GROUNDWATER MONITORING GUIDELINES

GROUNDWATER PROTECTION PROGRAM

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INTRODUCTION

Alameda County Water District's Groundwater Protection Program is designed to protect and preserve the community's drinking water resource for present and future use. These Groundwater Monitoring Guidelines (Guidelines) have been developed in cooperation with the cities which adopted their Hazardous Materials Ordinances before January 1, 1984, particularly the cities of Fremont and Union City. However, the Guidelines may also be used as reference for well construction by cities, such as Newark, which follow State of California Underground Storage Tank Regulations as set forth in California Code of Regulations, Title 23, Division 3, Chapter 16 (see Figure 1).

The purpose of a monitoring program is to detect as early as possible leakage from an underground storage tank, thus protecting the health and safety of the community and the environment. To accomplish this, wells should be constructed adjacent to underground storage tanks and, depending upon the depth of the water table beneath the facility, monitor either the first aquifer zone, the immediate unsaturated zone beneath the tank or the tank backfill.

In addition to this primary purpose of detecting leaks, these Guidelines also address the historical status of possible onsite contamination. This is accomplished through initial soil and groundwater sampling performed during monitoring well construction.

These Guidelines outline the general requirements, recommendations and suggested alternatives for the proper monitoring of underground storage facilities. A summary of the Guidelines appears in Table 1. Unusual or unique installations may be handled on a case by case basis.

If an unauthorized release (leak) is detected, both reporting and additional work are required. A portion of the Guidelines outlines the requirements related to both these tasks.

TABLE 1

SUMMARY OF GUIDELINES

		Storage Classification		
		Non-Motor Fuel (1)	Commercial Motor Fuel	Individual Agricultural/ Suburban Motor Fuel
Type of Wells Required	Depth to GW 0-20 feet 20-45 feet >45 feet	Groundwater only Combination Groundwater/Vadose Vadose Only	Groundwater only Groundwater and Vadose Vadose Only	Backfill Well
Number of Wells Required		One well or combination groundwater/vadose well (2) for each 35' of pipeline length plus longest backfill dimension	One well or combination groundwater/ vadose well for each 35' of pipeline length plus longest backfill dimension	One well
Soil (Laboratory) Testing Required		Yes	Yes	Yes
District Drilling Permit Required		Yes	Yes	Yes
Monitoring Schedule	Field Groundwater Vadose	Monthly Monthly	Monthly Monthly	Monthly
	Laboratory Groundwater Vadose	Semiannually Semiannually (3)	Semiannually Semiannually (3)	None

(1) Includes waste oil.
(2) See Section 6.4 for requirements applicable to alternative vadose systems.
(3) Vapors need not be laboratory tested if groundwater is laboratory tested.

Chapter 2

ADMINISTRATION AND ENFORCEMENT AGENCIES

All owners of underground hazardous materials storage facilities shall install a leak monitor/detector system. Owners of single-walled tanks shall install a suitable number of monitoring wells. The city of jurisdiction shall be the main administrative enforcement agency and Alameda County Water District (ACWD) shall act as a technical consultant to the city (i.e. Fremont, Newark, or Union City) for monitoring requirements.

The owner or engineering consultant (refer to Section 3), shall submit the monitoring proposal to the city of jurisdiction and to ACWD. This proposal shall include the names of all people (owner/manager/consultant) who can be contacted for information, a detailed site plan showing the configuration and location of tanks (both existing and former) and proposed wells relative to other site structures and street centerlines with all the related dimensions, as best known or estimated, the size and historical and current contents of each tank, and drawings showing a profile view of each storage tank. The proposal shall then specify the number of proposed wells, the proposed method of well installation, the proposed sampling method, the proposed number of soil and water samples and the proposed laboratory analyses to be performed. Copies of the proposal shall be submitted, simultaneously, to the city of jurisdiction and ACWD (*NOTE - if any spills are suspected or known at the site, RWQCB should also receive copies of all correspondence.)

ACWD shall then review the proposal, subsequently informing the tank owner or consultant of its adequacy. The applicant may be contacted by ACWD for information or, if necessary, be requested to make suitable revisions. Once the proposal is considered complete, the applicant shall apply for a well permit from ACWD. This permit must be issued before any well installation, in accordance with city well ordinances (refer to Subsections 3.2 and 3.3). In most cases, the permit includes a condition that all work performed must be in accordance with these Guidelines.

Monitoring wells are not required if double-walled tanks are installed and an acceptable alternative leak monitoring/detection program is proposed. However, such a proposal must be submitted to the city and ACWD for approval before installation.

ACWD also cooperates with the California Regional Water Quality Control Board - San Francisco Bay Region (RWQCB) in providing technical oversight of investigation and remediation at leaking underground fuel tank (LUFT) sites. Guidance for subsurface investigations at LUFT sites is contained in Chapter 8. Once cleanup has been completed at a site, ACWD refers the case to RWQCB for final review and sign-off.

Chapter 3

OWNER RESPONSIBILITY

Owner responsibility for groundwater monitoring is made up of two parts: 1) Installation of required leak monitoring/detection systems (Chapters 4-6); and 2) Required monitoring/reporting (Chapter 7).

3.1 Responsibility for Performance

The owner of any underground storage facility shall provide for the installation of an approved leak monitor/detector system and subsequently implement the required routine monitoring program. The owner should enlist a qualified professional/consultant to assume the technical responsibility for construction and monitoring. A State Certified Engineering Geologist (CEG) or a State Registered Civil Engineer (RCE) shall assume overall technical responsibility for said installations and all sampling for laboratory analyses.

3.2 Compliance with Well Ordinances

The construction of boreholes of any sort (including but not limited to those completed as wells), regardless of depth, which are drilled through the surface cover and therein have the potential to compromise or violate the natural protective overlying formation, is governed by city ordinance: Well Ordinance No. 950 as amended by Ordinance No. 963 of the City of Fremont; Well Ordinance No. 136 of the City of Newark; and Well Ordinance No. 109-73 of the City of Union City all of which are administered by ACWD. Such construction is solely limited to a driller with a valid California State Water Well Contractor's License (C57). Any well constructed as a monitoring well must be sampled annually (or more frequently) to avoid designation as an abandoned well, requiring State-mandated destruction.

3.3 Well Construction Permit

Well drilling permits must be secured from ACWD for the installation of monitoring wells or exploratory boreholes prior to construction. Each monitoring well requires a separate permit, while boreholes may be grouped together on the same permit application. With each permit, a site plan showing proposed locations of each borehole/monitoring well and a copy of the Site Hazard Information form should be attached. The owner, agent or consultant must apply for such a permit through ACWD's Engineering Department located at 43885 South Grimmer Boulevard, Fremont. The telephone number is 510-659-1970. The permit will be issued only after receipt of a complete application package, fees and acceptable proposal. All work must be tentatively scheduled with ACWD at least one week (7 days) in advance to allow scheduling of inspection; this tentative drilling date must be confirmed one working day in advance of field work.

3.4 Activities Following the Detection of an Unauthorized Release

Local hazardous materials ordinances, RWQCB's Basin Plan, and both the California Water Code and California Health and Safety Code all specify owner responsibilities for monitoring, reporting, and additional investigation and cleanup in the event leaks are detected. These responsibilities are clarified in Chapters 7 & 8.

3.5 Groundwater Extraction Wells

There is a replenishment assessment for all extracted groundwater. Therefore, extraction wells must be registered and metered. Contact the District's Engineering Department for additional information concerning this replenishment assessment program.

Chapter 4

CLASSIFICATION OF HAZARDOUS MATERIALS STORAGE FACILITIES

There are three classifications of hazardous materials storage facilities: 1) Non-motor Fuel Storage; 2) Commercial Motor Fuel Storage; and 3) Individual Agricultural and Suburban Motor Fuel Storage. Categorization is based on type, quantity and use of material stored (see Table 1).

4.1 Non-Motor Fuel Storage

Non-motor fuel storage facilities include all commercial and non-commercial underground tanks for the storage of non-motor fuel hazardous materials as described in the Hazardous Materials Storage Permit Ordinances. Bulk storages of waste oil are included in this classification as such storage could contain other than waste petroleum products.

4.2 Commercial Motor Fuel Storage

Commercial motor fuel storage facilities include all underground tanks for storage of motor fuels which are intended for commercial resale, including retail and wholesale outlets and bulk storage facilities. Also included are bulk storage for transit stations and industrial and municipal facilities as well as individual agricultural and suburban storage greater than 1,000 gallons.

4.3 Individual Agricultural and Suburban Motor Fuel Storage

Individual agricultural and suburban motor fuel storage facilities can include non-commercial underground tanks of less than 1,000 gallon capacity for motor fuel storage on agricultural properties, where fuel is stored solely for use by the owner/resident in the course of his farming or for his vehicles and equipment, and on suburban homesites with stored heating fuel. All motor fuel storage for commercial resale are excluded from this classification. This classification can only be applied by the City.

Chapter 5

MONITORING WELL REQUIREMENTS

In order to provide adequate coverage, monitoring well requirements may vary from one storage facility to another based upon the depth of groundwater beneath the facility, the size of the facility, the linear feet of piping, the character and properties of the materials stored and the age and condition of the storage tanks. Generalized requirements are summarized below but may vary on a site-specific basis.

5.1 Non-Motor Fuel Hazardous Materials Storage Facilities

5.1.1 Shallow Groundwater Conditions

A groundwater monitoring well is required at storage facilities where shallow groundwater exists within 20 feet of the surface (see Figure 2). Often the precise depth to groundwater is not known; the procedure then is to drill a hole outside the tank backfill, within 10 feet of the storage tank down to groundwater (or to a maximum depth of 45 feet if groundwater is not encountered; see Deep Groundwater Section 5.1.3). The hole is to be placed on the estimated down groundwater gradient side (based on professional judgment) of the underground storage tank(s). The well is to be completed as outlined in Section 5.4.

5.1.2 Intermediate Groundwater Conditions

If groundwater is encountered at less than 45 feet but greater than 20 feet from the surface both groundwater and vadose (unsaturated zone) wells shall be required so that early detection may be possible by the combination of monitoring wells. Refer to Figure 3 for a typical example of the combination groundwater/vadose monitoring well system. Exact construction requirements are outlined in Sections 5.4 and 5.5.

5.1.3 Deep Groundwater Conditions

If groundwater is not encountered within 45 feet of the surface, a vadose monitoring well shall be required.

If no permeable material was encountered in the original exploratory hole, drilled to 45 feet to determine depth to water, it shall be backfilled with neat cement (see Section 5.4 for sealing material and procedure description). A second hole shall be drilled within the tank backfill. A vadose well shall be constructed in accordance with Section 5.5 and Figures 3 and 4a.

If unsaturated, permeable material (e.g., Unified Soil Classification coarse grained soils) is encountered in the original borehole, a "dry groundwater well" may be required by the ACWD

well inspector; it shall be installed in the natural formation outside of the tank backfill. The full depth of the permeable materials (herein unsaturated) shall be slotted. If these permeable materials are not within 15 feet of the surface, a traditional backfill vadose well in combination with the "dry groundwater well" is required (see Figure 4). The occurrence of such a situation and the necessity for such a well is determined from the log of the borehole when it is drilled. Construction details of all monitoring wells are outlined below.

