Tennessee Department of Environment and Conservation
Division of Underground Storage Tanks
Environmental Assessment Guidelines

DISCLAIMER

This document has been prepared to provide guidance and standardized procedures for conducting petroleum site investigations. It is understood that the procedures outlined in this document cannot cover every eventuality; however, these guidelines shall be used in all cases where appropriate. If site-specific conditions warrant variations from these procedures, then the local environmental field office shall be informed prior to the implementation of these variations and prior approval shall be obtained. All variations from these procedures shall be noted in the applicable report.

All assessment activities shall be reasonable, proper, and justifiable in order to receive reimbursement from the Petroleum Underground Storage Tank Fund. **In accordance with rule 1200-1-15-.06(1)(b)1, the appropriate UST environmental field office shall be notified at least one (1) working day prior to conducting any routine field activity including but not limited to installation of borings/monitoring and recovery wells, sampling, water use surveys and installation and/or activation of treatment systems. Non-routine activities such as emergency response shall be reported no later than one (1) working day after the activity has taken place.**

All environmental assessment activities and evaluation of the subsurface investigation shall be directed by a registered professional geologist under the Tennessee Geologist Act *(T.C.A. §62-36-101 et seq.)* or registered professional engineer under the Tennessee Architects, Engineers, Landscape Architects, and Interior Designers Law and Rules *(T.C.A. §62-2-101 et seq.)*.

When performing assessment activities within these guidelines, all relevant data shall be collected and reported in the appropriate report format.

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APPENDICES

I. SOIL INVESTIGATION PROCEDURES

Prior to installing any soil borings, all aboveground and underground utilities, storage tanks, and lines shall be identified to prevent accidental damage.

A. Initial Soil Source Investigation

An initial soil source investigation shall be conducted in the following manner with a maximum of twelve (12) borings installed at any site. The results from this investigation shall be used to aid in the placement of the borings/monitoring wells in section I.B.1. to ensure that the most contaminated area is properly investigated. **If site-specific conditions warrant variations from these procedures, then the local environmental field office shall be informed prior to the implementation of these variations and prior approval shall be obtained. All variations from these procedures shall be noted in the applicable report.**

If soil samples have been previously collected during closure assessment, or the requirements in section I.A.3. and 4. have already been met as a result of another investigation, then it is not necessary to perform the tasks listed in the referenced sections. If petroleum contamination above the preliminary Risk Based Clean-up Levels (see Reference 3 in these guidelines) is not identified during the installation of tankhold and dispenser borings, then section I.A.5. is not applicable.

If the release location is unknown, then sections I.A.3.-5. shall be followed. If more than four (4) dispenser island borings or twelve (12) total borings are required, then prior Division approval is required.

If the release location is known, then one boring shall be placed within three (3) feet of the referenced location, and section I.A.5. shall be followed.

1. Reporting

The results of the soil source boring investigation shall be reported in accordance with the Initial Response and Hazard Management Report (IRHMR) Guidelines.

2. Boring Method

The boring method shall be direct push technology. If an alternate method of soil investigation is requested, then a proposal including, but not limited to, methodology, location, and costs shall be submitted to the Division for prior approval.

3. Tankhold Borings

Boring locations shall only be located near the suspect UST system, if known. For underground storage tankholds with a total capacity of less than or equal to 20,000 gallons, two (2) borings shall be installed, one of which shall be located where the release occurred or is most likely to have occurred. For tankholds with a total capacity of greater than 20,000 gallons, four (4) borings shall be installed. One boring shall be installed in the middle of each of the four (4) sides of the tankhold. All soil borings shall be installed in undisturbed soil located no more than three (3)

feet from the edge of the tank hold and be advanced to a depth of at least one (1) foot below the tankhold floor, at the zone of saturation, or at the soil/bedrock interface, whichever occurs first. If the zone of saturation and/or the soil/bedrock interface was not encountered at a depth of at least one (1) foot below the tankhold floor, and the Organic Vapor Detector (OVD) readings for the bottommost sample indicates petroleum contaminant levels in excess of contamination identified in shallower intervals for that boring, then the boring depth may be extended until OVD readings decrease, or the zone of saturation, and/or soil bedrock interface are encountered.

