampling, the name of the sampler, and other information deemed pertinent. The sampler signs his name and records the date and time on the record sheet when transferring the samples to another person. Custody transfers are recorded for every sample; for example, if samples are split and sent to more than one laboratory, a record sheet accompanies each sample. The number of custodians in the chain of possession is kept to a minimum. A copy of the sampling and analysis chain-of-custody record is returned to EMCON with the analytical results.

Soil Analysis Request

The Soil Analysis Request or the purchase order that accompanies samples to the laboratory serves as official communication of the particular analysis(es) required for each sample and is evidence that the chain of custody is complete.

At a minimum, the soil analysis request includes the following:

- Date submitted
- Specific analytical parameters
- Boring number
- Sample source

Analytical Methods

Samples collected as part of the proposed sampling programs are analyzed by accepted analytical procedures. The same publications cited under "Sampling and Analysis Procedures are the primary references.

- *Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods* (EPA, SW-846, 3rd edition, November 1986)

- *Leaking Underground Fuel Tank (LUFT) Manual*, State Water Resources Control Board, State of California Leaking Underground Fuel Tank Task Force, May 1988, revised October 1989

The laboratories performing the analyses are certified by the Department of Health Services (DHS) for hazardous waste testing.

Quality Control

Quality assurance measures confirm the integrity of field and laboratory data generated during the monitoring program. Procedures for assessing data quality are discussed in this section. Field and laboratory quality assurance data are evaluated in the technical reports.

Laboratory Quality Assurance

Laboratory quality assurance includes procedures required under the DHS Hazardous Waste Testing Program. For sites where Columbia Analytical Services conducts the chemical tests, quality assurance procedures include the reporting of surrogate recoveries, matrix spike recoveries, and matrix spike duplicates (or duplicate) results.

Method blanks are analyzed daily for the purpose of assessing the effect of the laboratory environment on analytical results, and are performed for each constituent analyzed.

Samples to be analyzed for organic constituents contain surrogate spike compounds. Surrogate recoveries are used to determine whether analytical instruments are operating within limits. Surrogate recoveries are compared with control limits established and updated by the laboratory on the basis of its historical operation.

Matrix spikes are analyzed at a frequency of approximately 10 percent. Matrix spike results are evaluated to determine whether the sample matrix is interfering with the laboratory analysis, and provide a measure of the accuracy of the analytical data. Matrix spike recoveries are compared with control limits established and updated by the laboratory on the basis of its historical operation.

Laboratory duplicates are analyzed at a frequency of approximately 10 percent. Spike duplicate results are evaluated to determine the reproducibility (precision) of the analytical method. Reproducibility values are compared with control limits established and updated by the laboratory on the basis of its historical operation.

Laboratory QC data included with the analytical results are method blanks, surrogate spike recoveries (for organic parameters only), matrix spike recoveries, and matrix spike duplicates.

When other state-certified laboratories conduct the testing, each laboratory will follow its own internal QA/QC program.

Vadose-Zone Well Installation

VADOSE ZONE WELL INSTALLATION

General procedures for installing vadose-zone wells are discussed below.

Exploratory borings to be converted to vadose-zone wells are drilled no deeper than first-encountered groundwater. Borings are converted to vadose-zone monitoring or soil-vapor extraction wells with 2- or 4-inch-diameter, flush-threaded, polyvinyl chloride (PVC) casing having a screen section of factory-perforated 0.060-inch slots.

Boring depths and screen lengths are established from geologic profiles and based on field screening of volatile hydrocarbons with a PID. The annulus is filled to approximately 2 feet above the screen with a gravel pack consisting of 3/8-inch-diameter pea gravel. The gravel pack is covered with a layer of bentonite a maximum of 1 foot thick, and the remaining annular space is sealed to the surface with a sanitary seal of neat cement in compliance with regulatory guidelines. The well heads are completed with traffic-proof vault boxes set in concrete to protect the well and are capped with water-tight locking devices. Well locations are surveyed and top-of-casing elevations measured to the nearest 0.01 foot. Detailed well completion diagrams are prepared. Water well driller's reports containing geological data, well locations, and construction details are submitted to the California Department of Water Resources.

GROUNDWATER WELL INSTALLATION

GROUNDWATER WELL INSTALLATION PROCEDURES

Well permits are obtained from local and state regulatory agencies preparatory to drilling exploratory borings that will be completed as groundwater wells.