5.2 Commercial Motor Fuel Storage Facilities

The monitoring well requirement for commercial motor fuel storage shall be essentially the same as for a non-motor fuel hazardous materials storage facility. The only difference in concept is in the extended length required in the slotted/perforated casing interval of the groundwater monitoring well. As motor fuel products are essentially immiscible in water and are lighter than water, they will float on top of the water table. The important interval to monitor is the uppermost saturated material. Since groundwater levels fluctuate seasonally and on a long-term basis, the slotted/perforated interval has to extend higher to accommodate these fluctuations. This consideration may also apply to floating, immiscible non-motor fuel hazardous materials.

All other well requirements, including the possible need of a combination groundwater-vadose monitoring installation, are the same as for the monitoring of non-motor fuel storage. Refer to Figures 2, 3 and 4 for monitoring installations herein described.

5.3 Individual Agricultural and Suburban Motor Fuel Storage Facilities

The monitoring of individual agricultural and suburban motor fuel storage facilities shall be accomplished by the installation of one "backfill" well to be placed within the tank backfill and extended to the bottom of the backfill, regardless of the depth to groundwater. This well shall be placed at the lowest level of the backfill, if known. The lower one-half of the total length of this well shall be slotted and gravel packed. An annular seal of neat cement (see Section 5.4 and 5.5 for sealing material and procedure description) shall be placed above the gravel pack extending to the surface to prevent surface drainage from entering the well. The "backfill" well must have similar construction to the backfill vadose well pictured in Figure 3.

5.4 Groundwater Monitoring Well Construction Requirements

Drilling shall be accomplished with a hollow-stem, continuous flight auger. An auger should be chosen that is large enough to provide for at least a two-inch annular space between the outside of the well casing and the borehole. Appropriate safety measures should be applied in the possible presence of hazardous materials. Prior to the commencement of drilling each hole, augers shall be cleaned to avoid the introduction of off-site or cross contamination. The drill hole should be extended through the depth of the aquifer to an underlying clay layer or aquitard. Drill cuttings are to be labeled and contained pending receipt of laboratory results on soil samples (reference Figure 8). Disposal shall conform to applicable hazardous waste requirements. No slotting shall be allowed to connect two relatively permeable lenses which appear to be separated

by a relatively impermeable zone without the express approval of the ACWD well inspector. Should the first saturated material be greater than 20 feet thick, the well will be completed at a depth of up to 20 feet below the top of the saturated material (NOT 20 feet below the stabilized water level). The well should be completed such that the top of the screen is positioned above the anticipated seasonal high level of groundwater.

Casings are to be of clean, inert materials and have a minimum diameter of 2 inches. All PVC casings shall be joined by flush threaded joints; no glues or cements shall be used. Whenever possible the well casing should be held in tension during construction; this can be accomplished by suspending the casing above the bottom of the hole during the gravel pack and seal installation. Also, well centralizers are to be attached to the well column every 15 feet so that the well casing can be properly centered in the gravel pack and annular seal. Centralizers may not be required when constructing through the center of a hollow-stem auger.

Selection of slot size and filter material should be based on standard design criteria. The placement of the uppermost slot or perforation should reflect anticipated fluctuations in the water table. Based on site lithology, the ACWD well inspector can require that this slotting be extended up to the mid-tank level. Generally, the slotted/perforated interval is gravel or sand packed 2 feet above the uppermost slot or perforation. The filter pack shall not extend into any less permeable zones that overlie or underlie the water bearing zone to be monitored, unless otherwise approved by the ACWD well inspector.

An annular seal of neat portland cement shall be placed from the top of the gravel pack to the surface. (Note: Up to one foot of bentonite can be used as a "spacer" between the gravel pack and the cement seal; this bentonite is not considered part of the seal.) Refer to Figure 2 for typical construction details of a groundwater monitoring well.

The sealing material shall be a neat cement grout composed of one sack of Portland Type I/II Cement (94 lbs.) to five gallons of clean water or a sand-cement slurry with a minimum of eleven sacks of Portland Type I/II Cement per cubic yard. The sand-cement slurry must be mixed at a batch plant; mixing of sand-cement slurries onsite will not be allowed. If standing water is present or if there is more than a 30 foot length to be sealed, the sealing material shall be placed by means of a tremie pipe (maximum diameter of 3 inches) lowered to within 3 feet of the underlying layer of material or bottom of the well. The sealing material shall be placed in one continuous operation until the specified interval or borehole is filled. If a tremie pipe is used, the end of the tremie pipe shall remain in place in the sealing material until placement is complete.

The surface of each monitoring well is to be protected from fluid entry, accidental damage, unauthorized access and vandalism. Wellheads may be secured above or below the ground surface, depending on local conditions. In all cases a watertight cap shall be installed on the wellhead and the wellhead shall be secured with a locking lid or cap and kept locked. Wellheads secured below the ground surface should be completed in a Christy-type box or other vault. If a well is installed in an open field or on undeveloped land, a stovepipe-type well head is preferred in order to protect the well from damage and prevent the well from being accidently covered with soil or other materials.

The cover of the monitoring well shall be clearly marked "Monitoring Well." A small metal tag or similar device containing the well number and summarized construction data such as depth, hole and casing diameters, and location of the screened interval shall be permanently attached to the well or somehow permanently located within the vault securing the wellhead.

5.5 Vadose Well Construction Requirements

The construction materials and procedures detailed in Section 5.4, Groundwater Monitoring Well Construction Requirements, should be followed in the construction of vadose wells. If the vadose well is located within the backfill, the borehole shall fully penetrate the depth of the backfill and extend into the native formation for about one to three feet. The well shall be slotted/perforated starting at the bottom with at least one foot in the native material and up to approximately mid-level of the tank (see Figure 3). The requirement for a gravel or sand pack throughout the screened interval in a traditional "backfill" vadose well may be waived in any or all of the portion of screened interval depending on the nature of the tank backfill material.

5.6 Number of Required Wells

The number of monitoring wells or combination groundwater/vadose monitoring wells shall depend upon the size of the entire underground storage facility including tanks and/or pipelines. One well or combination groundwater/vadose well shall be required for each 35 feet of dimensional tank backfill length (or collective length when tanks are clustered). In addition, wells or combination wells shall be required to monitor underground product lines. The total number of wells or combination wells is determined by adding pipeline dimensions to tank backfill dimensions and dividing by 35 feet.

Each well shall be appropriately placed so as to accomplish optimal distributed coverage, taking into consideration the gradient of groundwater for groundwater monitoring wells and the lowest level of the tank backfill bottom for vadose wells.

Where groundwater occurs at a depth greater than 45 feet, only the first borehole at a site where multiple wells are to be constructed shall be required to make the groundwater level determination. (Note: for large multiple-acre sites where local groundwater variations are possible, additional exploratory boreholes may be required.)

5.7 Monitoring Well Destruction

Before beginning any monitoring well destruction (vadose or groundwater), the owner, agent or consultant must apply for a well destruction permit at ACWD's office located at 43885 South Grimmer Boulevard, Fremont. The telephone number is 510-659-1970. The permit will be issued only after receipt of a completed permit application; site plan showing the location of the monitoring well; Site Hazard Information Form; fees, and a letter indicating the reason for the monitoring well removal. Each monitoring well destruction requires a separate fee and permit application package. The actual destruction shall conform to the permit conditions. Permit

conditions are site specific but, generally, the existing well casing, screen, filter pack and annular seal shall be removed by drilling (using at least the same size auger or overdrilling when necessary) to the full depth and diameter of the original boring; the hole shall then be backfilled with neat cement (see Section 5.4 for description and placement of sealing materials).

Chapter 6

SAMPLING AND MONITORING SCHEDULE

Initial sampling and testing establishes existing site conditions. The continued monitoring of wells insures the early detection of possible future leaks. Recommendations and requirements for sampling techniques, monitoring frequency and laboratory testing follow.

6.1 Soil Sampling, Handling and Preservation

Soil sampling is performed during the installation of the monitoring well(s). Each groundwater monitoring well is to be logged and soil samples are to be obtained for laboratory tests in order to determine historical and current performance of the tank. The soil samples are to be obtained, starting at a depth approximately equal to the tank backfill/native soil interface, every 5 feet, at any lithologic changes and areas of obvious contamination down to the water table. If the water table is above the bottom of the tank, a sample shall be obtained from directly above the saturated zone for floating, lighter-than-water materials or directly below the saturated zone (i.e., within the aquitard) for sinking, heavier-than-water materials. A single soil sample is to be collected from each vadose well directly beneath the tank backfill/native material interface.

The soil samples for laboratory analysis shall be collected by driving a thin-walled shelby tube or a California-type drive sampler (reference: ASTM D1586-84). Upon collection, the sample tube is to be capped on both ends with a teflon cap. Alternatively, aluminum foil or teflon sheeting can be used to cover the ends of the sampling tube and then sealed with an air-tight cap on each end. Sample containers are to be labeled with borehole number, depth of sample, site identification, date and time of sample collection and initials of person collecting sample. These samples are to be immediately placed in a refrigerated ice chest containing dry ice in order to minimize volatilization for transport to a certified laboratory under proper chain-of-custody protocol (see Figure 7). If crushed ice or block ice is used, sample temperature must be recorded on chain-of-custody forms immediately upon receipt by the laboratory. This can be accomplished by placing a thermometer in the cooler used for transport. Soil samples shall not be held for more than 14 days prior to analysis and at all times be kept at 4 degrees centigrade pending analysis. Soil samples for testing by field inspection in the installation of a monitoring well for individual agricultural and suburban motor fuel storage can be obtained in the same manner or by obtaining disturbed samples with a power or hand auger.

There is no requirement for initial soil sampling in the case of a new, as yet unused, underground storage tank installation. However, prior hazardous material storage on the site or background data requirements may suggest the advisability of soil sampling.

6.2 Soil Testing

6.2.1 Non-Motor Fuel and Commercial Motor Fuel Storage Facilities

Soil samples obtained from non-motor fuel and commercial motor fuel storage facilities shall be laboratory analyzed individually. The sample from the uppermost zone (i.e., the sample taken from a depth approximately level with the bottom of the tank) shall be analyzed first. In deep or intermediate groundwater conditions, the "shallow" soil sample which must be submitted for analysis shall come from the native material encountered at the base of the vadose well boring. (See Section 6.1 for high water tables.) Succeeding samples must be analyzed if any sample above is determined to be contaminated (any detectable level of compound) or if there is field evidence (e.g., vapors or staining) of contamination at any depth. When deep groundwater conditions exist on site, the 45 foot soil sample should always be additionally analyzed even if no contamination has been noted. This 45-foot soil sample replaces the groundwater sample that would otherwise have been analyzed had groundwater been encountered.

When the history of the storage facility is precisely known and documented to the satisfaction of the enforcing agency, laboratory analyses shall test for the materials and related materials that are and were stored in the facility. If the history of the site is not precisely known, both heavy and light hydrocarbons and/or a complete gas chromatography/mass spectroscopy (GC/MS) scan of volatile organics (EPA Method 8240) and/or acid/base neutral extractables (EPA Method 8270) shall be performed as appropriate for the types of materials which may have been stored. In the case of waste oil tanks, soil shall be analyzed for heavy/extractable hydrocarbons, oil and grease and volatile organics (EPA Method 8240). Testing of soils shall employ San Francisco Bay Regional Water Quality Control Board (RWQCB) Standard Procedures as presented in Table 2. Suggested detection limits have been provided by RWQCB and presented in Table 3.

All laboratory analyses are to be performed by a state-certified laboratory using chain-of-custody procedures (see Figure 7).