4. Dispenser Island Boring(s)

Boring locations shall only be located near the suspect UST system, if known. One (1) soil boring shall be placed adjacent to each suspect dispenser island not to exceed four (4) borings total. All borings shall be installed in undisturbed soil no more than three (3) feet from the dispenser islands and advanced to a depth of fifteen (15) feet, at the zone of saturation, or at the soil/bedrock interface, whichever occurs first. If the zone of saturation and/or the soil/bedrock interface was not encountered in the bottommost sample, and the Organic Vapor Detector (OVD) readings for the bottommost sample indicates petroleum contaminant levels in excess of contamination identified in shallower intervals for that boring, then the boring depth may be extended until OVD readings decrease, or the zone of saturation, and/or soil bedrock interface are encountered.

5. Soil Source Boring(s)

Boring(s) shall be placed no less than fifteen (15) feet from each suspected contaminated boring based on OVD screening. **Borings installed less than fifteen (15) feet apart will not be considered Fund reimbursable.** These borings shall be placed in undisturbed soil in a grid around the contaminated soil boring and advanced to the same depth as the contaminated soil boring, the zone of saturation, or the soil/bedrock interface, whichever occurs first. If the site has been built on fill material, then these borings shall be placed outside the UST system excavation. If the zone of saturation and/or the soil/bedrock interface was not encountered in the bottommost sample and the OVD readings for the bottommost sample indicates petroleum contaminant levels in excess of contamination identified in shallower intervals for that boring, then the boring depth may be extended until OVD readings decrease, or the zone of saturation and/or soil bedrock interface are encountered. Soil borings shall not be placed within an occupied tankhold or line trench.

6. Procedures for Sample Collection

a. Equipment and Collection

Samples shall be collected using a properly decontaminated stainless steel or new disposable scoop, knife, or spatula.

b. Procedure for Selection of Soil Samples

Upon collection, the soil sample shall be split in half lengthwise. One side of the sample shall be **immediately placed** into a laboratory prepared jar in a manner that eliminates headspace. The jar shall be properly labeled and stored at 4°C or less. All samples shall be maintained at 4°C until the samples are delivered to the laboratory.

Once the potential laboratory sample has been properly stored, the remainder of the soil shall be classified and placed in a sealing plastic bag, leaving some air space. The bag shall be properly labeled and the sample allowed to volatilize for a minimum of fifteen (15) minutes at a minimum of 68°F. All samples shall be allowed to volatilize for an equal period of time prior to screening. Once the sample has volatilized, the headspace shall be sampled with an OVD. The OVD shall either be a photoionization detector or a flame ionization detector. The use of vapor detection tubes or other methods of screening are not acceptable unless approved in advance by the Division.

The following criteria shall be used when selecting soil samples for laboratory analyses:

i. If the OVD readings and other field screening techniques (visual or olfactory) indicate that soil contamination does not exist at a boring location, then the deepest sample shall be submitted for analysis by the laboratory. The deepest sample shall be defined as that sample collected immediately above the soil/bedrock interface, the zone of saturation, or the bottom of the boring, whichever occurs first.

ii. If the OVD readings indicate that contamination does not exist in the soil at a boring location but visible or olfactory observations indicate that the soil is contaminated (i.e. heavy hydrocarbon staining), then two (2) samples shall be selected for laboratory analyses in accordance with the following:

    aa. The samples in which visible and/or olfactory observations indicated the highest level of contamination; and

    bb. The sample collected immediately above the soil/bedrock interface, above the zone of saturation or the bottom of the boring, whichever occurs first.

    If one (1) soil sample meets both of the above listed criteria, then only that sample shall be submitted for laboratory analyses.

iii. If the OVD readings indicate that contamination does exist in the soil at a boring location, then three (3) soil samples selected from the following locations shall be submitted for laboratory analyses:

    aa. The sample in which the OVD screening indicated the highest level of contamination; and

bb. The deepest sample in which the OVD screening indicated is contaminated; and

cc. The sample collected immediately above the soil/bedrock interface, above the zone of saturation or the bottom of the boring, whichever occurs first.

If one (1) soil sample meets more than one of the above listed criteria, then the sample with the second highest OVD screening shall also be submitted for laboratory analyses.

