



grettler — ryan inc.

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April 30, 1991

Ms. Pamela J. Evans
Department of Environmental Health
80 Swan Way, Room 200
Oakland, California 94621

Reference: ARCO Service Station #5387
20200 Hesperian Boulevard
Hayward, California

Ms. Evans:

As requested by ARCO Products Company, we are forwarding a copy of the Work Plan dated April 29, 1991, for the above referenced site.

If you should have any questions or comments, please call.

Sincerely,

Keith E. Bullock

Enclosure

cc: Mr. Charles Carmel, ARCO Products Company
Mr. H. C. Winsor, ARCO Products Company
Mr. Richard Hiatt, Regional Water Quality Control Board



GeoStrategies Inc.

WORK PLAN

**ARCO Service Station No. 5387
20200 Hesperian Boulevard
San Lorenzo, California**

792601-1

April 26, 1991

RECEIVED

APR 30 1991



GeoStrategies Inc.

2140 WEST WINTON AVENUE
HAYWARD, CALIFORNIA 94545

GETTLER-RYAN INC.

GENERAL CONTRACTORS

(415) 352-4800

April 26, 1991

Gettler-Ryan Inc.
2150 West Winton Avenue
Hayward, California 94545

Attn: Mr. Keith Bullock

Re: WORK PLAN
ARCO Service Station No. 5387
20200 Hesperian Boulevard
San Lorenzo, California

Gentlemen:

This Work Plan by GeoStrategies Inc. (GSI) describes a scope of work for the installation of five monitoring wells for the above referenced site (Plate 1). The scope of work was prepared in response to a letter from the Alameda County Health Care Services at the request of ARCO Products Company. Field work and laboratory analysis methods will be performed to comply with current State of California Water Resources Control Board (SWRCB) guidelines. Field Methods and Procedures are presented in Appendix A.

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Gettler-Ryan Inc.
April 26, 1991
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SITE BACKGROUND

There are currently three monitoring wells at the site. In August 1986, Groundwater Technology Inc. (GTI) drilled four exploratory soil borings (SB-1 through SB-4) and installed ~~three~~ three ground-water monitoring wells (MW-1 through MW-3). Exploratory boring and well locations are shown on Plate 1. Soil samples collected from these borings were analyzed for Total Petroleum Hydrocarbons (TPH) by EPA Method 418.1 (Modified). Laboratory analytical results for soil were verbally conveyed to GTI. TPH analytical results were verbally reported in the 9-9.5 foot soil samples from borings SB-2, SB-3 and SB-4 at concentrations of 49, 42 and 20 parts per million (ppm), respectively, and reported as none detected (ND) in soil samples collected from borings SB-1 and MW-1 through MW-3.

Initial groundwater samples collected from Wells MW-1 through MW-3 were analyzed for TPH and Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) by EPA method 602. TPH was detected in ground-water at concentrations of 14,300 parts per billion (ppb) (MW-1), 2,930 ppb (MW-2) and 14,100 ppb (MW-3). Additionally, benzene was detected at concentrations of 132 ppb (MW-1), 20.1 ppb (MW-2) and 510 ppb (MW-3). No further site background information is available to GSI at this time.

HYDROGEOLOGY

The site is located within the San Francisco bay plain approximately 2.5 miles east of the San Francisco bay and approximately 0.2 miles north of Sulphur Creek. The area is underlain by Holocene-age alluvial/fluvial deposits consisting of unconsolidated, moderately sorted, fine sand and silt, with clayey silt and occasional thin beds of coarse sand (Helley, E. J. and others., 1972). GTI boring logs indicate the site is underlain by silty to sandy clay from ground surface to 19 feet and sand with varying amounts of silts, clays and gravels to a total explored depth of 40 feet below grade. Ground-water was initially encountered at approximately 12 feet below grade (GTI, 1986).

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TECHNICAL RATIONALE

The technical rationale for this work includes the following:

- o Soil samples collected from on-site borings SB-2, SB-3 and SB-4 had verbally reported concentrations of TPH ranging from 20 to 49 ppm.
- o Initial ground-water samples collected from on-site wells contained detectable concentrations of TPH ranging from 2,930 to 14,300 ppb and benzene ranging from 20.1 to 510 ppb.
- o The five proposed wells will be used in addition to Wells MW-1 through MW-3 to evaluate the vertical and horizontal distribution of hydrocarbons in the soil and first encountered groundwater and calculate the local groundwater flow direction and hydraulic gradient. Regional groundwater flow patterns and local topography suggest that first encountered groundwater beneath the site flows to the west.
- o Hydrocarbons detected in off-site wells at a downgradient site have been attributed in part to the ARCO site by Alameda County Health Care Services. However, groundwater flow direction and distribution of hydrocarbons in ground-water on- and off-site are not sufficiently understood at this time.

As requested by the Alameda County Health Care Services (letter dated March 19, 1991), GSI proposes to install three monitoring wells on-site (two up- and one cross-gradient) and two downgradient monitoring wells off-site. These wells will also provide additional hydrogeologic information with respect to potential migration pathways.

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Following installation and development of the five wells (proposed designation MW-4, MW-5, MW-6, MW-7 and MW-8), groundwater samples will be collected to evaluate the extent of hydrocarbons in the shallow aquifer zone. In addition, the three existing Wells (MW-1 through MW-3) will be redeveloped and included in the groundwater sampling. Locking well caps and locks will be installed on the new and existing wells to provide well-head security.

SCOPE OF WORK

Five soil borings will be drilled using hollow-stem auger drilling equipment to an estimated depth of approximately 35 feet, unless a competent aquitard is encountered at a shallower depth. Soil samples will be collected by a California Modified split-barrel sampler equipped with pre-cleaned liners, and advanced ahead of the drill bit. Soil samples will be collected at five-foot intervals and at significant lithologic changes, at a minimum, for lithologic identification, field head-space analysis, physical testing, and chemical analysis. The borings will be logged by a GSI geologist using the Unified Soil Classification System (ASTM-D2488-84) and the Munsell Soil Color Chart.