6.2.2 Individual Agricultural and Suburban Motor Fuel Storage Facilities

Soil samples obtained at individual agricultural and suburban motor fuel storage facilities can be field tested. Tests to be performed are 1) presence of motor-fuel vapor; this can be most safely determined using field test apparatus; and 2) the observation of possible staining; in addition, the soil sample shall be vigorously mixed with water in a clear (transparent) glass vessel and the water inspected for the possible sheen of free product.

6.3 Groundwater Sampling and Testing

An initial laboratory analysis of groundwater from each installed groundwater well shall be performed after the well has been properly developed and purged (see below) to establish background levels that are site-specific. Following this initial sampling, monitoring shall continue for the life of the facility. Any excess water generated during development and/or

purging shall be handled in accordance with all hazardous waste requirements unless demonstrated through sampling to be nonhazardous.

Groundwater sampling for laboratory analysis shall be done in the following manner:

6.3.1 Well Development

All new groundwater monitoring wells shall be initially developed to clean the well and to stabilize the sand, gravel and aquifer materials around the slots/perforations. Well development may be accomplished by bailing, mechanical or air lift pumping, surging or swabbing. If mechanical development procedures are to be used, the well seal must be allowed to bond to the casing for 72 hours prior to development. Development water is to be labeled and contained pending receipt of laboratory results on groundwater samples (see figure 8). Disposal shall conform to applicable hazardous waste requirements. Well development shall continue until the well is thoroughly developed and as free of sand, silt and turbidity as possible. In some cases, initial development pumping may immediately dewater the well casing and thereby inhibit development. When this occurs, laboratory-clean water can be introduced into the well, followed by surging of the waters introduced with a swab or surge block. Care must be taken not to damage the well slots or perforations while swabbing or surging. This is to be followed by pumping or bailing. The procedure could be repeated as required to establish full development.

Since development can volatilize contaminants present, the well must be allowed to settle for at least 72 hours between development and the first purging/sampling incident.

6.3.2 Purging

The well shall be bailed or pumped (see "Sampling," below) to remove four to ten well volumes immediately preceding each sampling incident. Purged water is to be labeled and contained pending receipt of laboratory results on groundwater samples (see figure 8). Disposal shall conform to applicable hazardous waste requirements. If the well is evacuated prior to bailing the required volume, samples shall be taken after approximately 80 percent of the initial water level has been recovered. A field log shall be maintained by the sampler which includes observations of condition of water prior to purging (e.g., free product thickness), amount of water purged, ability to achieve stability of water quality parameters (e.g., temperature, pH and conductivity) and recharge.

6.3.3 Sampling

Samples to be submitted for laboratory analyses shall be obtained with a clean teflon or stainless steel bailer or a gas-actuated bladder pump. Alternative sampling techniques will be accepted only upon submittal of adequate documentation such as split sampling programs. The airlift form of sampling shall not be used for monitoring volatile compounds.

6.3.4 Handling and Preservation

Water samples shall be handled and preserved according to RWQCB guidance or DHS guidelines or the latest EPA methods as described in the Federal Register (Volume 44, No. 233, Monday, December 3, 1979, page 69544, Table II) or its amendments for the type of analysis to be performed. All sample containers shall be labeled with well number, site identification, date and time of sample collection and then transmitted to a state-certified laboratory under proper chain-of-custody protocol. A temperature reading should be recorded on the chain-of-custody form immediately upon receipt by the laboratory. Water samples shall not be held for more than 14 days prior to analysis and at all times be kept at 4 degrees centigrade pending analysis.

6.3.5 Testing and Monitoring Schedule

a. Non-Motor Fuel Storage Facilities: Constituents to be laboratory tested are to include materials or related materials that are being stored or had been stored in the underground storage tank. If this is not precisely known, a complete scan of all possible contaminants shall be performed. Recognized standard laboratory procedures are to be employed for non-motor fuels. Waste oil tanks should be monitored for: Oil and grease, volatile organics and heavy/extractable hydrocarbons. Table 2 specifies the minimum required testing. Monthly monitoring is required. If field analytical procedures are not feasible for the stored material, this monthly monitoring must, necessarily, consist of laboratory testing. Feasibility of field testing for non-motor fuels must be demonstrated to the satisfaction of both the City and ACWD prior to approval of such a monitoring plan.

b. Commercial Motor Fuel Storage Facilities: Qualitative sampling of both groundwater and vadose wells shall be performed on a monthly basis (see Section 6.4). Monthly water well sampling is to be done by using a clear (transparent) plastic ball-valve bailer. Water samples are to be field inspected for the presence of vapor and the observation of product or sheen on the water sample. Semiannual laboratory analyses of either groundwater (if present) or vapors (absorbed onto a carbon column and desorbed in the lab) are additionally required for quantitative evaluation. If fuel products are detected during routine monthly field testing, immediate notification of the City, ACWD and RWQCB is required (see Chapter 7). Initial and semiannual laboratory testing should include, at a minimum: Total Petroleum Fuel Hydrocarbons (TPH-g or light/volatile fraction) with benzene/toluene/xylene (BTX) distinction if gasoline is stored or Total Petroleum Hydrocarbons (TPH-d or heavy/extractable fraction) if diesel or long-chain fuel oils are stored. Analyses shall be performed using RWQCB procedures (see Table 2). All laboratory results should be forwarded to the City and ACWD in a timely manner, regardless of test results.

c. Individual Agricultural and Suburban Motor Fuel Storage Facilities: Currently, laboratory testing of wells at individual agricultural and suburban motor fuel storage facilities is not a requirement. However, monthly monitoring with field inspection of any liquid samples that can be obtained from the backfill well for vapor/sheen should be performed, at a minimum (see Section 6.5).

6.4 Vadose Zone Monitoring

Vadose zone monitoring includes the monitoring of vapors as well as any fluids that may be found in the soils above the saturated zone. This section also includes discussion of optional vadose continuous monitoring systems and guidelines specifying minimum requirements for their installation. Where vadose monitoring is required by the groundwater depth, a vapor monitoring system shall be installed where volatile and semivolatile products are stored, whereas either a suction lysimeter or an interface well shall be installed where nonvolatile products are stored.

6.4.1 Vapor Monitoring Well

A vapor monitoring well is one which will allow a vapor sample to be extracted from the soil for analysis. Installing a vapor monitoring well involves constructing a vadose well in the conventional manner as described in Section 5.5 and pictured in Figures 3 and 4. The well should be located within the tank backfill area, but, in some cases (see Section 5.1), it may be located outside the backfill area within ten feet of the tank. See "Performance Evaluation", Section 6.4. 5, for additional tests required in that case.

6.4.2 Vapor Extraction Well

A vapor extraction well is one which will allow vapors to be withdrawn from the soil for remedial purposes. Construction of new wells shall follow specifications presented on Figure 3; modifications to existing wells may require permitting and inspection.

6.4.3 Vapor Monitoring Systems

a. Field and Laboratory Monitoring: Monthly field testing can be accomplished through purging followed by vapor passage across approved detectors (check with the City for acceptable monitoring/detecting devices). A typical vapor well sampling protocol consists of: measuring and recording ambient vapor readings at the depth to be sampled, purging the well of at least five well volumes of vapors, and taking a second reading of contaminant vapors at the appropriate depth. Appropriate depths should be selected based on relative vapor densities of contaminants in question. Purging can be accomplished through the use of vacuum pumps. If groundwater samples are not laboratory analyzed on a semiannual basis, an additional vapor sample should be obtained semiannually, passed over a carbon tube and submitted to a certified lab under chain-of-custody for desorption/analyses. Typical protocols for obtaining semiannual vapor samples are contained in Bay Area Air Quality Management District's "Manual of Procedures" and the National Institute for Occupational Safety and Health's "Manual of Analytical Methods".

b. Continuous Monitoring Devices: The available continuous vadose monitoring devices which are placed into vadose wells can be broadly categorized into two groups: (1) active or aspirating devices which are sampling devices and (2) passive or non-aspirating

which are nonsampling devices. The minimum requirement for use of these devices, as specified under these Guidelines, only allows the use of devices which are specifically calibrated to detect the presence of the material stored in the tank. Manufacturer's instructions must be followed in all cases. Semiannual calibration of continuous monitoring systems by some third party qualified to perform such a calibration is required. Verification of these calibrations must be sent to the City.

(1) Aspirating Systems: Continuous aspirating systems generally consist of multiple probes connected to a central control/detector panel which alternately withdraws and analyzes vapor samples from each of the sampling probes/vadose wells on a rotational and periodic basis.

At least one probe should be placed for each tank, one additional probe for each 35-foot length of piping and one probe for each group of product-dispensing units (pump island). Additional probes may be required based on the permeability of the backfill material, volatility of the material stored and size of the tank. The required number and location of probes is subject to the discretion of the local agency of jurisdiction. Each probe should preferably be placed at the bottom of the tank or piping backfill for detection of heavier-than-air vapors. In all cases, the perforated portion of the probes should extend no higher than the midpoint of the tank or pipe.

Each probe is to be placed within a rigid chamber of a material impervious to the tank contents and any constituents which would be expected to be found in the backfill. This chamber shall conform to vadose monitoring well construction guidelines shown on Figure 3. At a minimum, each probe chamber must be sealed at the ground surface with at least a five-foot sanitary seal to prevent surface vapors from entering the chamber when a vacuum is applied to the chamber for purposes of obtaining a vapor sample. A typical installation is shown in Figure 6.

It is important that the construction details of the probe chamber allows access to the interior of the chamber for probe inspection, calibration, cleaning and/or replacement.

(2) Non-Aspirating Systems: Non-aspirating systems do not draw a vapor sample from the soil for transport to a central detector as aspirating systems do. Instead the detectors, themselves, are located in the probe assembly located within the vadose well (for construction, see "Aspirating Systems," above). Chemical concentrations in static soil vapors which are in direct contact with the sensing devices are recorded remotely at a central control board. The installation requirements for these devices are similar to those of aspirating systems with one possible further restriction.

The aspirating system draws vapors from the soil around the probe and there is a corresponding radius of influence of that well. The non-aspirating device is testing only those soil vapors which come in contact with the detector. Therefore, the non-aspirating systems can require a larger number of probes for an equally effective system.

As with the aspirating systems, it is important that the construction details of the probe allow access to the interior of the vadose well. In addition, the detector shall be able to be removed for inspection, calibration, cleaning and/or replacement.

6.4.4 Fluid Monitoring System

One of the following systems shall be installed to satisfy the vadose monitoring requirements for non-volatile types of materials:

a. Suction Lysimeter: Suction lysimeters are commonly used to extract small volumes of fluids from unsaturated, though quite moist, soil zones, usually at shallow depths. They shall be placed in a position to maximize leak detection. Ideally, the porous cup of the lysimeter should be seated into the fine-grained, rather than granular, geologic materials which coincide with a probable contaminant migration pathway. The hole shall be backfilled with a very fine, pure silica sand (commercially available) so as to encase the lysimeter. The very fine sand is to be installed by either tremiing a sand-water slurry into the hole or by hand pouring the sand into the hole and tamping continuously to insure a good, tightly-compacted contact between the lysimeter and the materials to be monitored (soil formation or tank backfill). A nominal bentonite pellet "seal" can be placed above the sand pack envelope followed by the placement of standard cement sealing materials to the surface. Other provisions for the installation of lysimeters shall follow instructions provided by the commercial supplier. It should be understood that the operational range for a suction lysimeter is between 5 and 60 centibars and that the device is not optimally suited for the collection of volatiles.

b. Interface Well: A traditional backfill vadose well is drilled and constructed in the manner described in Section 5.5 and Figure 3. The sensing zone is placed at the formational interface between the backfill of the tank and a less permeable underlying natural formation. Fluid sampling with a teflon or stainless steel bailer or a wick-style sampler may be possible when a temporary condition of saturation develops at the interface as a result of tank leakage or leaching down of surface drainage waters. This type of well will be most effective for collecting fluids when the backfill material is more permeable than the underlying natural formation.

