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Geological Technics Inc.

Work Plan - Addendum

Additional Site Characterization

Arrow Rentals Service
187 North L St.
Livermore, CA 94550

May 26, 2006
Project No. 1262.2

Prepared for:
Tony & Rita Sullins
Arrow Rentals Service
187 North L St.
Livermore, CA 94550

Prepared by:
Geological Technics Inc.
1101 7th Street
Modesto, California 95354
209-522-4119

Geological Technics Inc.

1101 7th Street
Modesto, California 95354
(209) 522-4119/Fax#522-4227

May 26, 2006

Project No.: 1262.2
Project Name: Sullins (L St.)

Tony & Rita Sullins
Arrow Rentals Service
187 North L Street
Livermore, CA 94550

RE: Work Plan Addendum: Additional Site Characterization
Location: 187 North L Street, Livermore, CA 94550.
(ACEH Fuel Leak Case No. RO0000394)

Dear Mr. & Ms. Sullins:

Geological Technics Inc. (GTI) is pleased to present the attached Work Plan – Addendum for additional site characterization work at the 187 North L St. property in Livermore. GTI has prepared this work plan to supplement the Aquifer Sciences, Inc. December 8, 2005 "Work Plan for Additional Soil and Investigation and Other Items". This plan calls for:

- The advancement of one soil boring to a maximum depth of 100' in the vicinity of the highest documented soil contamination & four soil borings to a maximum depth of 80';
- Obtaining soil samples from all five boreholes;
  Install, develop and sample the five additional groundwater monitoring wells screened in the deeper aquifer portion of the site;
- Surveying all active monitoring wells in accordance Geotracker reporting requirements;

The data obtained during this field work will also be used to develop a Site Conceptual Model (SCM) report as directed by Alameda County staff. If you have any questions or need additional information, please contact me. Thank you for this opportunity to serve your environmental needs.

Sincerely,

Raynold Kablanow II Ph.D.

Digitally signed by Raynold Kablanow II Ph.D
DN: cn=Raynold Kablanow II Ph.D., c=US, o=Geological Technics, ou=Professional Geoloist, email=gti@geologicaltehnics.com
Date: 2006.06.06 10:36:19 -07'00'

Raynold I. Kablanow II, Ph.D.
Vice President

cc: Jerry Wickham - ACEH
USTCUF
Chris Davidson, City of Livermore

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Modesto, California 95354
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Work Plan - Addendum

Additional Site Characterization

Arrow Rentals Services
187 North L St.
Livermore, CA

Project No. 1262.2
May 26, 2006

1.0 INTRODUCTION

Gasoline range petroleum hydrocarbons associated with underground storage tank (UST) systems have been documented in soil and groundwater at the above subject site (see Figures 1 and 2 for vicinity and site maps). The site also experienced an environmental impact when a gasoline delivery was introduced into a subsurface vapor/monitoring well rather than the UST fill pipe ("Petcock Release").

The work performed to date is summarized below*:

- 1972 – Three 1500 gallon USTs removed.
- 1984 – Two USTs removed (4000 & 6000 gallon); a single 1,000 gallon gasoline UST installed.
- June 1985 – Petcock Petroleum dispenses ~600 gallons into a vapor monitoring well adjacent to the 1,000 gasoline UST (Petcock Release).
- September 1988 – Three monitoring wells installed (W-1, W-2 and W-3).
- March 1989 – Five soil borings advanced (B-1 through B-5).
- July 1990 – Five monitoring wells installed (W-A through W-E), three soil borings advanced (B-7, B-8 and B-1A), and a soil gas survey was completed.
- March 1991 – A single soil boring advanced (B-F).
- January 1992 - UST pipeline soil excavation and sampling., two soil borings advanced (B-G and B-H).
- March 1994 – Dual Phase Extraction pilot test performed.
- March 1996- Four monitoring wells installed (W-1s, W-Bs, W-3s and W-Es).
- 1988 to present – intermittent monitoring/sampling of select wells.

* Data from Woodward Clyde Consultants and ACEH documentation.

The data compiled during the course of this investigation indicate that the soil and groundwater were impacted with petroleum hydrocarbons from at least two separate sources.

GTI has prepared this work plan addendum to supplement the Aquifer Sciences, Inc. (ASI) December 8, 2005 "Work Plan for Additional Soil and Investigation and Other Items". This work plan addendum will address Alameda County Environmental Health (ACEH) staff concerns that were not covered in the original ASI work plan.

The four soil borings and grab groundwater samples proposed in the ASI work plan will be replaced with five soil borings, the installation of dedicated monitoring wells and soil samples. The new groundwater monitoring wells will be sampled and incorporated into the existing sampling regime.

Monitoring well status: On April 27, 2006 GTI staff visited the site to determine the location/status of the site's existing wells. Wells W-1, W-A, W-B, W-E, W-1s, W-Bs and W-Es were located and appear to be serviceable. The remaining wells' status is as follows:

- W-2: apparently located, but well box missing and PVC riser may have been added to casing, not secure (see photo below);
- W-3: apparently located, but well box missing and PVC riser may have been added to casing, not secure (see photo below);
- W-C: unable to locate, new landscaping in location with fresh wood bark placed in vicinity of well, may be able to locate with metal detector if the traffic box is present;
- W-D: unable to locate, in residence rear yard, need legal access agreement;
- W-3s: unable to locate, under dirt/mud in equipment yard from recent rains, should be able to locate with metal detector.

Well W-2 on adjacent parcel (west)

Well W-3 on adjacent parcel (west)

The wells will be examined in greater detail during the field work proposed below. Access agreements will be developed to locate and monitor wells on adjacent private parcels not in the City of Livermore right-of-way.

2.0 ADDITIONAL SITE CHARACTERIZATION

The lateral and vertical extent of the groundwater plume is undefined. GTI proposes to install five groundwater monitoring wells (MW-4 through MW-8). Figure 3 includes the proposed well boring locations. The placement of the wells in these locations will enable the development of an updated Site Conceptual Model (SCM).

1. Well MW-4 will be placed in the location of the highest known soil contamination adjacent to a former UST excavation.
2. Well MW-5 will be placed adjacent to the former 1000 gallon UST and the Petcock release location.
3. Well MW-6 will be placed adjacent to the former dispenser island on the northeast corner of the parcel.
4. Well MW-7 will be placed adjacent to the former UST excavation to the southwest of the site building.
5. Well MW-8 will be situated in the historical down gradient direction near the well pair W-3 & W-3s.