Selected soil samples collected above the saturated zone will be analyzed for the presence of petroleum hydrocarbons. Additional samples may be selected for chemical analysis. Soil samples will be collected in clean brass or stainless steel liners, covered on both ends with aluminum foil and plastic end caps. Soil samples will then be labeled, placed in a cooler with blue ice and transported, under Chain-of-Custody, to a California State-certified analytical laboratory. Soil and groundwater samples collected from the exploratory borings and the wells will be analyzed for Total Petroleum Hydrocarbons calculated as Gasoline (TPH-Gasoline) according to EPA Method 8015 (Modified) and BTEX according to EPA Method 8020.

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The five monitoring wells will be constructed using 3-inch-diameter Schedule 40 PVC casing. The well screens will extend a minimum of 5 feet above the equilibrated water-level. The annular sandpack will be placed from the total depth of the designed well and will extend a minimum of 2-feet above the well screen. A minimum 1-foot bentonite seal, followed by a cement-grout seal to one-half foot below ground surface, will be placed above the sandpack. The well screens will be emplaced so that well designs are compatible with subsurface geologic conditions. Well screens will not be installed in a manner that could potentially permit cross contamination of adjacent aquifers.

Upon completion of field work and receipt of chemical analytical data, a report will be prepared presenting the field and laboratory data, including copies of the exploratory boring logs, chemical analytical reports, geologic cross-sections, and a brief site history. This report will be prepared under the supervision of a State of California Registered Geologist.

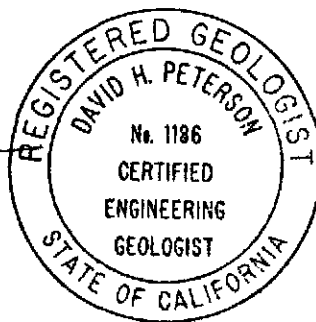
If you have any questions, please call.

GeoStrategies Inc. by,

Thomas D. Leavitt
Thomas D. Leavitt
Geologist

David H. Peterson

David H. Peterson
Senior Geologist
C.E.G. 1186



TDL/DHP/mlg

Plate 1. Site Plan

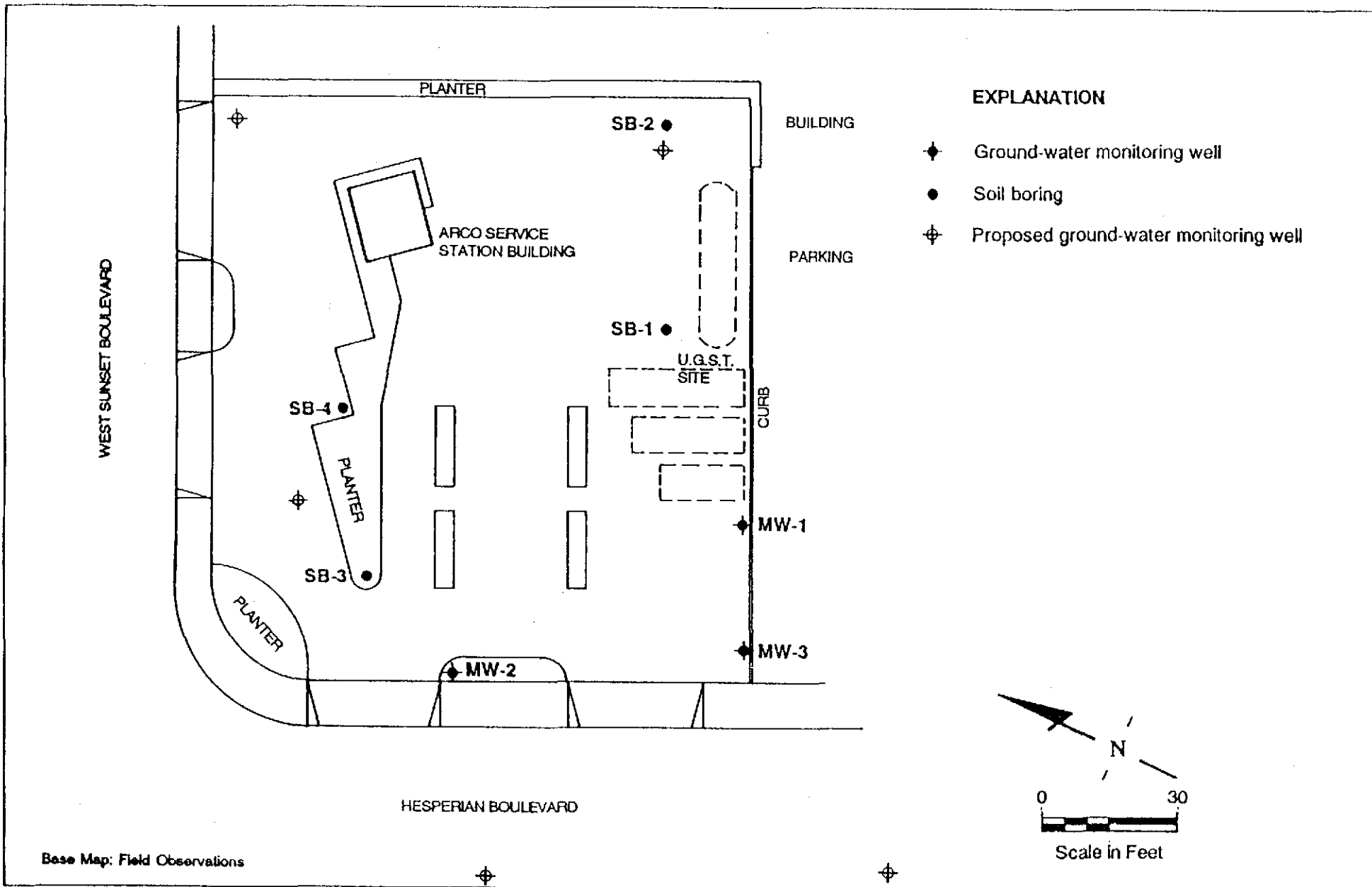
Appendix A: Field Methods and Procedures

GeoStrategies Inc.