6.4.5 Vadose Well Performance Evaluation

Vapor monitoring wells located within the backfill area are considered relatively reliable for detecting the presence of vapors; therefore, initial tracer studies will not be required for these wells. It shall be the responsibility of the owner of the facility to have the monitoring system periodically cleaned, inspected and otherwise maintained as necessary to insure the continued performance of that system.

Further, monitoring systems utilizing a dedicated sensing device (i.e., one that is permanently installed as part of the system) should be tested monthly to verify that the sensor is functioning properly. Semiannual testing and calibration of the sensor(s) shall be conducted by a third person qualified to conduct such a calibration or in the presence of the local agency of jurisdiction.

Vadose wells constructed outside the tank backfill, if used for routine vadose monitoring, are to undergo tracer studies to prove they can detect appropriate vapors in a timely manner. This can also be required, on a discretionary basis, in the case of a "questionable" site (i.e., field personnel were unsure whether or not backfill was present).

6.5 Individual Agricultural and Suburban Motor Fuel Storage Facilities Monitoring

Monitoring of individual agricultural and suburban motor fuel storage facilities shall be performed on a monthly basis and shall be accomplished by the probing of the monitoring well for the detection of motor fuel product or any fluids in the well. This can be performed by lowering a liquid-detecting tape.

If fluids are present in the well, a clear plastic ball-valve bailer should be lowered to secure a sample which can be tested for the presence of motor fuel by noting the presence of vapors and the visual observation of product or sheen on the water sample.

Chapter 7

INITIAL AND ROUTINE REPORTING

The results of initial soil testing, water analyses and vadose monitoring (Sections 6.2, 6.3 and 6.4) are to be reported to both the Administering/Enforcement Agency and to ACWD in a timely manner (e.g., within 15 days of completion of work). A DWR Water Well Driller's Report, Form 188, must also be filed with ACWD within the 15 days following completion of work to fulfill permit requirements. The format for such an initial report should be comprehensive and include information consistent with that presented in the proposal (Reference: Chapter 2 of these Guidelines).

Routine monitoring and reporting should comply with municipal Hazardous Materials Ordinances. All semiannual laboratory results should be forwarded in a timely manner to both the City and ACWD accompanied by a completed chain-of-custody form, summarized field notes and sampling protocol; this semiannual report should include a tabulation of monthly field testing results from the preceding six months. In the case of continuous monitoring devices, semiannual records of calibration by a third party qualified to perform such calibration shall be submitted to the City within 30 days of the calibration. State tank regulations require that all monitoring records be kept on site, available for inspection by the City, ACWD or RWQCB, for a minimum of 36 months.

Any significant increase above background/initial readings noted during field or laboratory testing is indicative of a suspected release and should be immediately (within 24 hours of receipt of results) reported to the City, ACWD and RWQCB. A confirmatory written notification is to follow to all three within five working days. Additional work, described in Chapter 8, should be initiated.

Chapter 8

GUIDANCE FOR SUBSURFACE INVESTIGATIONS AT LEAKING UNDERGROUND FUEL TANK SITES

Following the detection of an unauthorized release from a leaking underground fuel tank (LUFT), additional work is usually required on the site. Quarterly reports should be submitted detailing efforts to define and remediate soil and groundwater contamination.

The intent of this chapter is twofold: to give guidance in the process RWQCB has established for subsurface investigation and remediation and to provide guidance on the type of information to be included in proposals and technical reports. Prior to work at a site, an acceptable proposal for work must be submitted with an Application for Well Permit, Site Hazard Information Form, and appropriate fees (as required for proposed work) or included as part of a technical report. Work proposals will be reviewed and commented upon by ACWD staff.

Although the investigation and remediation process must be implemented for every site where a fuel leak has occurred, portions of the information to be included in proposals and reports may not be applicable for every report. However, the sections which do apply to the scope of work being performed should be included. All technical proposals and reports should be signed by a California-Certified Engineering Geologist, California-Registered Geologist, or a California-Registered Civil Engineer. Copies of all proposals and reports must be sent to ACWD, Regional Water Quality Control Board and the city of jurisdiction.

8.1 Regional Water Quality Control Board: Guidance for Investigation and Remediation

8.1.1 Determination of the Extent and Magnitude of Soil Contamination

The horizontal and vertical extent of soil contamination must be defined. Sampling protocols should conform to Sections 6.1 and 6.2. Soil boring or soil characterization may be used to define residual soil contamination after tank excavation. Soil characterization should be used for definition during overexcavation. Soil characterization sampling requires that an adequate number of soil samples be collected from all the sidewalls and the pit bottom in a grid matrix pattern between five and fifteen foot intervals depending on pit size, at relatively permeable lenses, at the soil/groundwater interface if encountered, and at obviously polluted locations which are determined either visually or by field screening devices. Results of soil sampling should be tabulated and depicted on cross-sections (See Figures 9 and 10). Excavations require engineered backfill which minimizes the potential for new pollutant migration pathways.

Soil samples should be analyzed in a Department of Health Services (DHS)-certified laboratory for the appropriate constituents as specified in Table 2. Detection limits shall meet those specified in Table 3.

8.1.2 Definition of the Horizontal and Vertical Extent of Groundwater Contamination, Both On-Site and Off-Site

Floating product and dissolved constituent plumes must be defined. Definition of contamination should be presented in plume maps for each constituent. "Zero lines" should be established based on current detection limits (see Table 3).

Construction of monitoring and extraction wells should be consistent with these Guidelines. Figure 2 shows construction details for a typical "first zone" groundwater monitoring well. Deeper wells for vertical definition should conform to Figure 5. Filter pack and slot sizes for all wells should be based on a particle analysis (ASTM D-422) from each water-bearing stratigraphic unit to be monitored as determined from at least one boring on the site. All wells should be surveyed vertically to mean sea level (MSL) and horizontally to a permanent benchmark.

Monitoring wells should be sampled for free product and dissolved constituents monthly for three consecutive months after well installation. Subsequent to the third monthly sampling, samples should be taken quarterly from all monitoring wells. In no case should the monitoring be less frequent than quarterly. It may be appropriate to sample more frequently following the initiation of groundwater remediation. All measurements of floating product in monitoring wells should be performed using an optical probe or other device which has been shown to be of equivalent accuracy. The water samples should be analyzed in a DHS-certified laboratory for the appropriate constituents as specified in Table 2 and at appropriate detection limits which are provided in Table 3. Sampling protocols should conform to Section 6.3.

8.1.3 Interpretation of Hydrogeologic Data

Water levels should be measured to the nearest 0.01 feet in all wells according to the monitoring schedule discussed in Section 8.1.2. Contour maps and gradient determinations should be submitted for every sampling incident.

The geologic characteristics of the aquifer must be adequately described. An estimate of vertical transmissivity, based on a laboratory permeability test or a pump test, is required for any unit identified as a clay. Identification of the clay should be verified by particle analysis (ASTM D-422). Geologic cross-sections should be prepared using appropriate boring logs. The cross-sections and groundwater gradients (both horizontal and vertical) should be interpreted to explain pollution migration patterns. At least one deep borehole on each site should be continuously cored and logged so that sandy zones 6-inches thick or greater are identified.

8.1.4 Determination of the Potential Short- and Long-Term Impacts of the Pollution Plume on the Beneficial Uses of Ground and Surface Water

Since local groundwater is a critical drinking water source, a complete survey of wells within a one-half mile radius of the site is required whenever there is groundwater contamination. This survey should document the location and current or planned use of these wells.

Identification and protection of other beneficial uses related to surface water which might be impacted by this site must also be addressed. Examples of beneficial uses other than drinking water include groundwater recharge, wildlife habitat and contact and noncontact recreation.

Evaluation of the actual or potential short- and long-term impacts of this site on these beneficial uses is also required.

8.1.5 Development of a Remediation Plan

In addition to the above investigative work, a remediation plan for each fuel leak site should be developed. The plan must include a time schedule and address the following issues:

a. All free product must be removed with an appropriate remediation system. Immediate implementation is expected; any delays must be explained using appropriate technical justification. Often, free product removal systems are considered interim/emergency procedures.

b. Soil contaminated with petroleum products in excess of 1,000 ppm is considered a hazardous waste (California Department of Health Services, executive memorandum). Storage on site (above or below grade) for more than 90 days is not allowed under Title 22, Article 6 (66508A) without either a variance or permit. Materials shown to contain concentrations between 100 and 1,000 ppm TPH or TOG are classified as "designated wastes" and may be subject to similar requirements.

c. Dissolved constituents and contaminated soils (including those not considered hazardous) must be remediated such that beneficial uses of the ground and surface water are restored and/or protected as required by RWQCB's "Policy with Respect to Maintaining High Quality of Waters in California."

d. The design of remedial action systems should be based on appropriate review of hydrogeologic and water quality data. Aquifer test data (pump and/or slug testing) should be used to determine aquifer characteristics and the probable capture zone(s) of extraction system(s). Manual bailing of fuel product is not acceptable as a recovery system. The overall effectiveness of the remediation system should be verified by an appropriate monitoring program following installation. Remediation effectiveness, such as an estimate of cumulative product removed and ability of the system to hydraulically contain all groundwater contamination should be documented in a capture-zone assessment report due 90 days after system start-up.

8.2 Information to be Included in Proposals and Technical Reports for Soil and Groundwater Investigations

8.2.1 Cover Letter

A cover letter from the responsible party or company must accompany each technical report; both letter and report must be submitted to the Alameda County Water District by the established due date. The cover letter should include, at a minimum, the following wording:

> "I declare under penalty of perjury, that the information and/or recommendations contained in the attached proposal or report is true and correct."

This letter must be signed by the responsible party or an officer or legally-authorized representative of the company.

8.2.2 Introduction

a. Site Contacts must be provided. Include the names, addresses and telephone numbers of all people (owner, occupant, consultant) who can be contacted for information. The name of the principal site contact should be specified.

b. A summary of the site history should be included which addresses the following:

(1) Tank owner and contact person, if different.
(2) Number, capacity, contents, and construction material of tanks.
(3) Age and historical use of the tanks and site.
(4) Spill, leak, and accident history of site.
(5) Copy of State's Unauthorized Release Report, as filed.
(6) Estimate of quantity lost.
(7) Previous subsurface work performed at the site.

c. Objective and Scope of Work should be submitted for each Work Plan or Proposal.