In the ASI work plan and ACEH December 27, 2005 work plan response correspondence grab groundwater samples are discussed. GTI proposes to replace depth discrete groundwater grab samples during borehole installation and depth discrete sampling in existing wells with continuous multi-chambered tubing (CMT™) well sets. The manufacturer's literature is included as Appendix B. These devices enable depth discrete groundwater sampling without the aquifer's water mixing during borehole sampling efforts. GTI has used CMT™ well sets

with success at other UST sites and they are currently in use at the B&C Gas Mini Mart site at 2008 First St. in Livermore (approximately two blocks southeast of the Arrow Rental site). The installation of these wells will also free the existing wells to be used for remedial efforts.

2.1 Soil Borings

Prior to commencing work, encroachment permits and soil boring/monitoring well permits will be secured and the ACEH will be notified 48 hours in advance. The subsurface will be cleared of underground utilities by notifying Underground Service Alert.

The borings will be drilled using an 8 to 10-inch outside diameter continuous flight hollow stem auger by an appropriately licensed driller. Soil cuttings will be containerized in DOT approved 55-gallon steel drums and held on site pending disposal.

The drilling will start with the borehole for well MW-4. The purpose of this borehole will be to affirm the geologic profile and vertical depth of the gasoline contamination.

2.2 Soil Sampling

In MW-4, soil sampling will be conducted at 5 foot intervals to the capillary fringe. Once groundwater is encountered, the borehole will be cored continuously to total depth [a maximum of 100 feet below grade surface (bgs)]. The ACEH has concerns regarding a potential regional clay aquitard beneath the site. It is anticipated that the clay unit may or may not be present based on GTI's discussion with Zone 7 Water Agency staff on April 27, 2006. Zone 7 Agency staff suggested that clay units are not regionally continuous. The B&C Gas Mini Mart site at 2008 First St. in Livermore consultant's reports state that a clay unit is present at a depth of 75 – 115 feet bgs in the site's vicinity. In order to preclude perforating this potential aquitard, GTI will not continue drilling past any significant clay layer (minimum five feet thick) once field evidence suggests contamination free zones are encountered below 60 feet in the MW-4 borehole. Otherwise, the borehole will advance to a maximum of 100 feet bgs.

The remainder of the boreholes will be drilled to a maximum depth of 80 feet bgs. Sampling will be conducted at five foot intervals with continuous coring as necessary if significant contamination is encountered. Soil samples for laboratory analysis will be taken in borings MW-5 through MW-8 at a minimum of 10 foot intervals from the capillary fringe and depths below. In borings MW-5, MW-6 and MW-7, soil samples will be taken in the vadose zone as necessary to define areas lower than the shallow borings previously advanced at the site.

Boring logs will be developed by a geologist under the supervision of a California Professional Geologist. The log will be prepared using the USCS and field observations to provide sediment descriptions. Soil samples will be collected in 6.0-inch brass liners using a 2.0-inch modified California split spoon sampler. All soil samples will be sealed with Teflon

sheets, capped, labeled and placed in a cooler at 4° Celsius for transport to the laboratory following Chain of Custody protocol.

A field observation process will be used to gather additional information through noting sediment type, especially grain size and clay content; moisture content; visible evidence of contamination, i.e., color change due to reduction of iron or discoloration from hydrocarbons and other pollutants, and any readings above background levels on an organic vapor meter (OVM). The OVM is a field portable photo ionization detector that uses a 10.0 eV lamp to detect compounds with ionization potential below 10.0 eV (hydrocarbon range).

2.3 Soil Laboratory Analysis

A maximum of twenty soil samples will be submitted to a California certified laboratory and will be analyzed for the following compounds:

- Benzene, toluene, ethylbenzene and xylene (BTEX) by EPA method 8260B
- Gasoline range petroleum hydrocarbons (TPH-G) by EPA method 8015M or (8260B).
- Oxygenated fuel compounds (MTBE, DIPE, TBA, TAME, ETBE) by EPA method 8260B
- Diesel range petroleum hydrocarbons (TPH-D) by EPA method 3545/8015M.

A Chain of Custody will be completed for all samples collected and tracked to ensure sample integrity.

2.4 Monitoring Well Installation

The CMT™ well sets will be constructed in the field by the drilling company with GTI staff assistance and supervision. The screened intervals will be chosen based on the lithology encountered in MW-4 and each successive borehole. Each well set will have three to five screened perforation points. The CMT™ tubing will be laid out on the ground and the screened intervals constructed using hand tools. The actual perforations in the walls of the CMT™ tubes are approximately four inches in length and are covered by stainless steel mesh. The perforations in the bottom caps are on four sides of the cap and approximately ¼ inch in diameter. This section is also covered by stainless steel screen.

Once the CMT™ tubing for each well set has been installed, alternating sections of #12 Monterey washed sand or equivalent and weighted bentonite pellets will be used to fill the annulus of the borehole (see Figure 4 for example of well construction). The sand filter packs will extend one foot above and one foot below the screened interval. A two foot thick bentonite annular seal will be placed at the top of uppermost screened interval's sand pack and the borehole grouted to the surface using neat cement grout augmented with 4% bentonite. The sections auger flights will be slowly removed one by one during the process to ensure correct annulus material placement and to keep the CMT™ tubing centered in the borehole.

The proposed screened interval details of the monitoring well sets are included in the following table (with simulated depths given as an example):

Well No.	Screen
MW-4	30'
MW-104	45'
MW-204	60'
MW-304	75'
MW-5	30'
MW-105	45'
MW-205	60'
MW-305	75'
MW-6...	etc.

2.5 Monitoring Well Development

After the well sealing materials have set (>48 hours) the new wells will be developed (using micro-pumping methods) until a clear stream of water is obtained. The wells will be purged and groundwater samples collected after well development. All development and purge water will be containerized in 55 gallon DOT approved containers and stored on site until their disposition can be arranged.

2.6 Groundwater Monitoring

The new monitoring wells will be incorporated into the existing semi-annual monitoring schedule.

2.7 Groundwater Sampling Procedure

Before sampling is attempted the wells will be sounded for depth to water. The wells will be purged of at least 3 well volumes of stagnant water using a dedicated Waterra pump system. Purging will continue until the temperature, conductivity, and pH of the groundwater has stabilized (<10% variation between three readings) indicating that formation water representative of aquifer conditions entering the well is being sampled. These water quality parameters are measured at intervals of each well volume purged.