References Cited

Groundwater Technology Inc., 1986, Site Assessment Investigation Report, Report No. 20-8127, dated August 21, 1986.

Helley, E.J. and others, 1972, Geologic map of late Cenozoic deposits, Alameda County, California: U.S. Geol. Survey Misc. Field Studies Map MF-429, 1:62,500.



Base Map: Field Observations



GeoStrategies Inc.

JOB NUMBER
792601-1

REVIEWED BY
DHP

SITE PLAN
ARCO Service Station #5387
20200 Hesperian Boulevard
San Lorenzo, California

DATE
4/91

REVISED DATE

REVISED DATE

PLATE

1

FIELD METHODS AND PROCEDURES

EXPLORATION DRILLING

Mobilization

Prior to any drilling activities, GeoStrategies Inc. (GSI) will verify that necessary drilling permits have been secured.

Utility locations will be located and drilling will be conducted so as not to disrupt activities at a project site. GSI will obtain and review available public data on subsurface geology and if warranted, the location of wells within a half-mile of the project site will be identified. Drillers will be notified in advance so that drilling equipment can be inspected prior to performing work.

Drilling

The subsurface investigations are typically performed to assess the lateral and vertical extent of petroleum hydrocarbons present in soils and groundwater. Drilling methods will be selected to optimize field data requirements as well as be compatible with known or suspected subsurface geologic conditions.

Monitoring wells are installed using a truck-mounted hollow-stem auger drill rig or mud-rotary drill rig. Typically, the hollow-stem rig is used for wells up to 100 feet, if subsurface conditions are favorable. Wells greater than 100-feet deep are typically drilled using mud-rotary techniques. When mud rotary drilling is used, an electric log will be performed for additional lithological information. Also during mud rotary drilling, precautions will be taken to prevent mud from circulating contaminants by using a conductor casing to seal off contaminated zones. Samples will be collected for lithologic logging by continuous chip, and where needed by drive sample or core as specified by the supervising geologist.

Soil Sampling

Shallow soil borings will be drilled using a truck-mounted hollow-stem auger drilling rig, unless site conditions favor a different drilling method. Drilling and sampling methods will be consistent with ASTM Method D-1452-80. The auger size will be a minimum 6-inch nominal outside-diameter (O.D). No drilling fluids will be used during this drilling method. The augers and other tools used in the bore hole will be steam cleaned before use and between borings to minimize the possibilities of cross-contamination between borings.

Soil samples are typically collected at 5-foot intervals as a minimum from ground surface to total depth of boring. Additional soil samples will be collected based on significant lithologic changes and/or potential chemical content. Soil samples from each sampling interval will be lithologically described by a GSI geologist (Figure 1). Soil colors will be described using the Munsell Color Chart. Rock units will be logged using appropriate lithologic terms, and colors described by the G.S.A. Rock Color Chart.

Head-space analyses will be performed to check for the evidence of volatile organic compounds. Head-space analyses will be performed using an organic vapor analyzer; either an OVA, HNU, or OVM. Organic vapor concentrations will be recorded on the GSI field log of boring (Figure 1). The selection of soil samples for chemical analysis are typically based on the following criteria:

- 1) Soil discoloration
- 2) Soil odors
- 3) Visual confirmation of chemical in soil
- 4) Depth with respect to underground tanks (or existing grade)
- 5) Depth with respect to ground water
- 6) OVA reading

Soil samples (full brass liners) selected for chemical analysis are immediately covered with aluminum foil and the liner ends are capped to prevent volatilization. The samples are labeled and entered onto a Chain-of-Custody form, and placed in a cooler on blue ice for transport to a State-certified analytical laboratory.

Soil cuttings are stockpiled on-site. Soils are sampled and analyzed for site-specific chemical parameters. Disposition of soils is dependent of chemical analytical results of the samples.

Soil Sampling - cont.

Soil borings not converted to monitoring wells will be backfilled (sealed) to ground surface using either a neat cement or cement-bentonite grout mixture. Backfilling will be tremied by continuously pumping grout from the bottom to the top of the boring where depth exceeds 20' or as required by local permit requirements.

All field and office work, including exploratory boring logs, are prepared under the direction of a registered geologist.

Monitoring Well Installation

Monitoring well casing and screen will be constructed of Schedule 40, flush-joint threaded polyvinylchloride (PVC). The well screen will be factory mill-slotted unless additional open area is required (eg. conversion to an extraction well in a low-yield aquifer). The screen length will be placed adjacent to the aquifer material to a minimum of 2-feet above encountered water. No screen shall be placed in a borehole that potentially creates hydraulic interconnection of two or more aquifer units. Screen slot size and well sand pack will be compatible with encountered aquifer materials, as confirmed by sieve analysis.

Monitoring wells will be completed below grade (Figure 2) unless special conditions exist that require above-grade completion design. In the event a monitoring well is required in an aquifer unit beneath an existing aquifer, the upper aquifer will be sealed off by installing a steel conductor casing with an annular neat cement or cement-bentonite grout seal. This seal will be continuously tremie pumped from the bottom of the annulus to ground surface.

The monitoring well sand pack will be placed adjacent to the entire screened interval and will extend a recommended minimum distance of 2-feet above the top of the screen. No sand pack will be placed that interconnects two or more aquifer units. A minimum 2-foot bentonite pellet or bentonite slurry seal will be placed above the sand pack. Sand pack, bentonite, and cement seal levels will be confirmed by sounding the annulus with a calibrated weighted tape. The remaining annular space above the bentonite seal will be grouted with a bentonite-cement mixture and will be tremie-pumped from the bottom of the annular space to the ground surface. The bentonite content of the grout will not exceed 5 percent by weight. A field log of boring and a field well completion form will be prepared by GSI for each well installed.