8.2.3 Site Description

a. Location of Site

b. Survey of Wells within a 1/2 Mile Radius of the Site

c. Description of Local Area (topography, geology, nearby creeks/flood control channels, groundwater recharge facilities, major underlying aquifers, etc.)

d. Depth to Groundwater

8.2.4 Site Status

a. Actions that Occurred in the Preceding Three Months

b. Actions Planned for the Following Three Months

c. Status of Soil Contamination Definition (tabulated and presented as cross sections, showing both lateral and vertical extent)

d. Status of Soil Remediation (hazardous waste issues as well as protection/restoration of beneficial uses)

e. Status of Free Product Plume Definition (tabulated and presented as a plume map showing measured thicknesses)

f. Status of Free Product Remediation (i.e., tabulation of episodic and/or continuous removal of free product during the quarter, with estimates of cumulative removal to date)

g. Status of Dissolved Constituent Plume Definition (tabulated and presented as plume maps of individual constituents) - include discussions pertaining to both lateral and vertical extent

h. Status of Dissolved Constituent Remediation (i.e., ongoing evaluation of remediation system performance in addition to detailed system assessment to be prepared within 90 days of start-up)

i. Status of Project Schedule (including design, construction and permit landmarks; identify any obstacles which may delay or interrupt the agreed upon schedule and what actions are being taken to overcome these obstacles)

8.2.5 Well Installation and/or Soil Boring Information

a. Rationale for Boring and/or Well Locations

b. Drilling Method

c. Lithologic Logs--Each boring log must be signed, dated and contain detailed geologic information, Unified Soil Classification System labeling, moisture content, initial and static water levels, and any field observations on amount of contamination.

d. Construction Materials--Rationale for selection of type of well casing material (including how casing sections are joined), screen (including size of openings), filter material and annular seal.

e. Well Construction Drawings--Specify the length, depth, and size of the well screen and filter pack on each diagram, and indicate initial groundwater level encountered during drilling (and date) and static water level (and date).

f. Wellhead Security Measures

g. Well Development Logs - Include well development method, casing volume, and total volume of water evacuated for each well.

h. Surveying Method--Specify the method used to measure well elevations with mean sea level (MSL) as the vertical reference benchmark; note measuring point (ground surface, top of casing or other). Horizontal surveying data also needs to be documented, noting benchmark.

i. Equipment Decontamination Procedures, as used for each well or boring.

j. Disposal Procedures Used, for contaminated or potentially contaminated materials (including drill cuttings, development water, purged water and steam cleaning wastewater). If any material was assumed uncontaminated, this should be documented and the rationale for such a determination should be included. Hazardous waste manifests should be provided where appropriate.

k. Well Destruction Details

8.2.6 Sample Collection

a. Groundwater Sampling

(1) Observation of free product, sheen, or odor
(2) Water and product level measurement procedure and accuracy
(3) Purging equipment and procedures--Document the volume of water evacuated and whether parameters (i.e., pH, temperature and specific conductivity) stabilized prior to sample collection. Specify procedures used if the well(s) dewatered.
(4) Sample collection equipment and procedures

b. Soil Sampling

(1) Soil sampling locations and depths
(2) Soil sampling method and equipment
(3) Depth to groundwater

c. Sample Shipment and Handling Procedures, Including Chain of Custody records and Preservation Procedures

d. Sampling Equipment Decontamination Procedures

e. Quality Assurance/Quality Control

(1) Split samples
(2) Duplicate samples
(3) Field blanks
(4) Equipment rinsate blanks

f. Disposal Procedures Used for Contaminated or Potentially-Contaminated Materials.

8.2.7 Sample Results

a. Laboratory-Originated Analytical Results: Laboratory data sheets must specify analytical method, sampling date, date received, sample condition upon receipt, date analyzed, dilution factors, and detection limits based on practical limits of quantification (see Table 3). The results of field and laboratory quality assurance samples should also be included, as should comments concerning the presence of unidentified or tentatively-identified peaks.

b. Assessment of Laboratory Performance (based on results of quality assurance/quality control work)

8.2.8 Extraction and Treatment System Details

a. Evaluation of groundwater remediation alternatives

b. Basis of remediation system selection

c. System layout

d. Equipment details (description of pump, placement of pump, meter, treatment system, etc.)

e. Copy of treated water discharge permit (copies of reports required by Union Sanitary District or RWQCB should be submitted to ACWD).

8.2.9 Tables

a. Well Construction Details: Well number, borehole depth, casing depth, screened depths (below ground surface), filter pack depths, ground surface elevation, well reference point elevation, diameter, installation date, and drilling method.

b. Soil Analytical Results Summary: Boring or well number, constituents, units, results and detection limits should be specified; the depths of soil samples should also be indicated.

c. Groundwater analytical results should be tabulated for at least four preceding quarters.

d. Water Level Measurements: Depth to water (below ground surface and relative to mean sea level) and measurement dates.

e. Free product removal: Quantity removed on a monthly basis and cumulative totals to date.

f. Groundwater Remediation: Quantity of groundwater extracted on a monthly basis and cumulative totals to date.

8.2.10 Maps

a. Site Vicinity Map showing site location relative to nearby landmarks, with North clearly indicated.

b. Site Map--Identify the locations of tanks, monitoring wells and boreholes relative to other site structures and street centerlines. Any known leak locations should also be noted on the diagram. The map must be drawn to scale with North clearly indicated.

c. Layout of All Tanks and Piping Systems (properly labeled for current contents and drawn to scale).

d. Gradient Maps Indicating the Direction of Groundwater Flow

e. Horizontal Plume Maps: For free product, for dissolved fuel constituents and for each fuel additive or solvent.

8.2.11 Cross-Sections

a. Plan View Map

The location of each cross-section must be shown on a plan view map with the same horizontal scale as the cross-section. Location of cross-sections should be selected to optimize presentation of available information--a typical plan view map is presented as figure 9.

b. Scale

(1) Horizontal scale should not exceed 1 inch = 200 feet.
(2) Vertical exaggeration should not exceed 10X and should permit the depiction of a sandy zone 6 inches thick.
(3) The ground surface should be represented accurately using the surveyed elevations of the wells.

c. Materials Indicated on the Cross-Section

(1) Sediment types should be accurately represented, including fill. Sediment types should be readily recognized from the boring logs.
(2) Positions of impoundments, tank excavations, or other contaminant sources should be shown.
(3) Formation boundaries may be shown if present.

d. Additional Information

(1) Position of wells and borings must be accurately depicted with identifying numbers.
(2) Indicate the position of well screens, filter pack and seals.
(3) Indicate the position of encountered water, with dates if applicable.
(4) Position of potentiometric surface indicated, with dates if applicable.

e. Contaminant Information

A second copy of each cross-section should be provided which depicts contamination and the direction of contaminant movement. This second cross-section should show areas of:

(1) Free product ("floaters")
(2) Dissolved contamination
(3) Contaminants heavier than water if present ("sinkers")
(4) Soil contamination

A typical cross-section showing contaminant information is presented as figure 10.

8.3 Information to be Included in Proposals for Case Closure

8.3.1 Introduction (include site contact and address)

8.3.2 Site Description

8.3.3 Previous Work

8.3.4 Investigative Methods

a. Drilling and Soil Borings
b. Soil Sampling
c. Construction of Monitoring Wells
d. Well Development
e. Groundwater Sampling
f. Analytical Methods

    (1) Soil Samples
    (2) Groundwater Samples

8.3.5 Extent of Hydrocarbon Presence in Soil and Groundwater

a. Hydrocarbons in Soil
b. Hydrocarbons in Groundwater

    (1) Floating Product
    (2) Dissolved Hydrocarbons

8.3.6 Hydrology

a. Regional Hydrogeology
b. Local Hydrogeology
c. Groundwater Gradient
d. Seasonal Variations of Groundwater
e. Aquifer Characteristics

8.3.7 Beneficial Uses of Groundwater

a. Well Inventory
b. Contaminant Fate Transport
c. Sources of Drinking Water Policy Determination

8.3.8 Remediation Activities and Effectiveness

a. Soil Remediation
b. Groundwater Remediation
c. Impact of Residual Hydrocarbons on Beneficial Uses

8.3.9 Summary and Conclusions

8.3.10 Recommendations

8.3.11 Tables

a. Cumulative Soil Sample Results
b. Cumulative Results of Groundwater Elevation and Flow Direction
c. Cumulative Groundwater Sample Results
d. Wells within 1/2-Mile Radius of the Site

Chapter 9

GLOSSARY

ACWD - Alameda County Water District.

Administering Agency - that local city or county government that administers the hazardous materials ordinance.

Annular Seal - that impermeable material such as neat cement grout that fills the space between the borehole and the blank well casing.

Aquifer - a geologic formation with relatively high permeability that allows fluid flow.

Aquitard - a geologic formation with very low permeability that restricts fluid flow.

Bentonite - a claylike material used to facilitate well construction.

Borehole - the hole created by a drilling device (see also exploratory borehole).

Bottom Plug - the plug or cap placed at the bottom of a well casing to preclude erosion of the backfill material.

Casing - the conduit placed in a borehole to extract fluids or vapors.

Continuous Monitoring - a system using automatic equipment which routinely performs the required monitoring on a periodic or cyclic basis throughout the day.

DHS - California Department of Health Services.

Double-Walled Tank - a container with two complete shells which provide both primary and secondary containment. The outer shell must provide structural support and must be constructed primarily of non-earthen materials.

Enforcement Agency - city fire department.

EPA - United States Environmental Protection Agency.

Exploratory Boreholes - any temporary excavation for the determination of subsurface conditions (including vapor probes, hydropunch holes, geotechnical borings, etc.).

Filter Pack - sand or gravel placed in the annular space of the well between the borehole and the screened or perforated interval of the well casing; usually washed and graded material (see also gravel pack envelope).

Formations - those geologic strata that underlie the ground surface.

GC/MS - gas chromatography/mass spectroscopy; analytical equipment used for identifying/quantifying organic compounds.

Gravel Pack Envelope - that properly-graded material used to backfill the annular space surrounding slotted casing.

Groundwater - subsurface water which will flow into a well.

Guidelines - these Groundwater Monitoring Guidelines.

Hazardous Materials - those materials discussed in the Hazardous Materials Ordinances.

Hazardous Materials Ordinance - the Ordinance adopted by the administering agency to regulate the construction, monitoring and reporting at hazardous materials facilities.

Hydrogeologic Conditions - those conditions dealing with the behavior of groundwater.

Interface Well - Vadose or unsaturated zone monitoring well, conventionally constructed with the screened or perforated interval located at a formational interface, usually permeable materials overlying impermeable or slightly permeable materials (i.e., in the case of tank backfill material contacting less-permeable natural sediments).

LUFT - leaking underground fuel tank.

Motor Vehicle Fuels - those hazardous materials used primarily to fuel motor vehicles or engines.

Natural Formation - an undisturbed material.

Perforated Casing - well casing with slots or holes to permit the passage of fluids or vapors.

RWQCB - California Regional Water Quality Control Board--San Francisco Bay Region.

Suction Lysimeter - a device for extracting liquid samples from the unsaturated zone.

Surface Seal - a shortened annular seal used to insure no contaminants will enter the annular space from the ground surface.

Tank - a container used to store product. Includes all associated piping that may also contain product.

Tank Backfill - that material used to backfill the excavation surrounding an underground storage tank.

Tremie Pipe - a conduit used during construction to place materials in a well from the bottom up.

Unauthorized Release - any unpermitted release or leak of hazardous materials into the environment.

Unsaturated Zone - those underlying strata that are above the water table.

Vadose Zone - unsaturated zone.

Water Table - the depth below which the ground is saturated.

Well Centralizer - a device used to center a well casing in a borehole.

Well Development - the procedure used to assure stabilization of the gravel pack envelope and adjacent formation following well construction.

Well Purging - the procedure used to assure removal of standing water prior to sampling of representative, formational groundwater.