A dedicated Waterra pump will be used to collect each groundwater sample for laboratory analysis. Care will be taken to minimize sample agitation while filling the VOA vials and glass amber liter bottles. Once the sample container is filled and capped, the bottle will be inverted, tapped, and checked for headspace bubbles. The sample container will be labeled with a unique designation, inserted into foam holders and placed in an ice chest cooled to 4°C for transport to the laboratory.

All non-disposable sampling equipment will be decontaminated using clean tap water, distilled water and Alconox detergent before and between uses. Disposable gloves will be used by the technician to collect all samples and will be changed with each sampling event.

A chain of custody document, listing all samples collected, accompanies the samples from field to laboratory, thereby providing a means to track their movement and insure their integrity.

All water purged from each monitoring well and not used as a sample, will be placed in a 55 gallon DOT approved container, properly labeled and stored on site until its proper disposition can be arranged.

2.8 Groundwater Laboratory Analysis

The groundwater samples will be delivered to California certified laboratory and analyzed for:

- Benzene, Toluene, Ethyl Benzene and Xylene (BTEX) by EPA method 8260B.
- Total Petroleum Hydrocarbons as Gasoline (TPH-G) by EPA method 5030/8015(M) or 8260B.
- Diesel range petroleum hydrocarbons (TPH-D) by EPA method 3510/8015M.
- Oxygenated Fuel Compounds (MTBE, DIPE, ETBE, TAME & TBA) by EPA method 8260
- EDB and 1,2 DCA (lead scavengers) by EPA method 8260.

2.9 Well Survey

The new and existing monitoring wells will be surveyed in accordance with GeoTracker requirements as soon as practical after installation.

3.0 GROUNDWATER MONITORING EVENT

GTI will perform the 2nd quarter 2006 groundwater monitoring event in June 2006 in accordance with the following procedures:

Before sampling is attempted the wells will be sounded for depth to water. The wells will be purged of at least 3 well volumes of stagnant water using a dedicated Waterra pump system. Purging will continue until the temperature, conductivity, and pH of the groundwater has stabilized (<10% variation between three readings) indicating that formation water representative of aquifer conditions entering the well is being sampled. These water quality parameters are measured at intervals of each well volume purged.

A dedicated Waterra pump or disposal Teflon bailer will be used to collect each groundwater sample for laboratory analysis. Care will be taken to minimize sample agitation while filling the VOA vials and glass amber liter bottles. Once the sample container is filled and capped, the bottle will be inverted, tapped, and checked for headspace bubbles. The sample container will be labeled with a unique designation, inserted into foam holders and placed in an ice chest cooled to 4°C for transport to the laboratory.

All non-disposable sampling equipment will be decontaminated using clean tap water, distilled water and Alconox detergent before and between uses. Disposable gloves will be used by the technician to collect all samples and will be changed with each sampling event.

A chain of custody document, listing all samples collected, accompanies the samples from field to laboratory, thereby providing a means to track their movement and insure their integrity.

All water purged from each monitoring well and not used as a sample, will be placed in a 55 gallon DOT approved container, properly labeled and stored on site until its proper disposition can be arranged.

The groundwater samples will be analyzed for constituents as above.

4.0 DATA ANALYSIS

The completion of the above field work will be documented in a site characterization report. In addition, GTI will also complete an updated Site Conceptual Model report for submittal to the ACEH. The Site Conceptual Model report will be presented in the following format:

1.0 INTRODUCTION

2.0 ASSESSMENT OF IMPACT
- *2.1 Release Documentation*
- *2.2 Site Investigation*
  - *2.2.1 Soil*
  - *2.2.2 Groundwater*
- *2.3 Chemicals of Concern*
- *2.4 Geologic/Hydrogeologic Site Characteristics*
- *2.5 Contaminant Distribution*
  - *2.5.1 Vadose Zone*
  - *2.5.2 Groundwater*
- *2.6 Contaminant Mass Estimate Calculations*
  - *2.6.1 Soil Gasoline Plume*
  - *2.6.2 Groundwater Gasoline Plume*
  - *2.6.3 Soil Contaminant Mass Estimate Calculations*
  - *2.6.4 Groundwater Contaminant Mass Estimate Calculations*
- *2.7 Groundwater Beneficial Uses*
- *2.8 Potential Effects of Residual Contamination*

3.0 DISCUSSION AND CONCLUSIONS
3.1 Discussion
3.2 Conclusions
4.0 RECOMMENDATIONS

This format has been submitted by GTI for other sites and found acceptable by various regulatory agencies.

5.0 SCHEDULES & REPORTING

Upon work plan approval, we will immediately proceed with budgeting/scheduling this project. Dr. Ray Kablanow, a California professional geologist, will supervise the project. Copies of the reports will be forwarded to the appropriate County and State regulatory agencies (ACEH and USTCFP).

With the intent of meeting the ACEH's April 16, 2006 schedule for reporting, our proposed schedule for performing the work proposed above is:

Additional Site Characterization

❑ Submit work plan	May 2006
❑ Receive work plan approval from ACEH	June 2006
❑ Perform Groundwater Monitoring Event (existing wells)	June 2006
❑ Finalize Budget	July 2006
❑ Install Monitoring Wells	August 2006
❑ Perform Groundwater Monitoring Event (new wells)	August 2006
❑ Submit groundwater monitoring report	August 2006
❑ Submit site characterization report	September 2006
❑ Submit Site Conceptual Model report	October 2006

6.0 SIGNATURES & CERTIFICATION

Geological Technics Inc. will perform this project in accordance with accepted geologic and hydrologic standards of the State of California accepted and in effect at the time of this investigation. Geological Technics Inc. is not responsible for undisclosed conditions.