Decontamination of drilling equipment before drilling and between wells will consist of steam cleaning, and/or Alconox wash.

Well Development

All newly installed wells will be properly developed within 48 hours of completion. No well will be developed until the well seal has set a minimum of 12 hours. Development procedures will include one or more of the methods described below:

Bailing

Bailing will be used to remove suspended sediments and drilling fluids from the well, where applicable. The bailer will be raised and lowered through the column of water in the well so as to create a gentle surging action in the screened interval. This technique may be used in conjunction with other techniques, such as pumping, and may be used alone if the well is of low yield.

Pumping

Pumping will be used in conjunction with bailing or surging. The pump will be operated in such a manner as to gently surge the entire screened interval of the well. This may involve operating the pump with a packer type mechanism attached and slowly raising and lowering the pump, or by cycling the pump off and on to allow water to move in and out of the screened interval. Care will be used not to overpump a well.

Surging

Surging will be performed on wells that are screened in known or suspected high yield formations and/or on larger diameter (recovery) wells. A surge block will be raised and lowered through the entire screened interval, forcing water in and out of the well screen and sand pack. Pumping or air lifting will be used in conjunction with this method of development to remove any sediment brought into the well during surging.

Air Lifting

Air lifting will be used to remove sediment from wells as an alternative to pumping under certain conditions. When appropriate, a surge block designed for use with air lifting will be used to agitate the entire screened interval and water will be lifted out of the well using forced air. When air lifting is performed, the air source will be either nitrogen or filtered air and the procedure will be performed gently to prevent any damage to the well screen or casing and to insure that discharged water is contained.

Well Development - cont.

All well developing equipment will be thoroughly decontaminated prior to development using a steam cleaner and/or Alconox detergent wash and clean water rinse. During development procedures, field parameters (temperature, specific conductance and pH) will be monitored and recorded on well development forms (Figure 3). Equilibration requirements consist of a minimum of three readings with the following accuracy standards:

pH	± 0.1 pH units
Specific Conductance	± 10% of full scale reading
Temperature	± 0.5 degrees Celsius

The wells will be developed until water is visibly clear and free of sediment, and well purging parameters stabilized. A minimum of 8 to 10 well volumes will be purged from each well, if feasible. If well purging parameters have not stabilized before 10 casing volumes have been removed, well development will continue until purging parameters have stabilized and formation water is being drawn into the well. The adequacy of well development will be judged by the field technician performing the well development and based on known formation conditions.

Well Surveying

Monitoring wells will be surveyed to obtain top of box elevations to the nearest ±0.01 foot. Water level measurements will be recorded to the nearest ±0.01 foot and referenced to Mean Sea Level (MSL). If additional wells are required, then existing and newly installed wells are surveyed relative to MSL.

GROUND-WATER SAMPLING AND ANALYSIS

Quality Assurance/Quality Control Objectives

The sampling and analysis procedures employed by Gettler-Ryan Inc. (G-R) for ground-water sampling and monitoring follow specific Quality Assurance/Quality Control (QA/QC) guidelines. Quality Assurance objectives have been established by G-R to develop and implement procedures for obtaining and evaluating water quality and field data in an accurate, precise, and complete manner so that sampling procedures and field measurements provide information that is comparable and representative of actual field conditions. Quality Control (QC) is maintained by G-R by using specific field protocols and requiring the analytical laboratory to perform internal and external QC checks. It is the goal of G-R to provide data that are accurate, precise, complete, comparable, and representative. The definitions for accuracy, precision, completeness, comparability, and representativeness are as follows:

- Accuracy - the degree of agreement of a measurement with an accepted referenced or true value.
- Precision - a measure of agreement among individual measurements under similar conditions. Usually expressed in terms of the standard deviation.
- Completeness - the amount of valid data obtained from a measurement system compared to the amount that was expected to meet the project data goals.
- Comparability - expresses the confidence with which one data set can be compared to another.
- Representativeness - a sample or group of samples that reflects the characteristics of the media at the sampling point. It also includes how well the sampling point represents the actual parameter variations which are under study.

As part of the G-R QA/QC program, applicable federal, state, and local reference guidance documents are followed. The procedures outlined in these regulations, manuals, handbooks, guidance documents, and journals are incorporated into the G-R sampling procedures to assure that; (1) ground-water samples are properly collected, (2) ground-water samples are identified, preserved, and transported in a manner such that they are representative of field conditions, and (3) chemical analysis of samples are accurate and reproducible.

Guidance and Reference Documents Used to Collect Groundwater Samples

These documents are used to verify G-R sampling procedures and are consistent with current regulatory guidance. If site specific work and sampling plans are required, those plans will be developed from these documents, and newly received applicable documents.

U.S.E.P.A. - 330/9-51-002	NEIC Manual for Groundwater/Subsurface Investigation at Hazardous Waste Sites
U.S.E.P.A. - 530/SW611	Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities (August, 1977)
U.S.E.P.A. - 600/4-79-020	Methods for Chemical Analysis of Water and Wastes (1983)
U.S.E.P.A. - 600/4-82-029	Handbook for Sampling and Sample Preservation of Water and Wastewater (1982)
U.S.E.P.A. - 600/4-82-057	Test Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (July, 1982)
U.S.E.P.A. - SW-846#, 3rd Edition	Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (November, 1986)
40 CFR 136.3e, Table II (Code of Federal Regulations)	Required Containers, Preservation Techniques, and Holding Times
Resources Conservation and Recover Act (OSWER 9950.1)	Groundwater Monitoring Technical Enforcement Guidance Document (September, 1986)
California Regional Water Quality Control Board (Central Valley Region)	A Compilation of Water Quality Goals (September, 1988); Updates (October, 1988)
California Regional Water Quality Control Board (North Coast, San Francisco Bay, and Central Valley)	Regional Board Staff Recommendations for Initial Evaluations and Investigation of Underground Tanks: Tri-Regional Recommendations (June, 1988)

Guidance and Reference Documents Used to Collect Groundwater Samples (cont.)