TABLE 2

RECOMMENDED MINIMUM VERIFICATION ANALYSES FOR UNDERGROUND TANK LEAKS

Revised-June, 2005

HYDROCARBON LEAK	SOIL ANALYSES		WATER ANALYSES	
Unknown Fuel	TPH-G	8015M	TPH-G	8015M
	TEH/TPH-D	8015M	TEH/TPH-D	8015M
	BTEX	8260B or 8021B	BTEX	8260B or 8021B
	EDB & EDC	8260B	EDB & EDC	8260B
	MTBE and other oxygenates by EPA Method 8260B for soil and water.			
	Total Lead	AA	Total Lead	AA
Leaded Gas	TPH-G	8015M	TPH-G	8015M
	BTEX	8260B or 8021B	BTEX	8260B or 8021B
	EDB & EDC	8260B	EDB & EDC	8260B
	MTBE and other oxygenates by EPA Method 8260B for soil and water.			
	Total Lead	AA	Total Lead	AA
Unleaded Gas	TPH-G	8015M	TPH-G	8015M
	BTEX	8260B or 8021B	BTEX	8260B or 8021B
	MTBE and other oxygenates by EPA Method 8260B for soil and water.			
Diesel, Jet Fuel, Kerosene and Fuel/Heating Oil	TEH/TPH-D	8015M	TEH/TPH-D	8015M
	BTEX	8260B or 8021B	BTEX	8260B or 8021B
	MTBE and other oxygenates by EPA Method 8260B for soil and water.			
Chlorinated Solvents	CL HC	8260B	CL HC	8260B
	BTEX	8260B or 8021B	BTEX	8260B or 8021B
Non-Chlorinated Solvents	TEH/TPH-D	8015M	TEH/TPH-D	8015M
	BTEX	8260B or 8021B	BTEX	8260B or 8021B
Waste, Used, or Unknown Oil	TPH-G	8015M	TPH-G	8015M
	TEH/TPH-D	8015M	TEH/TPH-D	8015M
	O & G	5520 E & F or 418.1	O & G	5520 B & F or 418.1
	BTEX	8260B or 8021B	BTEX	8260B or 8021B
	CL HC	8260B	CL HC	8260B
	MTBE and other oxygenates by EPA Method 8260B for soil and water.			
	Metals (Cd, Cr, Pb, Ni, Zn) by ICAP or AA for soil and water.			
	EPA Method 8270 for soil and water to include PCB*, PCP*, PNA, and Cresote.			
	* If found, analyze for dibenzofurans (PCBs) or dioxins (PCP).			

NOTES:

EPA Method 8021B may be used if sample results are similar to results by EPA Method 8260B.

EDB and EDC - ethylene dibromide and ethylene dichloride (also known as 1,2-DCA or 1,2-dichloroethane).

It is recommended that a silica gel cleanup method be used if there is a concern about natural organics interfering with the TEH/TPH-D analysis.

TABLE 3

ANALYTICAL DETECTION/REPORTING LIMITS [1]

Revised-June, 2005

Analysis	Soil	Water
Total Petroleum Hydrocarbons		
as Gasoline	**1.0 ppm**	**50.0 ppb**
as Diesel [2]	**1.0 ppm**	**50.0 ppb**
Benzene, Toluene, Ethyl Benzene and Xylenes (BTEX)	**0.005 ppm**	**0.5 ppb**
Methyl Tertiary Butyl Ether (MTBE)	**0.005 ppm**	**2.0 ppb**
Oil and Grease (O&G)	**50.0 ppm**	**5,000.0 ppb**

At a minimum for water samples, California Department of Health Services Maximum Contaminant Levels (MCLs) for drinking water standards, primary or secondary, whichever is lower, must be used as a reporting limit for all other organic and inorganic constituents.

NOTES:

1. ***When the reporting limits are not achievable, an explanation of the problem is to be submitted on the laboratory data sheets.***
2. ***It is recommended that a silica gel cleanup method be used if there is a concern about natural organics interfering with the TPH as Diesel analysis.***

Examples of

Quantitative Release Detection Methods for Tanks

Detection Method	Performance Standards
Automatic Tank Gauging (Monthly)	Subsection 2643 (c)(1)
Tank Integrity Test (Annually) and Inventory Reconciliation (Monthly)	Subsection 2643 (c)(2)(A) and Subsection 2643 (c)(2)(B)
Manual Tank Gauging (Weekly)	Section 2645

Examples of

Quantitative Release Detection Methods for Pressure Piping

Detection Method	Performance Standards
Automatic Line Leak Detector (Hourly) and Electronic Line Leak Detector (Monthly)	Subsection 2643 (d)(1) and Subsection 2643 (d)(2)
Automatic Line Leak Detector (Hourly) and Electronic Line Leak Detector (Annually)	Subsection 2643 (d)(1) and Subsection 2643 (d)(3)
Automatic Line Leak Detector (Hourly) and Line Tightness Test (Annually)	Subsection 2643 (d)(1) and Subsection 2643 (d)(3)
Electronic Line Leak Detector (Hourly)	Subsection 2643(d)(3)

Examples of

Quantitative Release Detection Methods for Suction Piping

Line Tightness Test (Triannually) and Daily Monitoring	Section 2643 (e) and Appendix II

Examples of

Qualitative Release Detection Methods

Vapor Monitoring or Ground Water Monitoring	Sections 2644 (b) and 2647 or Sections 2644 (c) and 2648

FIGURE 1

CALIFORNIA UNDERGROUND STORAGE TANK REGULATIONS

TITLE 23, DIVISION 3, CHAPTER 16, APPENDIX IV.

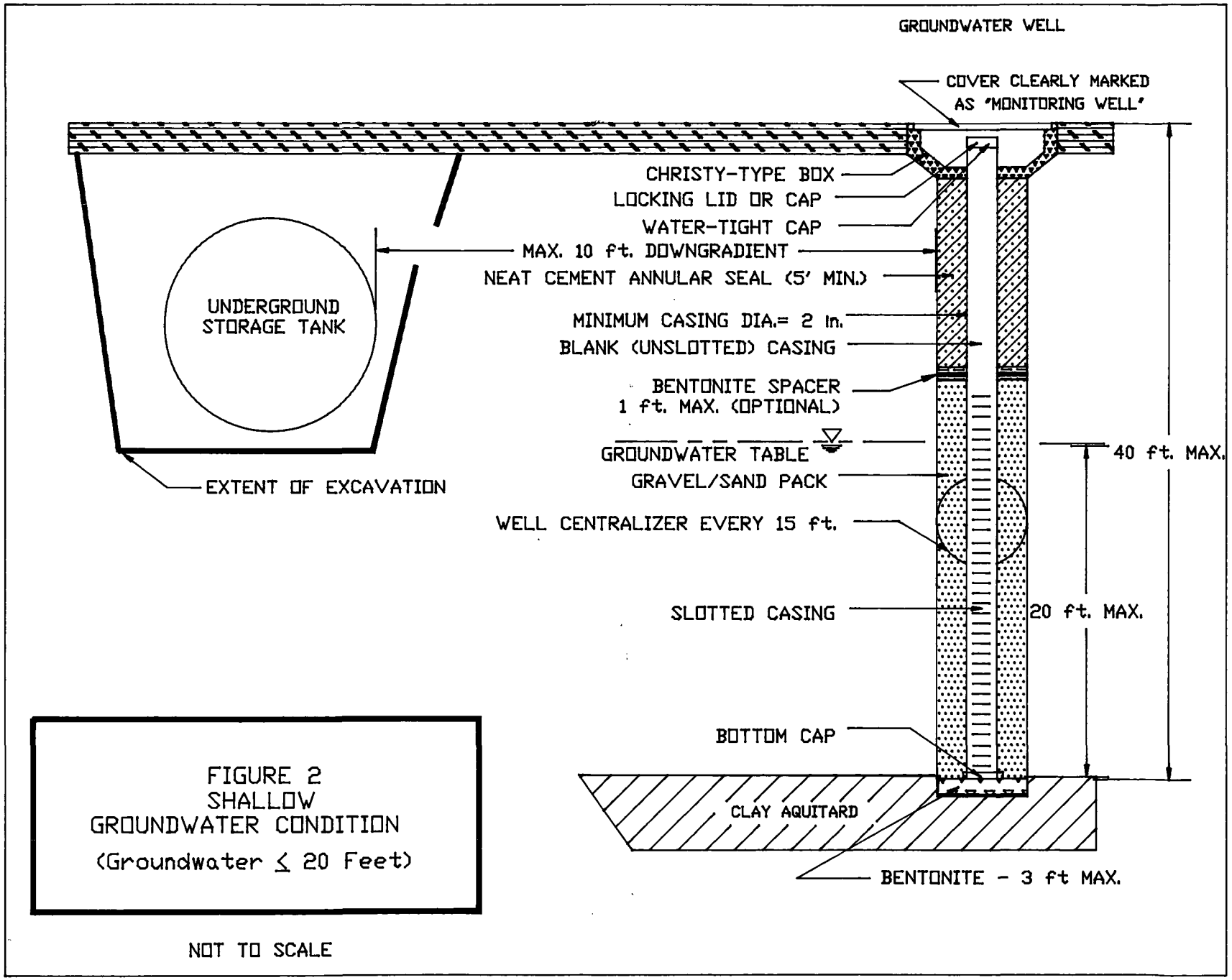


FIGURE 2
SHALLOW
GROUNDWATER CONDITION
(Groundwater ≤ 20 Feet)

NOT TO SCALE

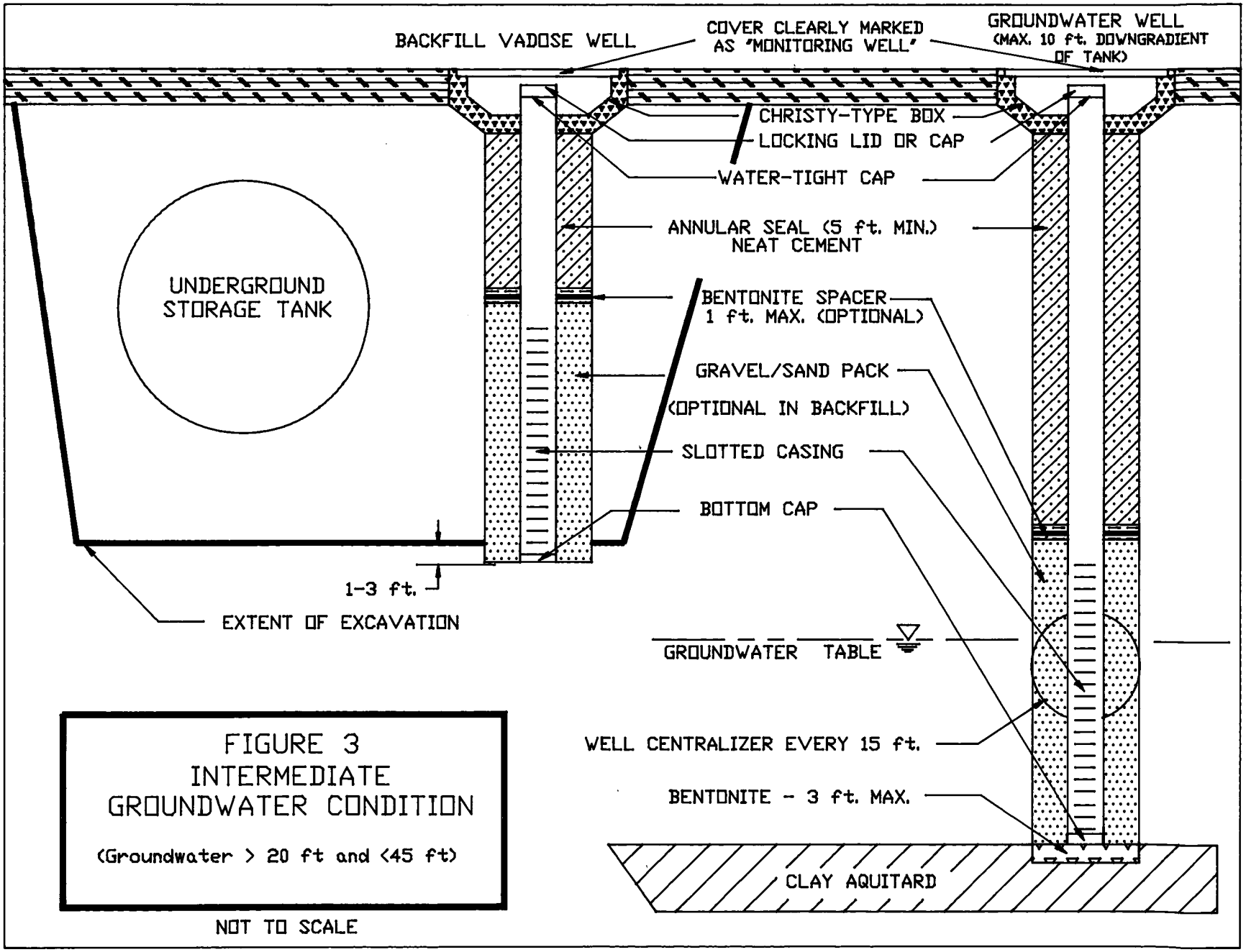


FIGURE 3
INTERMEDIATE
GROUNDWATER CONDITION

(Groundwater > 20 ft and <45 ft)