This work plan was prepared by:

Joseph D. Angulo
Geologist

Professional Geologist
R.I. Kablanow II
No. 5234
08-31-06
Expiration Date
State of California

Raynold Kablanow II, Ph.D.
California Professional Geologist #5234
Certified Hydrogeologist #442

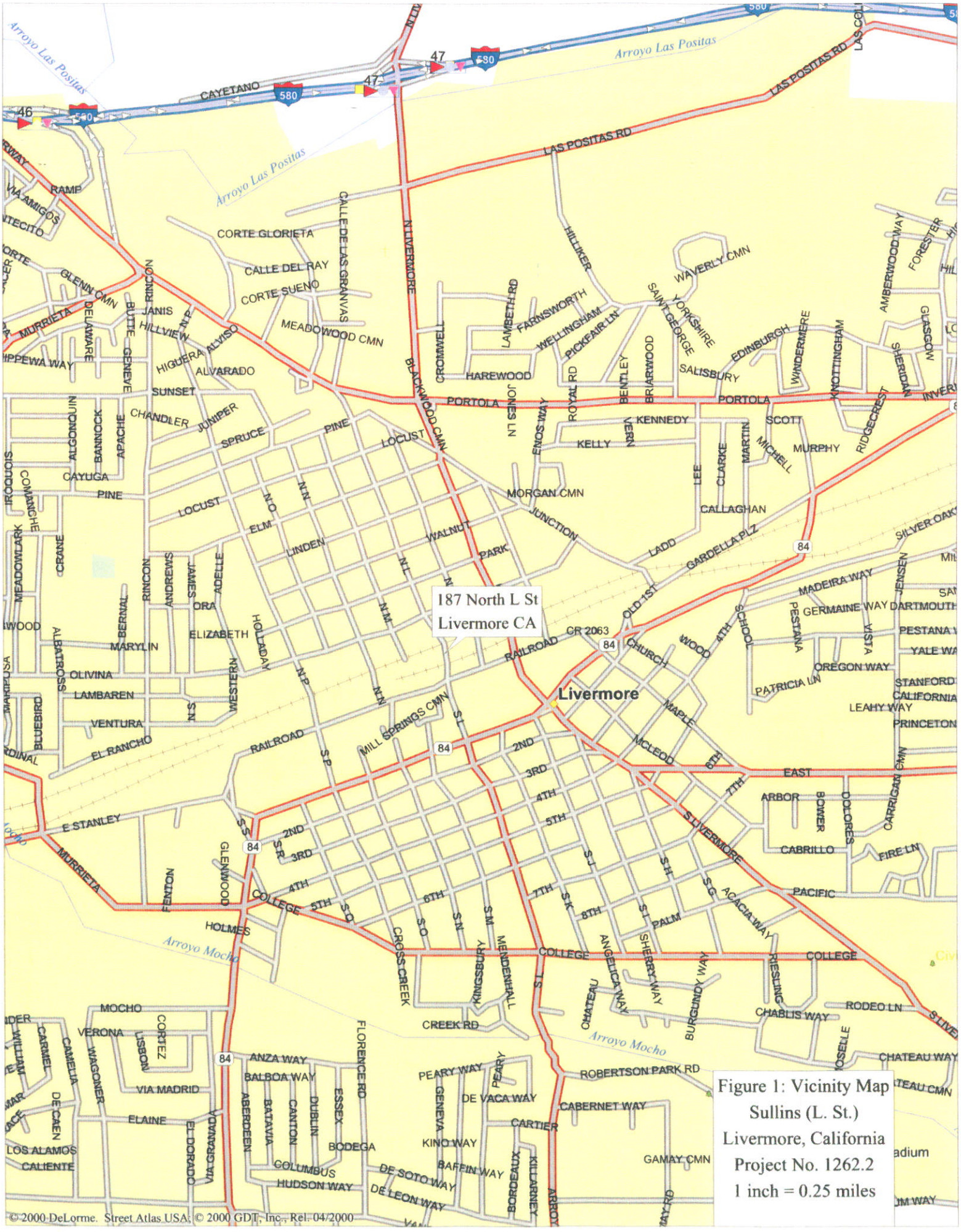


Figure 1: Vicinity Map
Sullins (L. St.)
Livermore, California
Project No. 1262.2
1 inch = 0.25 miles