The exploratory borings to be converted to verification monitoring wells or extraction wells are drilled no deeper than 20 feet into saturated soil, or until a layer at least 3 feet thick of relatively impermeable clayey material (aquitard) is encountered, whichever comes first. If the aquitard is sufficiently thick, it is backfilled with bentonite through a tremie pipe. Borings are converted to verification monitoring wells with 2-inch-diameter, flush-threaded, polyvinyl chloride (PVC) casing with a screened section of machine-perforated, 0.020-inch slots. For extraction wells, the boring is reamed with a 12-inch-diameter auger, and 6-inch-diameter casing is installed inside the enlarged borehole.

Boring depths and screen lengths are determined from geologic profiles of the boring. Screened sections of casing extend through the saturated interval as much as 5 feet above first-encountered groundwater. A well is completed by the placement of various materials in the annular space around the casing. The annulus is filled to approximately 2 feet above the screen with a sand pack of a grain size predetermined by sieve analysis of the soil. The sand pack is covered with a bentonite plug at least 1-foot thick, and the remaining annular space is sealed within 1 foot of the surface with a sanitary seal of neat cement in compliance with regulatory guidelines. The wells are completed to ground surface with PVC casing. The well heads are protected with traffic-proof vault boxes set in concrete and capped with water-tight locking devices. Well locations are surveyed and top-of-casing elevations measured to the nearest 0.01 foot. Detailed well completion diagrams are prepared. Water well drillers' reports containing geological data, well locations and construction details are submitted to the California Department of Water Resources.

GROUNDWATER SAMPLING AND ANALYSIS

GROUNDWATER SAMPLING AND ANALYSIS

EMCON's sampling and analysis procedures for water-quality monitoring are designed to provide consistent and reproducible results and ensure that the objectives of the monitoring program are met.

The following publications were used as guidelines for developing these procedures:

- Procedures Manual for Ground-Water Monitoring at Solid Waste Disposal Facilities (EPA-530/SW-611, August 1977)
- RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (OSWER 9950.1, September 1986)
- Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (EPA SW-846, 3rd edition, November 1986)
- Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA-600/4-82-057, July 1982)
- Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79-020, revised March 1983)

Sample Collection

Sample collection procedures include equipment cleaning, well purging, and water-level, floating-hydrocarbon thickness, and total well-depth measuring.

Equipment Cleaning

The bottles, caps, and septa used to hold samples for volatile and semivolatile organic analysis are triple-rinsed with high-purity deionized water and dried overnight, the bottles at 200°C, the caps and septa at 60°C. The bottles, caps, and septa are protected from solvent contact between drying and use at the site.

The plastic bottles and caps used to hold samples for metals analysis are soaked overnight in a 1 percent nitric acid solution, triple-rinsed with deionized water, and air-dried.

Equipment for sampling groundwater (i.e., pumps, bailers, etc.) is first disassembled, cleaned thoroughly with diluted detergent, and steam-rinsed with deionized water. Parts such as plastic pump valves and bladders, which may absorb contaminants, are cleaned before each use or replaced. The inside of the positive-displacement (bladder) pump tubing is cleaned overnight with a low-flow, inert air source heated to 120°C.

A pump blank made of organic-free water is pumped through the clean bladder-pump assembly, and the resulting effluent is sampled and analyzed by EPA Method 601 or 602. Analytical results must be below the method reporting limit for each constituent analyzed before the pump is used at the site.

The surfaces of well equipment that comes in contact with groundwater during well purging and sampling are steam-cleaned with deionized water between each use.

Water-Level, Floating Hydrocarbon, and Total Well-Depth Measurements

Water levels, floating-hydrocarbon thickness, and total well-depth are measured before wells are purged and sampled. An electric sounder, a bottom-filling, clear Teflon bailer, or an oil-water interface probe is used to make these measurements. The electric sounder is a transistorized instrument with a reel-mounted, two-conductor, coaxial cable which connects the control panel to the sensor. The cable is stamped in 1-foot increments. The sensor is lowered into the well and as it makes contact with the water, which acts as an electrolyte, a low-current circuit is completed. The current is amplified and fed into an indicator light and an audible buzzer, which produce a signal as the sensor touches the water. A sensitivity control compensates for highly saline or conductive water. The sounder is decontaminated after each use with a deionized-water rinse. The bailer is lowered to a point just below the liquid level, retrieved, and inspected for floating hydrocarbon.

Alternately, an oil-water interface sonic probe can be used to measure floating-hydrocarbon thickness. The probe emits a continuous tone when immersed in a nonconductive fluid, such as oil or gasoline, and an intermittent tone when immersed in a conductive fluid, such as water. Fluid levels are recorded relative to which tone is emitted. The sonic probe is decontaminated after each use with a deionized-water rinse.