7. Soil Analytical Methods

When analyzing soil samples for volatile organics the laboratory shall follow the procedures outlined in the Test Methods for Evaluating Solid Waste, SW-846. At a minimum, the following constituents shall be analyzed: benzene, toluene, xylenes, ethylbenzene, MtBE, and naphthalene. The purge and trap procedures for the soil samples in Method 5030B shall be followed. The actual constituent analysis using gas chromatography with a mass spectrometer shall follow Method 8260B. The practical quantitation limit for any individual constituent using this method is 0.002 Parts Per Million (PPM) for low level soil samples. All results shall be reported in PPM. **Lab analyses that report below detection levels (i.e. "BDL" or "ND") with Method Detection Limits (MDLs) above program Maximum Contaminant Levels (MCLs) (0.005 PPM for low level soils) or RBCLs will not be eligible for Fund reimbursement.**

When analyzing soil samples for semi-volatile organics [i.e. Polycylic Aromatic Hydrocarbons (PAHs)], the laboratory shall use Test Methods for Evaluating Solid Waste, SW-846, Method 8270C. All soil MDLs must be less than required MCLs and all MDLs must meet or exceed SW846 described MDLs for soils. **Lab analyses that report below detection levels (i.e. "BDL" or "ND") with MDLs above program MCLs or RBCLs will not be eligible for Fund reimbursement.** The practical quantitation limit for PAH constituents using these methods is 0.660 PPM for low level soil samples. All results shall be reported in PPM.

Refer to Reference 1 and Reference 2 in the appendices for assistance in determining the applicable COCs for laboratory analysis.

8. Borehole Abandonment

All direct push soil borings shall be plugged with bentonite to surface completion.

9. Decontamination Procedures

Drill rigs and other equipment shall be inspected for lubricant or fluid leaks that could be a potential contaminant to soil or ground water. All "over-the-hole" portions of the drilling equipment shall be steam cleaned prior to use and as necessary between borings. All down hole equipment (i.e. augers, drill rods, tools, etc.) shall be steam cleaned prior to use and between all subsequent boring locations.

All sampling equipment that is not pre-cleaned and disposable (i.e. stainless steel scoops, split spoons, etc.) and all monitoring equipment, shall be properly decontaminated before each use by the following procedure:

a. Cleaned with a laboratory grade detergent wash;

b. Triple rinsed with distilled water; and

c. Allowed to air dry.

B. Soil Borings for Conversion to Monitoring Wells

1. Number and Location of Soil Borings

During the investigation, soil samples shall be collected and analyzed from borings placed in the following locations unless site-specific conditions warrant variations from these procedures. **If so, then the local environmental field office shall be informed prior to the implementation of these variations and prior approval shall be obtained. All variations from these procedures shall be noted in the applicable report.**

a. The first boring (B-1/MW-1) shall be placed in the upgradient direction of the release.

b. The second and third borings (B-2/MW-2, B-3/MW-3) shall be placed in the downgradient direction of the release.

c. The fourth boring (B-4/MW-4) shall be placed as close as possible to the location with the previously identified highest level of benzene contamination. If benzene contamination is not present, then the fourth boring shall be placed as close as possible to the location with the previously identified highest level of MtBE concentration (and so forth in this order – toluene, total xylenes, ethyl benzene, naphthalene, and PAHs).

2. Boring Methods

All soil borings shall be advanced utilizing a hollow-stem auger or a direct push instrument. A hand auger or power auger may be utilized if one of the following conditions exists:

a. The area to be investigated is inaccessible to drill rigs;

b. The sampling point is at a shallow depth and therefore appropriate for the technique; or,

c. The sampling point is near utilities, product lines, tanks or buried structures and extreme care must be taken to prevent damage.

3. Procedures for Sample Collection

a. Equipment and Collection

i. Samples shall be collected using a properly decontaminated stainless steel or new disposable scoop, knife or spatula.

ii. Samples from hand augers and power augers shall be allowed only if discrete samples can be obtained utilizing a properly decontaminated auger bucket, split spoon, or shelby tube. The sampling of auger cuttings is not acceptable.

iii. Samples from borings advanced by a drill rig shall be collected utilizing properly decontaminated split spoon samplers. Soil samples shall be collected continuously for the entire depth of the boring. A five (5) foot long split spoon sampler is recommended.

iv. When site conditions are suitable, the use of a direct push technology may be utilized. When using the direct push sampling method, all applicable sections of this guidance document shall be followed.

b. Procedure for Selection of Soil Samples

All sampling shall be conducted in accordance with Section I.A.6.b.