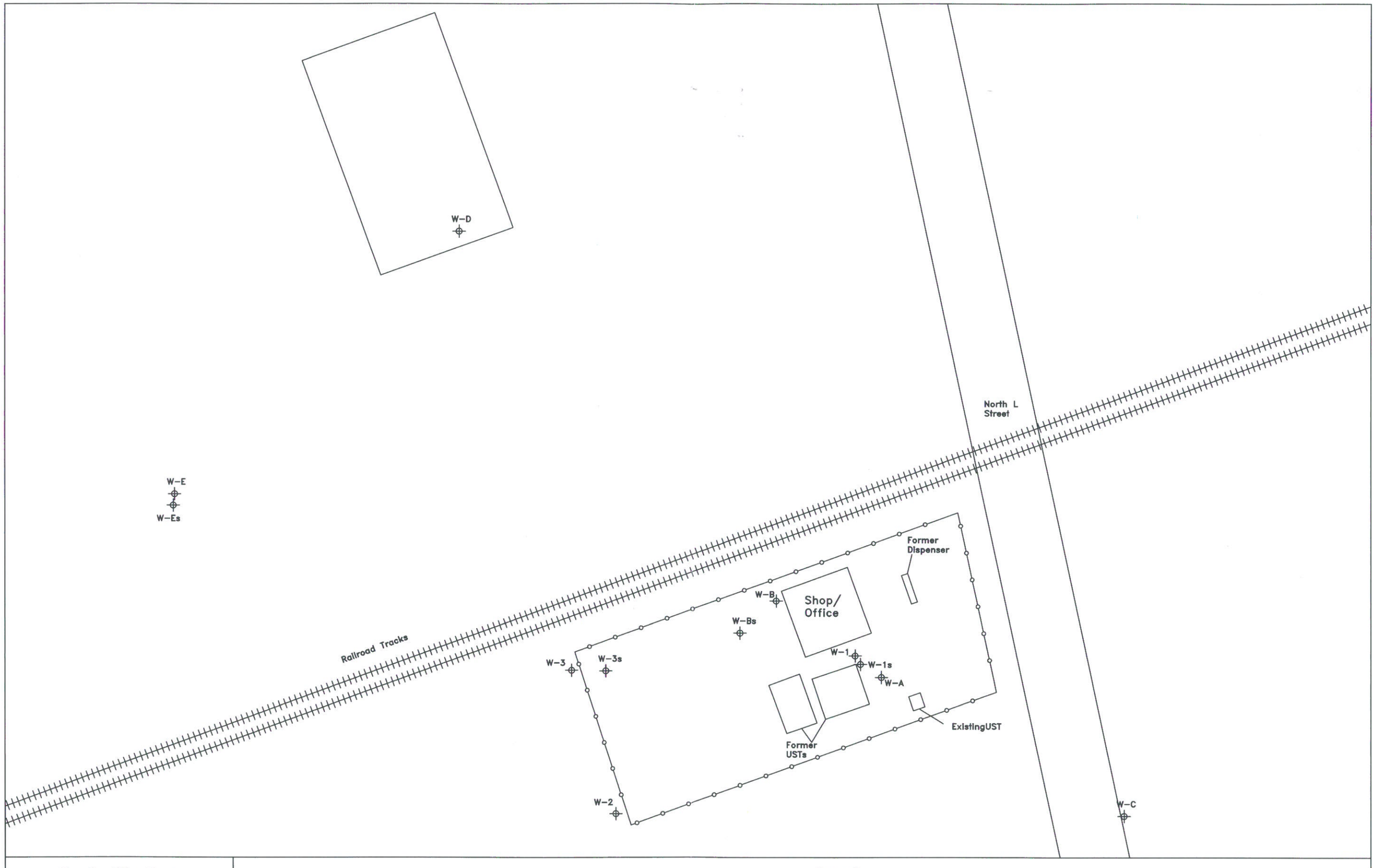


Fig 2: Site Map

Arrow Rentals
187 North L Street
Livermore, CA

Geological Technics Inc. 3/16/06

Legend

Monitoring Well

Soil Boring

N

0 50'

Scale

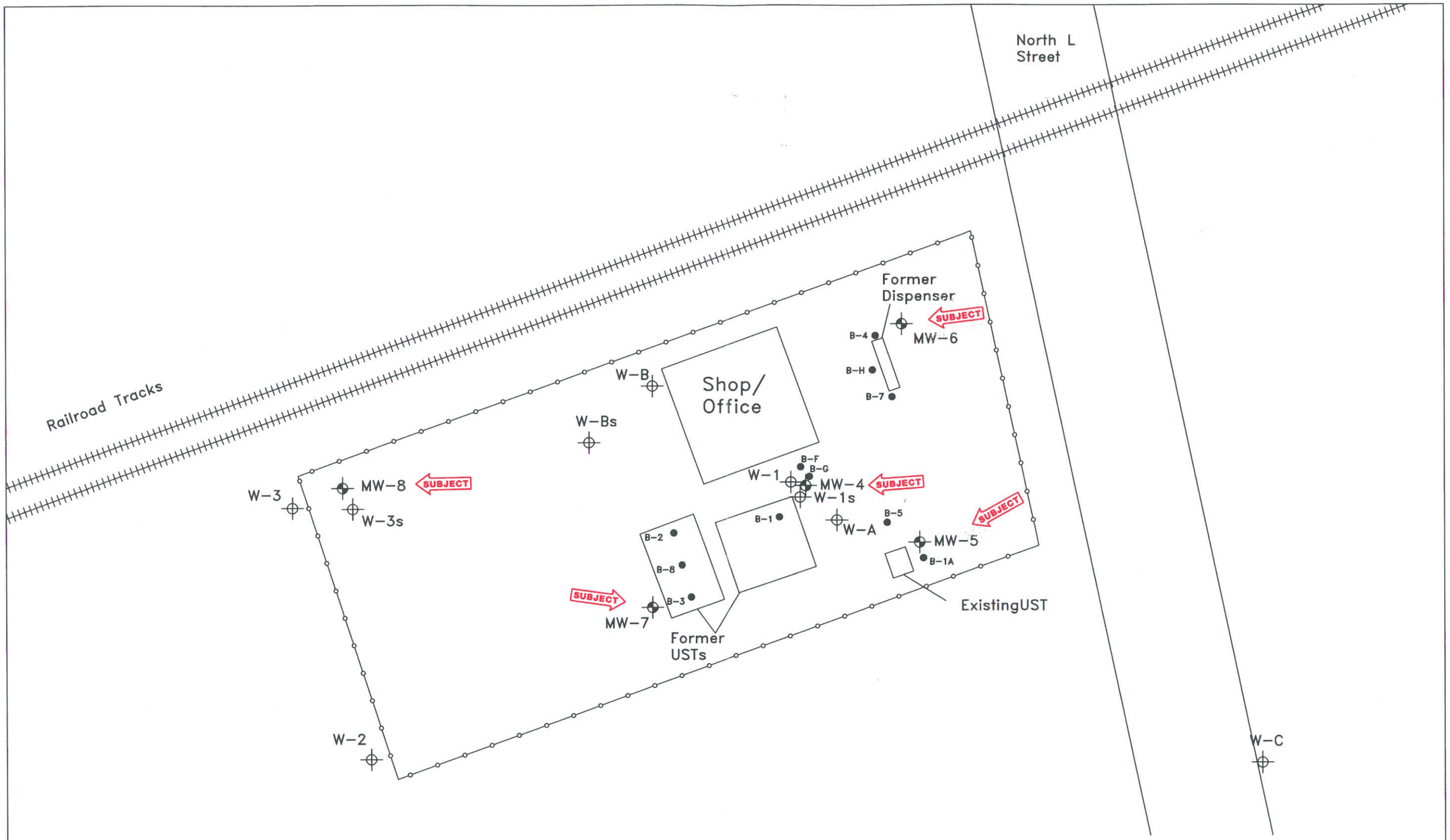


Fig 3: Site Detail Map

Arrow Rentals
187 North L Street
Livermore, CA

Geological Technics Inc. 5/18/06

Legend

- Monitoring Well
- Soil Boring
- Proposed Monitoring Well

N

0 30'

Scale

Appendix A

Health and Safety Plan

1.0 HEALTH AND SAFETY PROGRAM

Geological Technics has incorporated the following health and safety precautions while working on sites containing unidentified hazardous waste. Once the nature and extent of contamination has been determined, additional work on site will be met with the proper precautions.

1.1 Workers Health and Safety

1.1.1 Work Space Safety

The perimeter of the work space should, if possible, be 20 feet from the drilling rig or excavation site. Brightly colored delineators will mark the working perimeter. All unauthorized personnel will not be allowed access into the workspace.

The project supervisor will coordinate all field activities and maintain the safest possible working environment at all times. If an emergency occurs, the supervisor will immediately contact the proper authorities.

1.1.2 Skin and Head Protection

Disposable suits, boots, and gloves will be worn when the working conditions require such precautions.