Regional Water Quality Control Board (Central Valley Region)	Memorandum: Disposal, Treatment, and Refuse of Soils Contaminated with Petroleum Fractions (August, 1986)
State of California Department of Health Services	Hazardous Waste Testing Laboratory Certification List (March, 1987)
State of California Water Resources Control Board	Leaking Underground Fuel Tank (LUFT) Field Manual (May, 1988), and LUFT Field Manual Revision (April, 1989)
State of California Water Resources Control Board	Title 23, (Register #85.#33-8-17-85), Subchapter 16: Underground Tank Regulations; Article 3, Sections 2632 and 2634; Article 4, Sections 2645, 2646, 2647, and 2648; Article 7, Sections 2670, 2671, and 2672 (October, 1986: including 1988 Amendments)
Alameda County Water District	Groundwater Protection Program: Guidelines for Groundwater and Soil Investigations at Leaking Underground Fuel Tank Sites (November, 1988)
American Public Health Association	Standard Methods for the Examination of Water and Wastewaters, 16th Edition
Analytical Chemistry (journal)	Principles of Environmental Analysis, Volume 55, Pages 2212-2218 (December, 1983)
Napa County	Napa County Underground Storage Tank Program: Guidelines for Site Investigations; February 1989.
Santa Clara Valley Water District	Guidelines for Preparing or Reviewing Sampling Plans for Soil and Groundwater Investigation of Fuel Contamination Sites (January, 1989)

Guidance and Reference Documents Used to Collect Groundwater Samples (cont.)

Santa Clara Valley Water District	Investigation and Remediation at Fuel Leak sites: Guidelines for Investigation and Technical Report Preparation (March 1989)
Santa Clara Valley Water District	Revised Well Standards for Santa Clara County (July 18, 1989)
American Petroleum Institute	Groundwater Monitoring & Sample Bias; API Publication 4367, Environmental Affairs Department, June 1983
American Petroleum Institute	A Guide to the Assessment and Remediation of Underground Petroleum Releases; API Publication 1628, February 1989
American Petroleum Institute	Literature Summary: Hydrocarbon Solubilities and Attenuations Mechanisms, API Publication 4414, August 1985
Site Specific (as needed)	General and specific regulatory documents as required.

Because ground-water samples collected by G-R are analyzed to the parts per billion (ppb) range for many compounds, extreme care is exercised to prevent contamination of samples. When volatile or semi-volatile organic compounds are included for analysis, G-R sampling crew members will adhere to the following precautions in the field:

1. A clean pair of new, disposable gloves are worn for each well being sampled.
2. When possible, samples are collected from known or suspected wells that are least contaminated (i.e. background) followed by wells in increasing order of contamination.
3. Ambient conditions are continually monitored to maintain sample integrity.

When known or potential organic compounds are being sampled for, the following additional precautions are taken:

1. All sample bottles and equipment are kept away from fuels and solvents. When possible, gasoline (used in generators) is stored away from bailers, sample bottles, purging pumps, etc.
2. Bailers are made of Teflon or Stainless Steel. Other materials such as plastic may contaminate samples with phthalate esters which interfere with many Gas Chromatography (GC) analyses.
3. Volatile organic ground-water samples are collected so that air passage through the sample does not occur or is minimal (to prevent volatiles from being stripped from the samples): sample bottles are filled by slowly running the sample down the side of the bottle until there is a positive convex meniscus over the neck of the bottle; the Teflon side of the septum (in cap) is positioned against the meniscus, and the cap screwed on tightly; the sample is inverted and the bottle lightly tapped. The absence of an air bubble indicates a successful seal; if a bubble is evident, the cap is removed, more sample is added, and the bottle is resealed.
4. Extra Teflon seals are brought into the field in case seals are difficult to handle and/or are dropped. Dropped seals are considered contaminated and are not used. When replacing seals or if seals become flipped, care is taken to assure that the Teflon seal faces down.

Sample analysis methods, containers, preservatives and holding times are shown on Table 1.

Laboratory and field handling procedures of samples are monitored by including QC samples for analysis with every submitted sample lot from a project site. QC samples may include any combination of the following:

- A. Trip Blank: Used for purgeable organic compounds only; QC samples are collected in 40 milliliter (ml) sample vials filled in the analytical laboratory with organic-free water. Trip blanks are sent to the project site, and travel with project site samples. Trip blanks are not opened, and are returned from a project site with the project site samples for analysis.
- B. Field Blank: Prepared in the field using organic-free water. These QC samples accompany project site samples to the laboratory and are analyzed for specific chemical parameters unique to the project site where they were prepared.
- C. Duplicates: Duplicated samples are collected "second samples" from a selected well and project site. They are collected as either split samples or second-run samples collected from the same well.
- D. Equipment Blank: Periodic QC sample collected from field equipment rinsate to verify decontamination procedures.

The number and types of QC samples are determined as follows:

- A. Up to 2 wells - Trip Blank Only
- B. 2 to 5 Wells - 1 Field Blank and 1 Trip Blank
- C. 5 to 10 Wells - 1 Field blank, 1 Trip Blank, and 1 Duplicate
- D. More than 10 Wells - 1 Field Blank, 1 Trip Blank, and 1 Duplicate per each 12 wells
- E. If sampling extends beyond one day, quality control samples will be collected for each day.

Additional QC is performed through ongoing and random reviews of duplicate samples to evaluate the precision of the field sampling procedures and analytical laboratory. Precision of QC data is accomplished by calculating the Relative Percent Difference (RPD). The RPD is evaluated to assess whether values are within an acceptable range (typically $\pm 20\%$ of duplicate sample).