Fluid measurements are recorded to the nearest 0.01 foot in a field logbook. The groundwater elevation at the monitoring wells is calculated by subtracting the measured depth to water from the surveyed top-of-casing elevation. When possible, depth to water is measured in all wells on the same day. Water levels are converted to elevations above mean sea level (MSL) and contoured on a groundwater map. Total well depth, recorded to the nearest 0.5 foot, is measured by means of an electric sounder which is lowered to the bottom of a well. This measurement is used for calculating purge volumes and determining the degree to which silt may have obstructed the well screen.

Well Purging

Before a monitoring well is sampled, it is purged of standing water in the casing and gravel pack by one of several devices: a bladder pump, a pneumatic displacement pump, a centrifugal pump, or a Teflon bailer. Water will be evacuated from the well until the amount equals the calculate purge volume (as shown in Monitoring Well Purging Protocol, Figure 3), which will allow indicator parameters to stabilize, or until the well is evacuated to practical limits of dryness, if this occurs before the calculated purge volume is removed. These low-yield monitoring wells are allowed to recharge until the volume of water is sufficient for sampling, but not longer than 24 hours. If insufficient water has recharged after 24 hours, a monitoring well is recorded as dry for the sampling event.

The pH, specific conductance, and the temperature meter are calibrated daily before field activities are begun. Meter calibration is checked daily during field activities to verify performance. Field measurements are recorded on a water-sample field-data sheet (Figure 4) and kept in a waterproof logbook. Data sheets are reviewed by the sampling coordinator at the end of the sampling event.

Well Sampling

A Teflon bailer or a bladder pump is the only acceptable equipment for well sampling. When samples are collected for volatile organic compound (VOC) analysis with a bladder pump, the pump flow is regulated to approximately 100 milliliters per minute to minimize pump-effluent turbulence and aeration. Samples for VOC analysis are preserved in 40-milliliter glass bottles (or larger), which are fitted with Teflon-lined septa. The bottles are filled completely to force out air and to aid in forming a positive meniscus. Bottles are capped with convex Teflon septa to seal out air, and are inverted and tapped to verify that no air bubbles remain. Containers of samples to be analyzed for other constituents are filled, filtered as required, and capped.

When required, an appropriate field-filtration technique is used to determine dissolved concentrations of metals. When a Teflon bailer is used, the contents are emptied into a pressure transfer vessel. A disposable 0.45-micron acrylic copolymer filter is threaded onto the transfer vessel at the discharge point and the vessel is sealed. The vessel is pressurized with a hand pump and the filtrate directed into appropriate containers. Each filter is used once and discarded.

When a bladder pump is used to collect samples for dissolved constituents, a sample is filtered through a disposable 0.450-micron acrylic copolymer filter attached directly to the pump effluent line with a pressure fitting. As the pump cycles, the effluent is pressured through the filter and directed into an appropriate container. Each filter is used once and discarded.

Sample Preservation and Handling

Procedures for handling and preserving samples are consistent with the guidelines referenced in the Introduction. Sample containers vary depending on the type of analysis required (e.g., volatile organics, hydrocarbons, or dissolved metals) and are nonreactive with a given chemical.

Sample Handling

Sample containers are labeled immediately after sample collection, and are kept on cold packs which are replaced daily until the containers are received at the laboratory. As a sample is collected, it is logged on the chain-of-custody record that accompanies samples to the laboratory.

Samples are transferred from the site to EMCON's laboratory by the sampling team. Laboratory personnel assign a different number to each sample container and the number is recorded on the chain-of-custody record and used to identify the sample on all subsequent internal chain-of-custody and analytical records. Within 24 hours of sample receipt, samples are routinely shipped from EMCON to laboratories performing the selected analyses. EMCON's laboratory manager ensures that the holding times for requested analyses are not exceeded.

Sample Documentation

The procedures for sample handling provide chain-of-custody control from collection through storage. Sample documentation includes the following:

- Field logbooks for documenting sampling activities in the field
- Labels for identifying individual samples
- Chain-of-custody records for documenting possession and transfer of samples
- Laboratory analysis requests for documenting analyses to be performed

Field Logbook

In the field, the sampler records the following information on the water sample field data sheet (Figure 4) for each sample:

- Project number
- Client name
- Location
- Sampler's name
- Date and time
- Well accessibility and integrity
- Pertinent well data (e.g., casing diameter, depth to water, well depth)
- Calculated and actual purge volumes
- Purging equipment
- Sampling equipment
- Appearance of each sample (e.g., color, turbidity, sediment)
- Results of field analyses (temperature, pH, specific conductance)
- General comments

The field logbooks are signed by the sampler.