Disposable plastic gloves will be worn at all times during soil and groundwater sampling. The gloves will be changed after each sample has been collected.

Used disposable clothing will be properly discarded at the end of each working day.

Hard hats will be worn during drilling, excavation, and other activities in which potentially dangerous equipment is being operated within the workspace.

1.1.3 Face and Respiratory Protection

During drilling and excavation activities, the working air space will be periodically monitored with a Photo Ionization Detector (PID) vapor content. The PID measures the total organic compounds (VOC) vapor concentration. Monitoring of the working air space shall be concentrated around the drilling rig and in the down wind direction.

If working air space concentrations exceed the Permissible Exposure Limits, then the workers will wear respirators with organic vapor cartridges.

If working air space at the perimeter of the working space has levels that exceed the Permissible Exposure Limits for more then 15 minutes, then the drilling or excavation activity will halt until the concentrations can be maintained below the Permissible Exposure Limits.

1.2 Health and Safety Agencies

1. Alameda County Environmental Health Services
   Name: Jerri Wickham
   Phone No: (510) 567-6791

2. Fire Department
   Name: Alameda Fire Department
   Phone No: 911

3. Company Health and Safety Coordinator
   Name: Ray Kablanow
   Phone No: (209) 522-4119

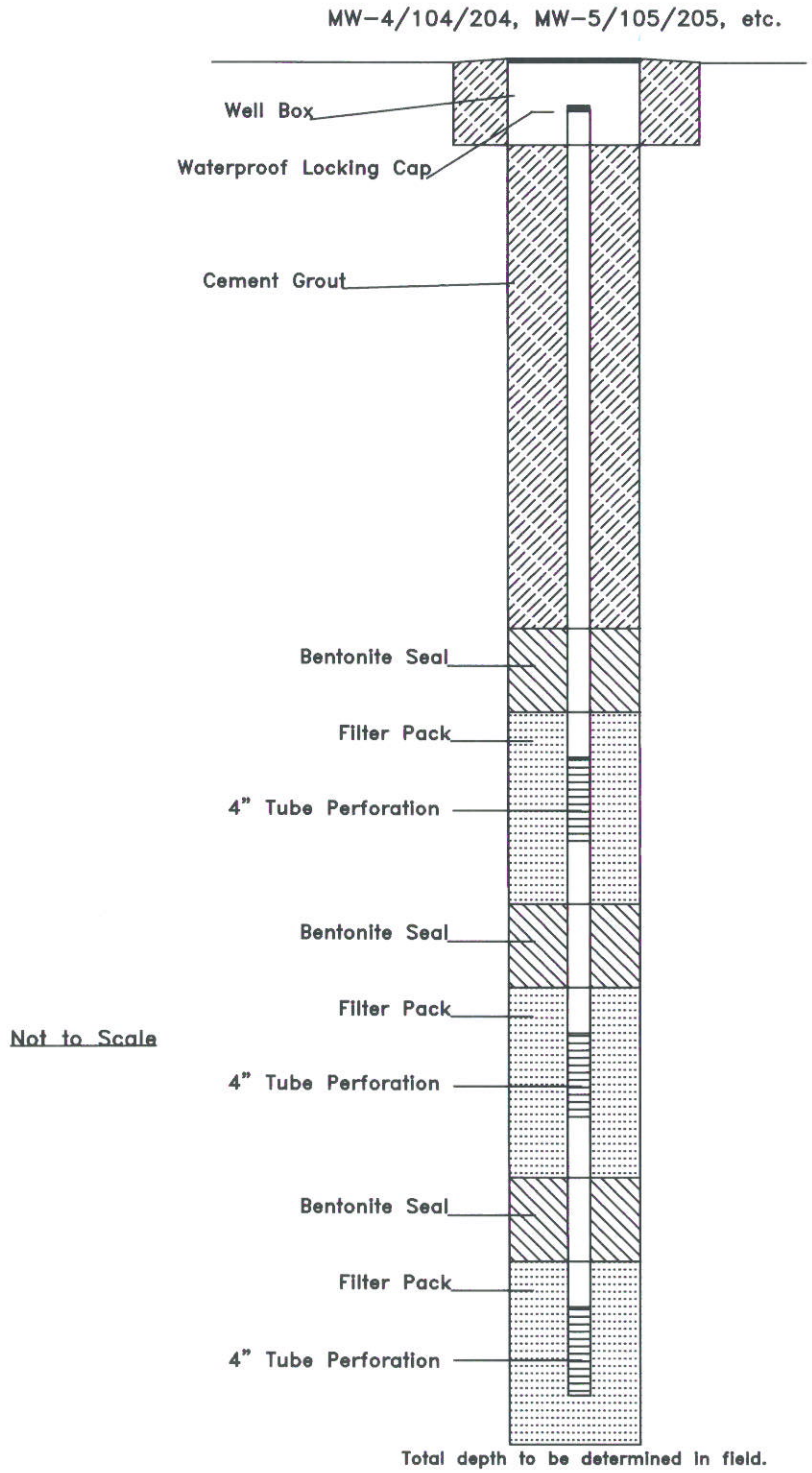
Appendix B

CMT™ Data

Figure 4: Schematic of Proposed CMT Monitoring Wells' Construction

Arrow Rentals Service (L St.)

187 North L St.
Livermore, CA



Not to Scale

Solinst® CMT Multilevel System

Model 403 Data Sheet

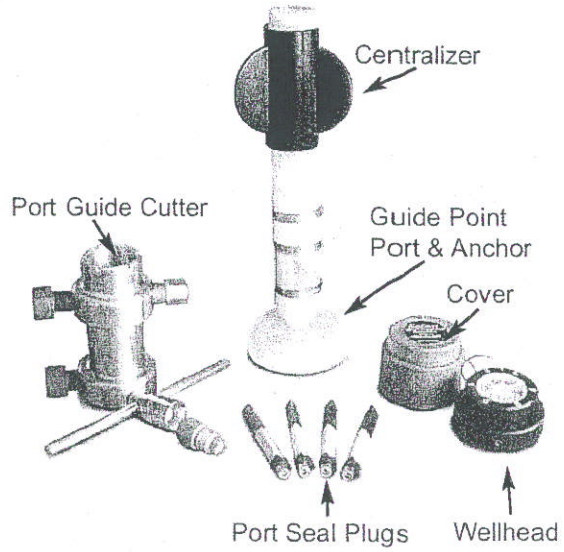
CMT Multilevel
Continuous Multichannel Tubing

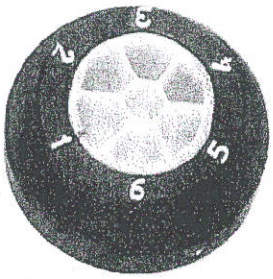
CMT Multilevel System

Model 403

This reliable, easy to install and inexpensive multilevel system provides site assessors with a better understanding of the 3 dimensional distribution of contaminants. Remediation strategies can then be targeted more precisely, focusing efforts in the most effective manner.