NOT TO SCALE

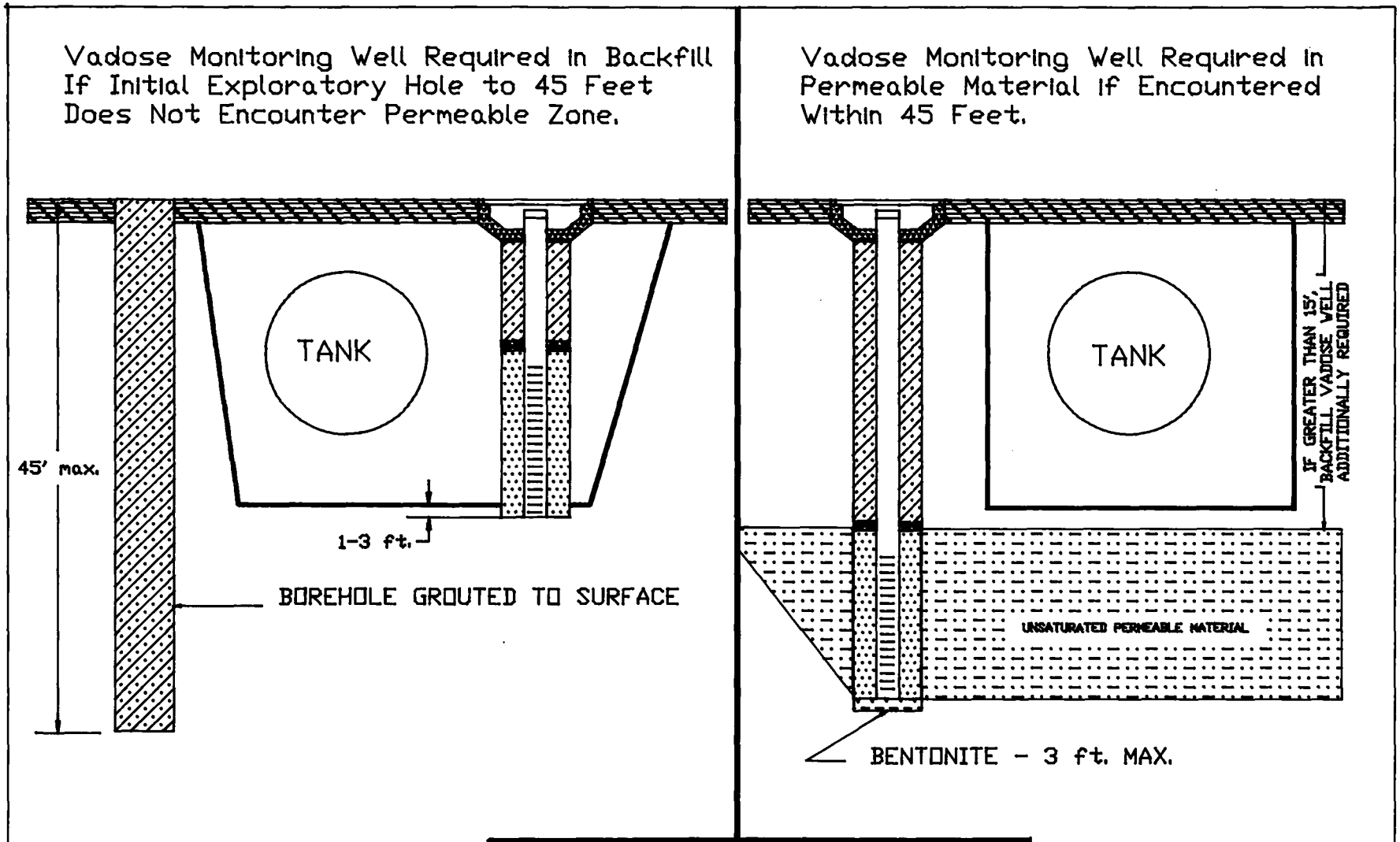


FIGURE 4
DEEP GROUNDWATER CONDITION
(Groundwater > 45 ft.)