SAMPLE COLLECTION

This section describes the routine procedures followed by G-R while collecting ground-water samples for chemical analysis. These procedures include decontamination, water-level measurements, well purging, physical parameter measurements, sample collection, sample preservation, sample handling, and sample documentation. Critical sampling objectives for G-R are to:

1. Collect ground-water samples that are representative of the sampled matrix and,
2. Maintain sample integrity from the time of sample collection to receipt by the analytical laboratory.

Sample analyses methods, containers, preservation, and holding times are presented in Table 1.

Decontamination Procedures

All physical parameter measuring and sampling equipment are decontaminated prior to sample collection using Alconox or equivalent detergent followed by steam cleaning with deionized water. Any sampling equipment surfaces or parts that might absorb specific contaminants, such as plastic pump valves, impellers, etc., are cleaned in the same manner.

Sample bottles, bottle caps, and septa used for sampling volatile organics are thoroughly cleaned and prepared in the laboratory. Sample bottles, bottle caps, and septa are protected from all potential chemical contact before actual usage at a sample location.

During field sampling, equipment placed in a well are decontaminated before purging or sampling the next well. The equipment are decontaminated by cleaning with Alconox or equivalent detergent followed by steam cleaning with deionized water.

Water-Level Measurements

Prior to purging and sampling a well, the static-water levels are measured in all wells at a project site using an electric sounder and/or calibrated portable oil-water interface probe (Figure 4). Both static water-level and separate-phase product thickness are measured to the nearest ± 0.01 foot. The presence of separate-phase product is confirmed using a clean, acrylic or polyvinylchloride (PVC) bailer, measured to the nearest ± 0.01 foot with a decimal scale tape.



Water-Level Measurements (continued)

The monofilament line used to lower the bailer is replaced between wells with new line to preclude the possibility of cross-contamination. Field observations (e.g. well integrity, product color, turbidity, water color, odors, etc.) are noted on the G-R Well Sampling Field Data Sheet shown in Figure 4. Before and after each use, the electric sounder, interface probe and bailer are decontaminated by washing with Alconox or equivalent detergent followed by rinsing with deionized water to prevent cross-contamination.

As mentioned previously, water-levels are measured in wells with known or suspected lowest dissolved chemical concentrations to the highest dissolved concentrations.

Well Purging

Before sampling occurs, well casing storage water and interstitial water in the artificial sand pack will be purged using (1) a positive displacement bladder pump constructed of inert, non-wetting, Teflon and stainless steel, (2) a pneumatic-airlift pumping system, (3) a centrifugal pumping system, or (4) a Teflon or Stainless steel bailer (Figure 5). Methods of purging will be assessed based on well size, location, accessibility, and known chemical conditions. Individual well purge volumes are calculated from borehole volumes which take into account the sand packed interval in the well annular space. As a general rule, a minimum of 3 and a maximum of 10 borehole volumes will be purged. Wells which dewater or demonstrate slow recharge periods (i.e. low-yield wells) during purging activities may be sampled after fewer purging cycles. If a low-yield (low recovery) well is to be sampled, sampling will not take place until at least 80 percent of the previously measured water column has been replaced by recharge, or as per local requirements. Physical parameter measurements (temperature, pH, and specific conductance) are closely monitored throughout the well purging process and are used by the G-R sampling crew as indicators for assessing sufficient purging. Purging is continued until all three physical parameters have stabilized. Specific conductance (conductivity) meters are read to the nearest ± 10 umhos/cm, and are calibrated daily. pH meters are read to the nearest ± 0.1 pH units and are calibrated daily. Temperature is read to the nearest 0.1 degree F. Calibration of physical parameter meters will follow manufacturers specifications. Monitoring wells will be purged according to the protocol presented in Figure 5. Collected field data during purging activities will be entered on the G-R Well Sampling Field Data Sheet shown in Figure 4. Copies of the G-R Field Data Sheets will be reviewed by the G-R Sampling Manager for accuracy and completeness.

DOCUMENTATION

Sample Container Labels

Each sample container will be labeled by an adhesive label, noted in permanent ink immediately after the sample is collected. Label information will include:

- Sample point designation (i.e. well number or code)
- Sampler's identification
- Project number
- Date and time of collection
- Type of preservation used

Well Sampling Data Forms

In the field, the G-R sampling crew will record the following information on the Well Sampling Data Sheet for each sample collected:

- Project number
- Client
- Location
- Source (i.e. well number)
- Time and date
- Well accessibility and integrity
- Pertinent well data (e.g. depth, product thickness, static water-level, pH, specific conductance, temperature)
- Calculated and actual purge volumes

Chain-of-Custody

A Chain-of-Custody record (Figure 6) shall be completed and accompany every sample and every shipment of samples to the analytical laboratory in order to establish the documentation necessary to trace sample possession from time of collections. The record will contain the following information:

- Sample or station number or sample identification (ID)
- Signature of collector, sampler, or recorder
- Date and time of collection
- Place of collection
- Sample type
- Signatures of persons involved in chain of possession
- Inclusive dates of possession

Samples shall always be accompanied by a Chain-of-Custody record. When transferring the samples, the individual relinquishing and receiving the samples will sign, date, and note the time on the Chain-of-Custody record. G-R will be responsible for notifying the laboratory coordinator when and how many samples will be sent to the laboratory for analysis, and what types of analyses shall be performed.