4. Analytical Methods

All analytical methods shall be conducted in accordance with Section I.A.7.

5. Borehole Abandonment

All soil borings that are not converted into ground water monitoring wells shall be filled with grout. The grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. The grouting operation shall continue until the grout flowing out of the borehole has a minimum density of 13.5 lbs/gal. If water is present in the boring or the total depth of the borehole is greater than thirty (30) feet, then a tremie pipe shall be utilized to place the grout. The upper two (2) feet of the boring does not have to remain filled with grout at completion and may be filled with material that is appropriate for the location.

6. Decontamination Procedures

All decontamination shall be conducted in accordance with Section I.A.9.

II. GROUND WATER INVESTIGATION PROCEDURES

A. Number, Type and Location of Monitoring Wells

A minimum of four (4) single cased or open hole monitoring wells shall be required to investigate ground water contamination. These wells shall be constructed by converting soil borings B1 through B4, as referenced in Section I.B.1. into monitoring wells.

All single cased or open hole monitoring wells shall be installed to monitor the uppermost water bearing zone.

If site specific conditions indicate that contamination may exist in a deeper aquifer, then double cased monitoring wells may be necessary. The Division shall be contacted, and prior approval received, before proceeding with the installation of double cased wells.

A licensed well driller shall be used to install all monitoring wells.

B. Drilling Methods

The following drilling methods are approved by the Division:

1. Hollow Stem Auger
2. Air Rotary (downhole hammer or tri-cone)

The following drilling methods shall be allowed only upon approval by the Division:

1. Mud Rotary
2. Cable Tool
3. Rock Coring
4. Wash Rotary (Tri-Cone)

C. Single and Double Cased Monitoring Well Installation Procedures

Follow the procedures below when installing a single or double cased monitoring well.

1. Casing and Screen Type

a. Single Cased

The casing and screen shall be constructed of two (2) inch inside diameter (I.D.) pre-cleaned, flush threaded, Schedule 40 PVC. The screen shall have 0.01 inch factory milled slots. The well screen shall be terminated with a threaded end cap and the casing shall be terminated with a locking, watertight cap.

b. Double Cased

The outer casing shall be decontaminated black steel. If site-specific conditions and drilling methods are compatible (i.e. hollow stem auger drilling), then schedule 80 PVC may be used in lieu of black steel with prior approval by the Division. The inner casing and screen shall be constructed of pre-cleaned, flush threaded, Schedule 40 PVC. The screen

shall have 0.01 inch factory milled slots. The screened section shall be terminated with a threaded end cap and the casing shall be terminated with a locking, watertight cap.

2. Outer Casing Placement (For Double Cased Wells Only)

The outer casing shall be set at least two (2) feet into competent bedrock, the confining layer, or five (5) feet below the last indication of soil contamination. The casing shall then be grouted into place using a bentonite/cement grout. The grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. If water is present in the boring or the total depth of the borehole is greater than thirty (30) feet, then a tremie pipe shall be used to place the grout unless the well is being installed through a hollow stem auger. The grout shall be allowed to set for a minimum of 24 hours before continuation of drilling activities.

3. Screen Length and Placement

The screen length and placement shall be installed where the zone of saturation is intersected at all times. If the screen is placed where ground water does not enter the well or ground water is above the top of the screen, then the cost for the installation of the monitoring well may not be reimbursed by the Petroleum Underground Storage Tank Fund. Typical placement is where two-thirds of the screen is below the zone of saturation and one-third is above. Longer screen lengths may be necessary for areas with large seasonal ground water fluctuations. A centralizer shall be used in all monitoring wells greater than twenty (20) feet in depth. The centralizer shall be placed below the screened interval at the bottom of the well.

If a confined aquifer is encountered, then the water bearing section of the aquifer shall be screened.