NOTE-SEE FIG. 2 AND 3 FOR WELL CONSTRUCTION DETAILS

NOT TO SCALE

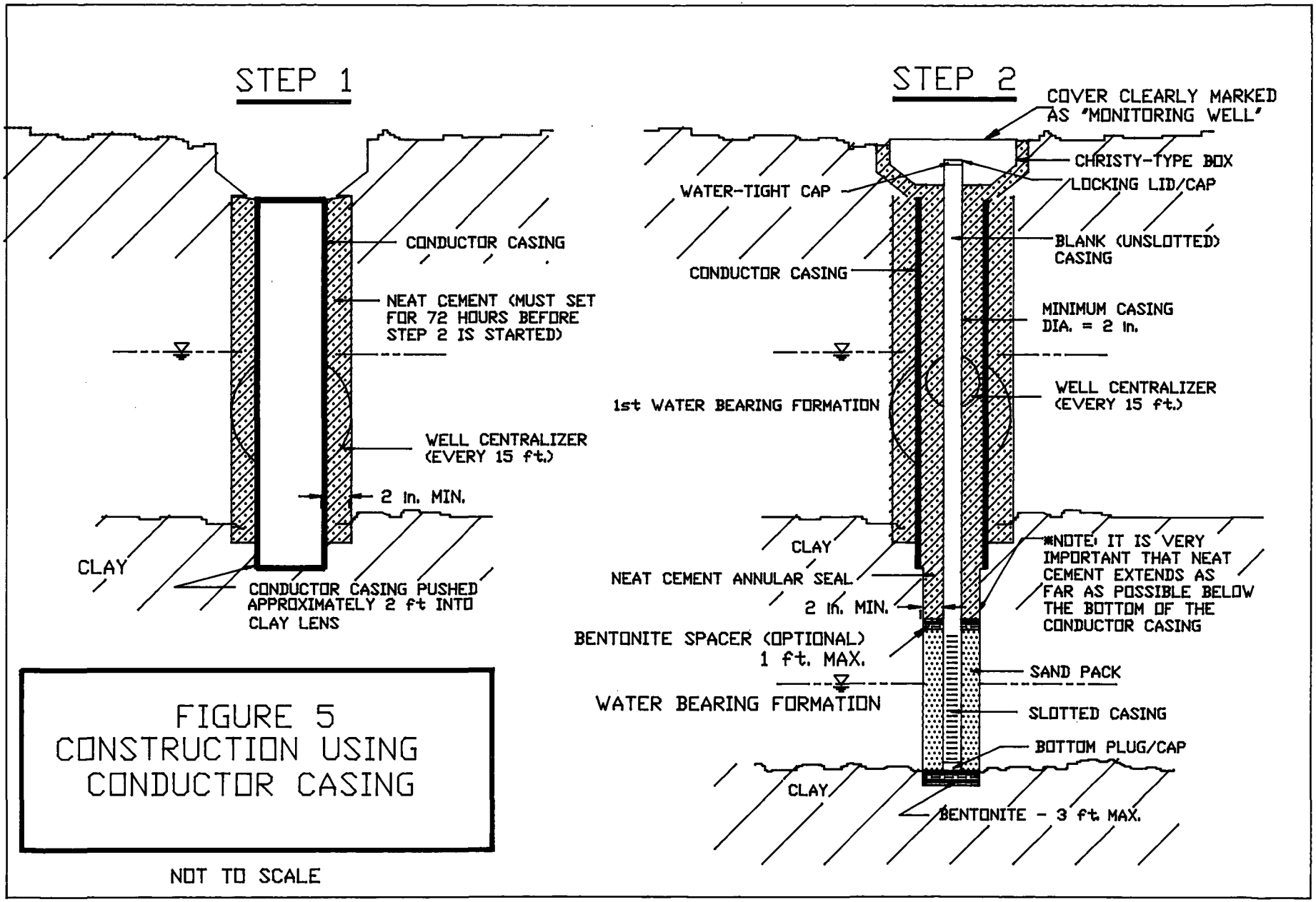


FIGURE 5
CONSTRUCTION USING
CONDUCTOR CASING

NOT TO SCALE

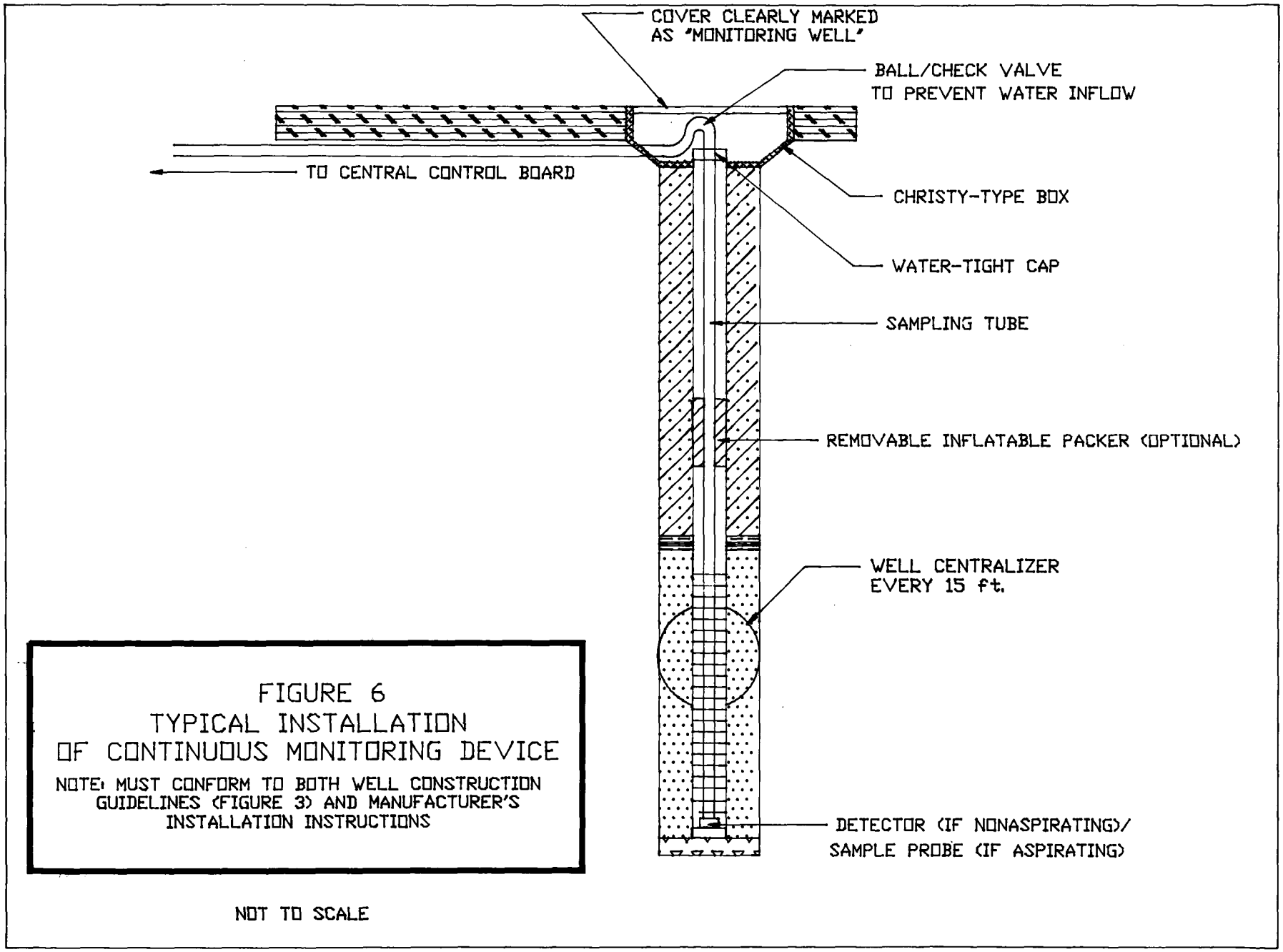


FIGURE 6
TYPICAL INSTALLATION
OF CONTINUOUS MONITORING DEVICE

NOTE: MUST CONFORM TO BOTH WELL CONSTRUCTION GUIDELINES (FIGURE 3) AND MANUFACTURER'S INSTALLATION INSTRUCTIONS

NOT TO SCALE

FIGURE 7

CHAIN OF CUSTODY EXAMPLE*

PROJECT NO.	SITE NAME & ADDRESS															
SAMPLERS--NAME, ADDRESS AND TELEPHONE NUMBER																
ID NO.	DATE	TIME	SOIL	WATER	SAMPLING LOCATION	(1) TYPE OF CON-TAINER	ANALYTES REQUESTED	TOTAL LIGHT HC	AROMATIC HC (BTX)	TOTAL HEAVY HC	OIL & GREASE	VOC SCAN (624's)	OTHER			REMARKS
																(1) Check with certified laboratory

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Temperature/Remarks	

*Should be attached to lab data sheets and site plan for agency reporting.

MATERIAL: PURGED WATER

KNOWN OR SUSPECTED
CHEMICAL CONTAMINANT: DIESEL FUEL

DATE CONTAINER FILLED: DEC. 15 1988

EXPECTED REMOVAL DATE: UNKNOWN

COMPANY NAME: XYZ SERVICE STATION

CONTACT: MR. JOHN DOE

PHONE: (415) 555-1234

FIGURE 8
TYPICAL LABEL FOR CONTAINERIZED
DRILL CUTTINGS OR PURGED WATER *

* Note – One or more labels should be affixed to each container in an easy-to-see location, such as the top third of a barrel.

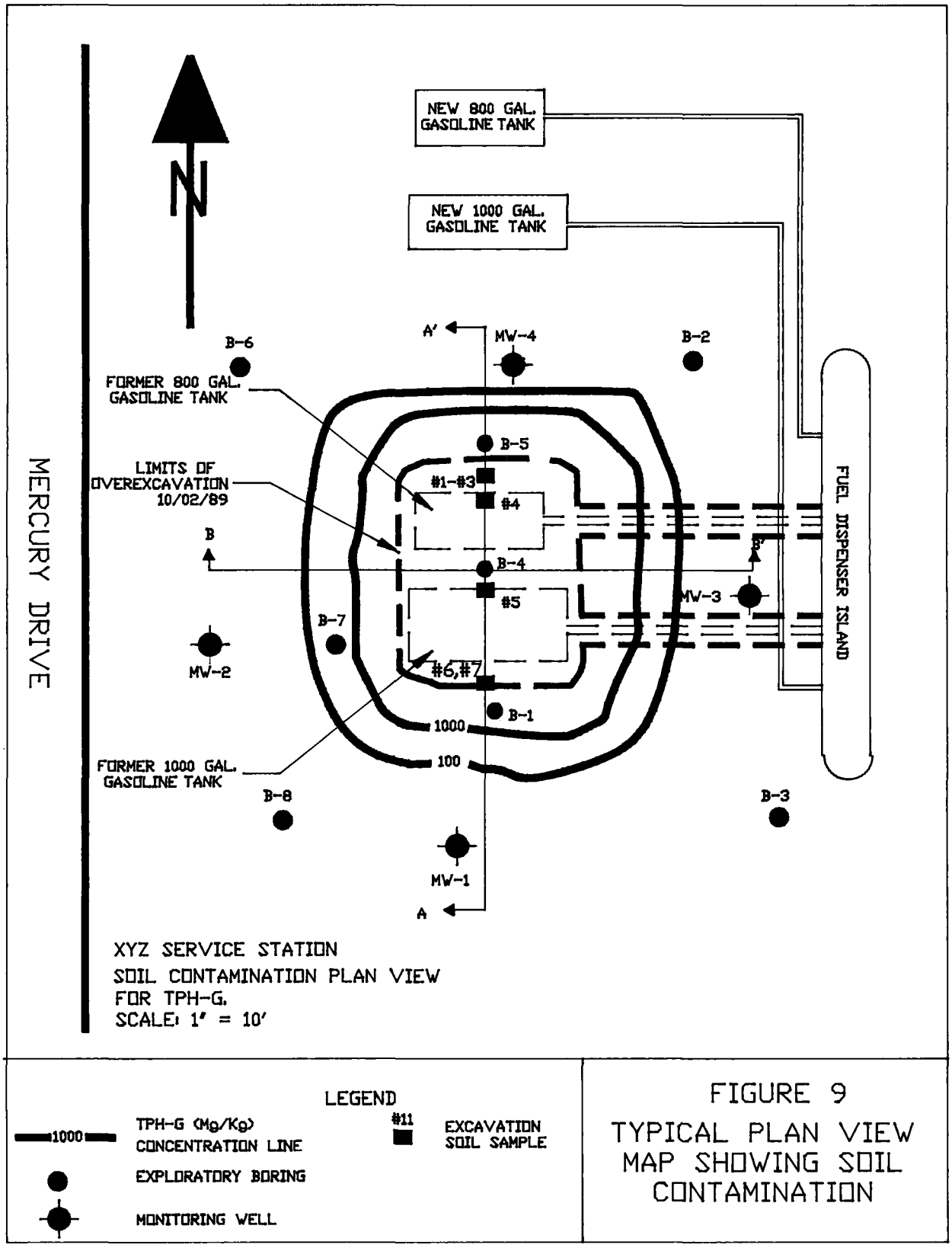
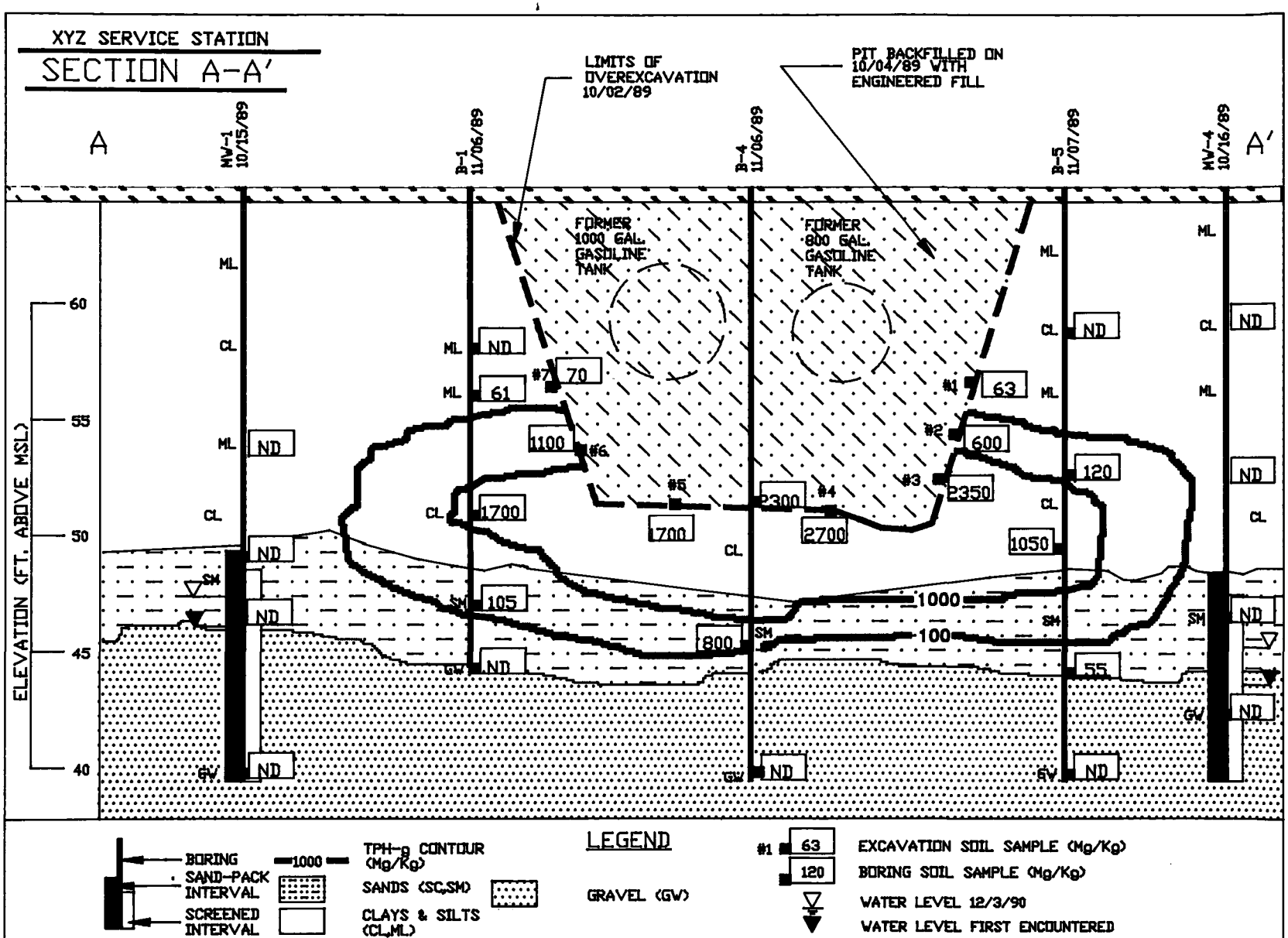


FIGURE 9

TYPICAL PLAN VIEW MAP SHOWING SOIL CONTAMINATION



SCALE: 1 in. = 5 ft. Vertical

1 in. = 5 ft. Horizontal

FIGURE 10
TYPICAL CROSS-SECTION
SHOWING SOIL CONTAMINATION