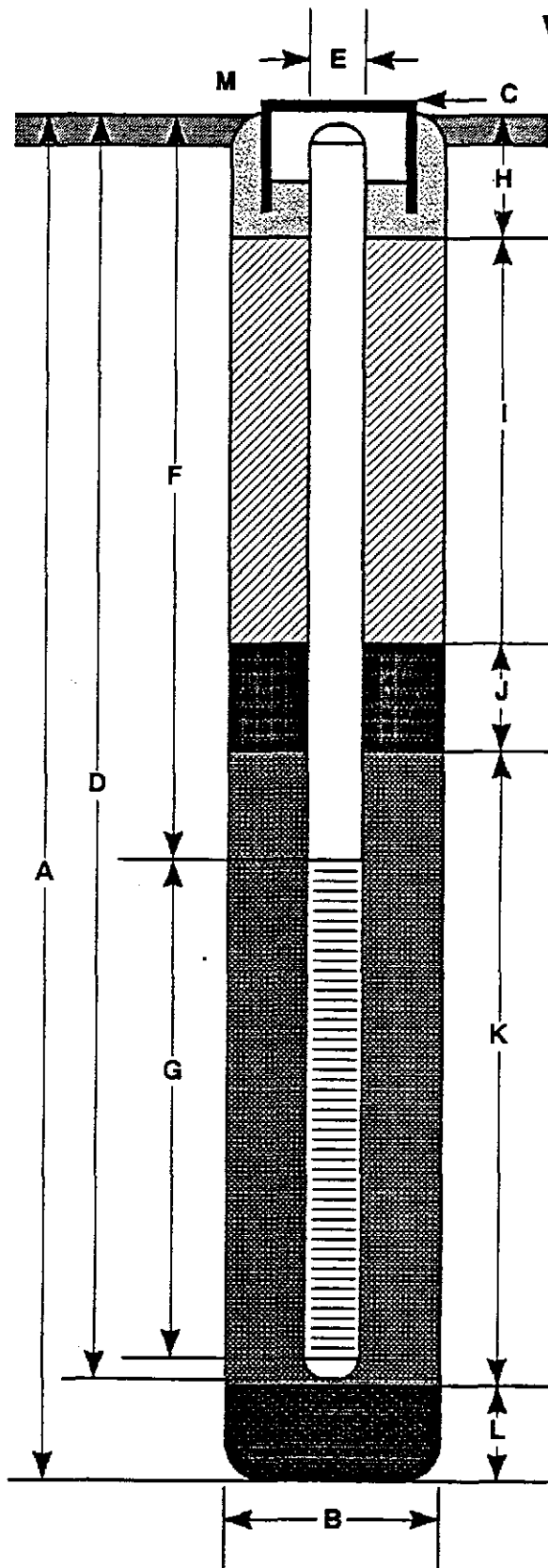
TABLE 1

SAMPLE ANALYSIS METHODS, CONTAINERS, PRESERVATIONS, AND HOLDING TIMES

Parameter	Analytical Method	Reporting Units	Container	Preservation	Maximum Holding Time
Total Petroleum Hydrocarbons (Gasoline)	EPA 8015 (modified)	mg/l ug/l	40 ml. vial glass, Teflon	cool, 4 C HCl to pH<2	14 days (maximum)
Benzene	EPA 8020	mg/l	50 ml. vial	cool, 4 C	7 days (w/o preservative)
Toluene		ug/l	glass, Teflon lined septum	HCl to pH<2	14 days (w preservative)
Ethylbenzene					
Xylenes (BTEX)					
Oil & Grease	SM 503E	mg/l ug/l	1 l glass, Teflon lined septum	H2SO4 or HCl to pH<2	28 days (maximum)
Total Petroleum Hydrocarbons (Diesel)	EPA 8015 (modified)	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C	14 days (maximum)
Halogenated Volatile Organics (chlorinated solvents)	8010	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C	14 days (maximum)
Non chlorinated solvents	8020	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	14 days (maximum)
Volatile Organics	8240	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	14 days (maximum)
Semi-Volatile Organics	8270	mg/l ug/l	1 l amber glass, Teflon lined septum	cool, 4 C	7 days extract 40 days (maximum to analyze)
Specific Conductance (Field test)		umhos/cm			
pH (Field test)		pH units			
Temperature (Field test)		Deg F			

WELL CONSTRUCTION DETAIL

FIGURE 2



- A Total Depth of Boring _____ ft.
- B Diameter of Boring _____ in.
Drilling Method _____
- C Top of Box Elevation _____ ft.
 Referenced to Mean Sea Level
 Referenced to Project Datum
- D Casing Length _____ ft.
Material _____
- E Casing Diameter _____ in.
- F Depth to Top Perforations _____ ft.
- G Perforated Length _____ ft.
Perforated Interval from _____ to _____ ft.
Perforation Type _____
Perforation Size _____ in.
- H Surface Seal from _____ to _____ ft.
Seal Material _____
- I Backfill from _____ to _____ ft.
Backfill Material _____
- J Seal from _____ to _____ ft.
Seal Material _____
- K Gravel Pack from _____ to _____ ft.
Pack Material _____
- L Bottom Seal _____ ft.
Seal Material _____
- M _____

Note: Depths measured from initial ground surface



GeoStrategies Inc.

Well Construction Detail

WELL NO. _____

JOB NUMBER _____

REVIEWED BY RG/CEG

DATE _____

REVISED DATE _____

REVISED DATE _____

WELL DEVELOPMENT FORM

FIGURE 3

Page _____ of _____

(to be filled out in office)

Client _____ SS# _____ Job# _____

Name _____ Location _____

Well# _____ Screened Interval _____ Depth _____

Aquifer Material _____ Installation Date _____

Drilling Method _____ Borehole Diameter _____

Comments regarding well installation: _____

(to be filled out in the field) Name _____

Date _____ Development Method _____

Total Depth _____ - Depth to liquid _____ = Water Column _____

Product thickness _____

Water Column x Diameter (in.) x #Vol x 0.0408 = _____ gals

Purge Start _____ Stop _____ Rate _____ gpm

Table with 6 columns: Gallons, Time, Clarity, Temp., pH, Conductivity. Includes a row for '0' and multiple blank rows for data entry.

Total gallons removed _____ Development stop time _____

Depth to liquid _____ at _____ (time)

Odor of water _____ Water discharged to _____

Comments _____

GETTLER-RYAN INC.