The CMT Multilevel System makes the accurate monitoring of MTBE and other contaminant plumes much more affordable. It provides detailed vertical as well as horizontal data. The simple 1.7" OD polyethylene tube is segmented into 7 channels, allowing groundwater monitoring at up to 7 depth-discrete zones. Monitoring zones are set where needed and the single tube design allows reliable seals between zones.





CMT System installed in a well

Applications

- Ideal for shallow wells in high water table
- Multilevel water sampling and level monitoring in overburden, bedrock or screened wells.
- Monitoring of natural attenuation or remediation processes
- Identify vertical as well as horizontal contaminant distribution with transect monitoring.
- MTBE Monitoring
- Mass transport calculations
- Determination of the best location for reactive barrier walls.

Endorsements

"We used CMT to monitor groundwater down gradient of an ORC barrier wall in a pilot study at a Superfund site....Our results showed that the CMT and packers performed as expected, isolating each sampling zone. Use of the CMT was an excellent idea".

Brian Butler, Senior Geologist,
Harding ESE

"Our initial assessment of the CMT system is that, it is performing as expected and we are pleased with the capability it provides..... Really great innovation, characterizes core of plume with far fewer wells."

Fred Kintzer, Principal
Geologist,Project Manager
Parsons Engineering Science Inc.

"On a chlorinated solvent site, it was extremely useful as a site characterization tool to better map contaminant's in 3D .... allowed targeting of remediation efforts."

Tim Buscheck,
Senior Staff Hydrogeologist,
ChevronTexaco

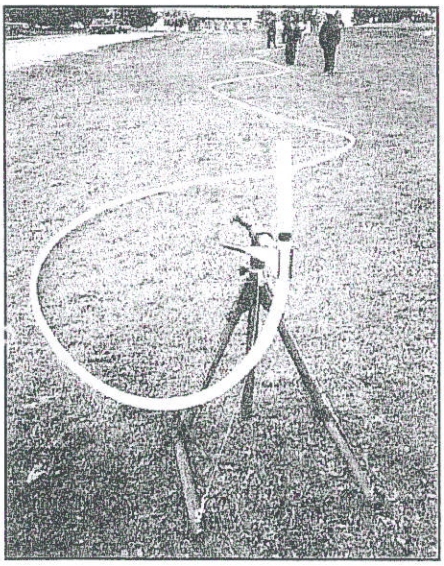
Advantages of Multilevel Systems

- Provide the most accurate 3-D assessment of a site
- Vital to understanding vertical flow of contaminants
- Allow documentation of changes in the concentraion and delineation of a contaminant plume
- Low cost compared with multiple individual wells.

Research has shown that contaminant plumes are often thin and highly stratified. Traditional monitoring wells, with screened intervals of 10 ft. (3 m) or more, blend the groundwater over the entire length of the screen. This can mask the true concentrations and distribution of contaminants. Multilevel wells with short screened intervals overcome this problem and offer more precise identification, better design options for treatment, and excellent ongoing monitoring.

Advantages of the CMT Multilevel

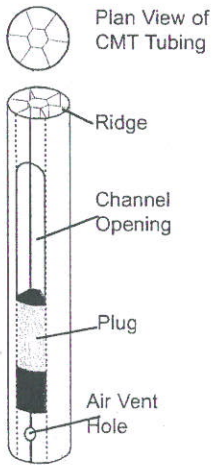
- Low cost and ease of use
- Up to 7-zone monitoring in a single tube
- No joints - offers one smooth surface for easy, effective sealing
- Ports and packers can be located anywhere along the tubing
- Double-Acting Packers allow easy system removal
- Simple system usually customized and built on site
- The hole is not left open to deteriorate or contaminant
- Installs quickly in large direct-push casing and bigger holes
- One seven-zone CMT System can be completed by two people in under 3 hours.
- Minimizes the risk of producing new contaminate pathways.
- Installations completed using alternate sand and bentonite layers are reliable and inexpensive.



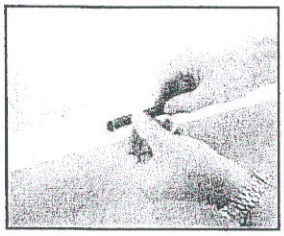
Convenient stand is used during port construction

Multichannel Tubing

A multilevel well that uses a continuous length of multichannel tubing has the advantage over other multilevels in that there are no joints. This significantly reduces the time and cost of installing wells and at the same time increases the reliability of the system. The CMT tubing is very simple and convenient to use, as it gives full flexibility as to where monitoring zones are located. Also a single coil of tubing can be used for a number of well installations. The tubing has a ridge down its entire length to allow for easy identification of specific channels. Ports and packers can be assembled onto the tubing in the field, immediately after drilling, to reduce open hole time and potential cross-contamination between zones.