LABELS

Sample labels contain the following information:

- Project number
- Sample number (i.e., well designation)
- Sampler's initials
- Date and time of collection
- Type of preservative used (if any)

Sampling and Analysis Chain-of-Custody Record

The sampling and analysis chain-of-custody record (Figure 1), initiated at the time of sampling, includes the well number, sample type, analytical request, date of sampling, the name of the sampler, and other information deemed pertinent. The sampler signs his name and records the date and time on the record sheet when transferring the samples to another person. Custody transfers are recorded for every sample; for example, if samples are split and sent to more than one laboratory, a record sheet accompanies each sample. The number of custodians in the chain of possession is kept to a minimum. A copy of the sampling and analysis chain-of-custody-record is returned to EMCON with the analytical results.

Groundwater Sampling and Analysis Request

The Groundwater Sampling and Analysis Request or the purchase order that accompanies samples to the laboratory serves as official communication of the particular analysis(es) required for each sample and is evidence that the chain of custody is complete (Figure 5).

At a minimum, the groundwater sampling and analysis request includes the following:

- Date submitted
- Specific analytical parameters
- Well number
- Sample source

Analytical Methods

Samples collected as part of the proposed monitoring programs are analyzed by accepted analytical procedures. The following publications are the primary references:

- Methods for Chemical Analysis of Water and Wastes (EPA-600/4-79-020, revised March 1983)
- Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA-600/4-82-057), July 1982)
- Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods (EPA SW-846, 3rd edition, November 1986)
- Leaking Underground Fuel Tank (LUFT) Manual, State Water Resources Control Board, State of California Leaking Underground Fuel Tank Task Force, May 1988

The laboratories performing the analyses are certified by the Department of Health services (DHS) for hazardous waste testing.

Quality Control

Quality assurance measures confirm the integrity of field and laboratory data generated during the monitoring program. Procedures for assessing data quality are discussed in this section. Field and laboratory quality assurance data are evaluated in the technical reports.

Field Quality Assurance

Field quality assurance for each monitoring event includes the documentation of field instrument calibration and collection and analysis of trip blanks, field blanks, and duplicate samples. Split samples may also be included in the monitoring program.

Trip and Field Blanks

Trip and field blanks are used to detect contamination introduced through sampling procedures, external field conditions, sample transportation, container preparation, sample storage, and the analytical process.

Trip blanks are prepared at the same time and location as the sample containers for a given sampling event. Trip blanks accompany the containers to and from that event, but are never opened or exposed to the air. One trip blank for volatile organic parameters is typically included for each sampling event.

Field blanks are prepared in the same manner as trip blanks, but are exposed to the ambient atmosphere at a specific monitoring point during sample collection for the purpose of determining the influence of external field conditions on sample integrity. One field blank for volatile organic parameters is typically included for each day of sampling.

Duplicate Samples

Duplicate samples are collected so that field precision can be documented. For each sampling event, a specified percentage (typically 5 percent) of monitoring well samples is collected in duplicate. Where possible, field duplicates are collected at sampling points known or suspected to contain constituents of interest. Duplicates are packed and shipped blind to the laboratory to be analyzed with the samples from that particular event (i.e., duplicates have no special markings indicating that they are quality control samples).

Laboratory Quality Assurance

Laboratory quality assurance includes procedures required under the DHS Hazardous Waste Testing Program. For sites where Columbia Analytical Services conducts the chemical tests, its quality assurance procedures include the reporting of surrogate recoveries, matrix spike recoveries, and matrix spike duplicates (or duplicate) results.

Method blanks are analyzed daily for the purpose of assessing the effect of the laboratory environment on analytical results, and are performed for each constituent analyzed.

Samples to be analyzed for organic constituents contain surrogate spike compounds. Surrogate recoveries are used to determine whether analytical instruments are operating within limits. Surrogate recoveries are compared with control limits established and updated by the laboratory on the basis of its historical operation.

Matrix spikes are analyzed at a frequency of approximately 10 percent. Matrix spike results are evaluated to determine whether the sample matrix is interfering with the laboratory analysis, and provide a measure of the accuracy of the analytical data. Matrix spike recoveries are compared with control limits established and updated by the laboratory on the basis of its historical operation.

Laboratory duplicates are analyzed at a frequency of approximately 10 percent. Spike duplicate results are evaluated to determine the reproducibility (precision) of the analytical method. Reproducibility values are compared with control limits established and updated by the laboratory on the basis of its historical operation.

Laboratory QC data included with the analytical results are method blanks, surrogate spike recoveries (for organic parameters only), matrix spike recoveries, and matrix spike duplicates.

When other state-certified laboratories conduct the testing, each laboratory will follow its own internal QA/QC program.