General and Environmental Contractors

WELL SAMPLING FIELD DATA SHEET

FIGURE 4

COMPANY _____ JOB # _____
 LOCATION _____ DATE _____
 CITY _____ TIME _____

Well ID. _____ Well Condition _____

Well Diameter _____ in. Hydrocarbon Thickness _____ ft.

Total Depth _____ ft.

Volume Factor (VF)	2" = 0.17	6" = 1.50	12" = 5.80
	3" = 0.38	8" = 2.60	
	4" = 0.66	10" = 4.10	

Depth to Liquid- _____ ft.

(# of casing volumes) _____ x _____ x(VF) _____ = (Estimated Purge Volume) _____ gal.

Purging Equipment _____

Sampling Equipment _____

Starting Time _____ Purging Flow Rate _____ gpm.

(Estimated Purge Volume) _____ gal. / (Purging Flow Rate) _____ gpm. = (Anticipated Purging Time) _____ min.

Time	pH	Conductivity	Temperature	Volume
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Did well dewater? _____ If yes, time _____ Volume _____

Sampling Time _____ Weather Conditions _____

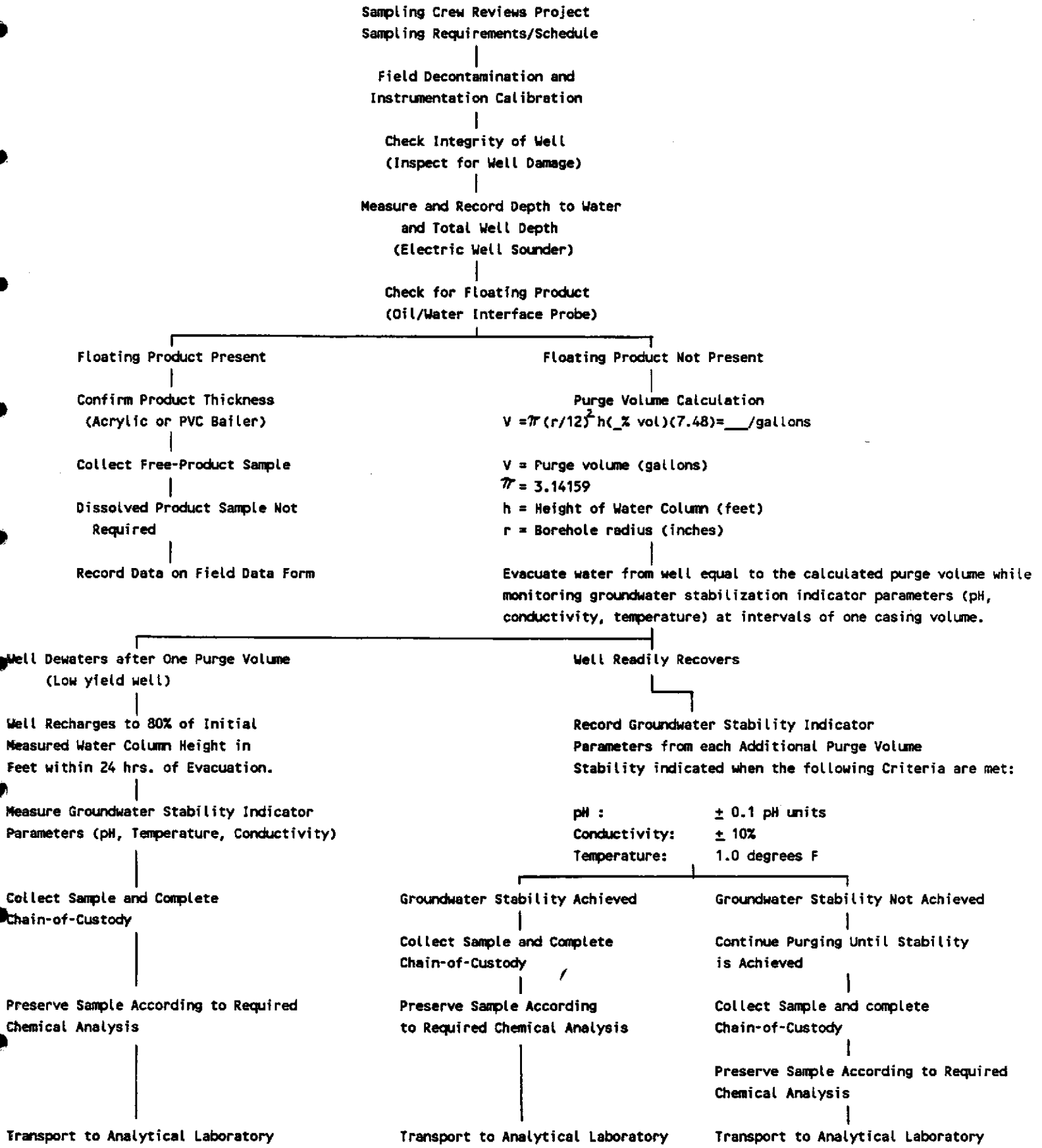
Analysis _____ Bottles Used _____

Chain of Custody Number _____

COMMENTS _____

FOREMAN _____ ASSISTANT _____

Monitoring Well Sampling Protocol Schematic



COMPANY _____ JOB NO. _____

JOB LOCATION _____

CITY _____ PHONE NO. _____

AUTHORIZED _____ DATE _____ P.O. NO. _____

SAMPLE ID	NO. OF CONTAINERS	SAMPLE MATRIX	DATE/TIME SAMPLED	ANALYSIS REQUIRED	SAMPLE CONDITION LAB ID

RELINQUISHED BY: _____

RECEIVED BY: _____

RELINQUISHED BY: _____

RECEIVED BY: _____

RELINQUISHED BY: _____

RECEIVED BY LAB: _____

DESIGNATED LABORATORY: _____ DHS #: _____

REMARKS: _____

DATE COMPLETED _____ FOREMAN _____