Port Configuration



Inserting a Plug

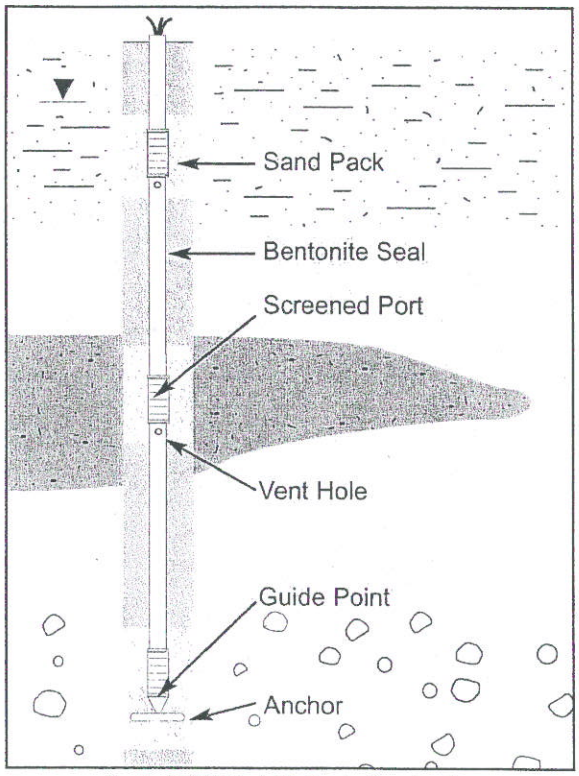
Completed Port

Ports

The number and location of ports may be determined in advance of drilling, or after coring. A Port Guide Cutter is used to cut 2 holes in a vertical line into a given channel, at the specified depth for each zone to be monitored. The wall of the channel between the holes is cut out leaving an opening suitable for inserting a plug, as illustrated above. The plug is positioned in the channel just below the channel opening. A vent hole is also placed just below the plug to allow air to escape as the system is lowered into the borehole. This allows water from the monitoring zone to fill the channel below the zone to overcome buoyancy. A stainless steel screen is fixed in place over the port to prevent fines from entering the channel. The screen kits come in a variety of mesh sizes, complete with clamps and plugs. Each channel is sealed at the bottom.

Seals & Packers

The CMT tubing can be installed using standard sand and bentonite layers placed using a tremie pipe, shallow depth gravity feed, or with the Solinst Mini Sand Bentonite Injector, (Model 561M). If the application is in loose sands, direct burial can be used, allowing the sand to collapse around the tubing.



Typical CMT Installation in Overburden with Bentonite Seals and Sand Pack

Double-Acting Packers

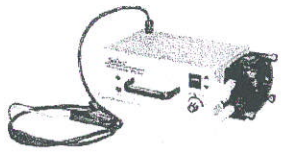
Ports and packers are placed exactly where needed prior to installation

Double-Acting Packers are ideal for use in situations where a CMT System is to be put inside an existing casing, or in a smooth rock borehole and when removal of the system for decommissioning or reuse is important. The Double-Acting Packers expand with an inner and outer gland to seal against the CMT Tubing and the borehole. The packers are hydraulically inflated allowing easy removal.

Monitoring Your CMT Multilevel

Water levels can be accurately established using the Solinst Mini 101 Water Level Meter.The Mini 101 is ideal for use in shallow CMT Systems. Lengths of 30ft, 65ft, 10m or 20m of the narrow 1/4" (6 mm) tape are mounted on a convenient small reel. A narrower coaxial cable Model 102 Water Level Meter may be easier for use in deeper CMT Systems. Levels can also be datalogged using a 3/8" diameter Druck Transducer. Sampling can be performed using the Solinst Model 410 Peristaltic Pump or a mini inertial Pump.

Model 101 mini



Peristaltic Pump Model 410

3/8"dia. Druck Transducer

Model 102 Water Level Meter

CMT System Components

The tubing is available in lengths of 100', 200' & 300' (30m, 60m and 90m). The tubing coils are approximately 4ft. (1.2m) in diameter. If deeper multilevels are desired the Waterloo Multilevel System be considered. (See Data Sheet 401). CMT tubing is laid out on the ground or plastic sheeting for the preparation of ports, and for placement of packers, if used. The 1.7" OD CMT tubing (43mm) has 7 channels. The 6 outer channels are approximately 7/16" ID (11mm) and the smaller central channel is 3/8" (9.5mm). The port screens are held in place using low profile clamps.

Double-Acting Packers are available in diameters to seal 3" and 4" wells. Centralizers can be used to help position the tubing in the borehole to ensure proper sand and bentonite distribution. The base of the system is completed with a Guide Point Port, which functions both as a point for easier installation and as a seventh port when needed. An optional anchor be added to prevent the system from lifting during installation. The top of the CMT is completed with a wellhead that labels each channel for easy identification.

Solinst

Drilling Methods & Techniques for Installing CMT Wells in Unconsolidated Aquifers

Drilling Method	Advantages	Preferred CMT Installation Technique	Comments
Sonic	Advancing casing during drilling minimizes redistribution of contaminant's in borehole. Steel casing prevents borehole from collapsing as CMT well is being built. Vibrating casing during removal reduces likelihood of bridging annular materials.	Place CMT tubing into casing with anchor plate attached to bottom of tubing. Use tubing centralizers to center tubing inside of sonic casing. Add alternating lifts of sand and bentonite pellets* as casing is withdrawn, either by gravity placement, tremie methods or using the Solinst Sand Bentonite Injector.	Depths up to 300 feet. Use casing with an inside diameter (ID) of at least 4 inches. Addition of water to casing may be needed to counteract heaving sand as casing removed.
Hollow Stem Auger (HSA)	Rigs widely available. Augers provide temporary casing that can be withdrawn as CMT well is constructed.	Place CMT tubing with anchor plate into borehole inside of hollow stem augers. Add alternating lifts of bentonite pellets and sand pack from surface as augers are removed. CMT tubing centralizers may be needed to keep annular space open during well construction.	Generally limited to depths of approximately 100 feet. Water may need to be added to augers to counteract heaving sand conditions. Use augers with at least a 4-inch internal diameter (ID).
Direct Push (DP)	Rigs are widely available.	Insert CMT tubing into DP casing, then withdraw casing.	Best for shallow installations where sand collapses around CMT tubing. May be difficult to tremie sand and bentonite due to small annular space between CMT tubing and DP casing.
Air Rotary with Casing Advance	Casing prevents borehole from collapsing as CMT well is being built. Consistent-diameterborehole. Prevents redistribution of contaminants along borehole wall during drilling.	Place CMT tubing into casing with anchor plate. CMT tubing centralizers should be used to center tubing in borehole. Add alternating lifts of sand and bentonite pellets* as casing is withdrawn, either by gravity placement, tremie methods or using the Solinst Sand Bentonite Injector.	Select casing with at least a 4-inch ID. Addition of water commonly needed to prevent heaving as casing removed.
Mud Rotary	Widely available.	Place CMT tubing directly into borehole with anchor plate attached to bottom of tubing. CMT tubing centralizers should be used to center CMT tubing in borehole. Place sand pack and bentonite with a tremie tube and grout pump.	Thin drilling fluid as much as possible prior to installing annular materials. Use a coarse-grained filter pack. Mud filter cake can be difficult to remove with development methods available for CMT wells.

* Coated bentonite pellets do not hydrate as quickly, therefore these pellets are useful for deeper applications.

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