4. Minimum Borehole Diameter

a. Single Cased

The borehole diameter shall be a minimum of four (4) inches larger than the outside diameter (O.D.) of the well casing. For example, a 2.5 inch O.D. casing would require a 6.5 inch diameter borehole. A waiver is granted in cases where a 5.5 inch O.D. or larger core barrel will be used to drill the bedrock portion of the hole.

b. Double Cased

The outer borehole diameter shall be a minimum of four (4) inches larger than the O.D. of the well casing. For example, an eight (8) inch O.D. casing would require a twelve (12) inch diameter borehole. The annular space between the inner and outer casing shall also be four (4) inches. A waiver is granted in cases where a 5.5 inch O.D. or larger core barrel will be used to drill the bedrock portion of the hole.

5. Placement and Type of Filter Pack

A minimum of six (6) inches of the filter pack material shall be placed under the bottom of the well screen to provide a firm footing. The filter pack shall extend two (2) feet above the top of the screened section. A weighted tape shall be used to help prevent bridging and ensure the proper placement of the filter pack. If the total depth of the borehole exceeds thirty (30) feet, then a tremie pipe shall be utilized to properly place the filter pack unless the well is being installed through a hollow stem auger. The filter pack shall consist of clean, washed, well-sorted silica sand. To minimize particulate infiltration in the well, the formation grain size encountered shall be considered when selecting the filter pack grain size.

6. Placement and Type of Filter Pack Seal

The filter pack seal shall be placed atop the filter pack and have a minimum thickness of two (2) feet. The filter pack seal shall consist of a high solids, pure bentonite material. A weighted tape shall be used to help prevent bridging and ensure the proper placement of the filter pack seal. If the total depth to the top of the filter pack exceeds thirty (30) feet, then a tremie pipe shall be utilized to place the filter pack seal unless the well is being installed through a hollow stem auger. If the bentonite seal is placed above the zone of saturation, then two (2) gallons of potable water shall be used to hydrate the pellets. The hydration time for the bentonite pellets shall be a minimum of one (1) hour.

7. Placement and Type of Annular Grout

The annular grout shall extend from the top of the filter pack seal to within two (2) feet of the surface. The annular grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. If water is present in the boring or the depth to the filter pack seal is greater than thirty (30) feet, then a tremie pipe shall be used to place the annular grout unless the well is being installed through a hollow stem auger.

8. Surface Completion

The final two (2) feet of the annular space shall be filled with concrete terminating with a flush-mounted manhole with a watertight, bolt-down loadbearing cover unless an alternate construction is approved in writing by the Division. These manholes shall be concreted in place and sloped so that surface drainage will be diverted. Above ground protective covers may be used if required by site conditions. All monitoring wells shall be clearly marked as monitoring wells and numbered.

D. Open-Hole Well Installation Procedures

Open hole monitoring wells may be used in areas where competent bedrock is encountered and geologic conditions (e.g. karst terrain) warrant their use.

In constructing an open hole monitoring well, the surface casing shall be set at least two (2) feet into competent bedrock. The surface casing shall be black steel in all cases. The casing shall be grouted into place using a bentonite/cement grout. The grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. If water is present in the boring or the total depth of the

borehole is greater than thirty (30) feet, then a tremie pipe shall be used to place the grout. The grout shall be allowed to set for a minimum of 24 hours before continuation of drilling activities.

Upon setting the surface casing, a borehole with a minimum diameter of three and one-half (3.5) inches shall be advanced to the desired depth.

The final two (2) feet of the annular space shall be filled with concrete terminating with a flush-mounted manhole with a watertight, bolt-down loadbearing cover unless alternate construction is approved by the Division in writing. These manholes shall be concreted in place and sloped so that surface drainage will be diverted. A locking, watertight cap shall be used. All monitoring wells shall be clearly marked as monitoring wells and numbered.

E. Well Development

Monitoring well development shall not begin until a minimum of 24 hours following completion of the well and shall continue until such time as the water column is free of visible sediment. If development procedures do not produce a water column that is sediment free, then development shall continue until pH, specific conductance, and temperature have stabilized.

The following methods shall be used individually or in combination for well development:

1. Bailing
2. Pumping
3. Surging

F. Surveying

A survey shall be performed to obtain the following information:

1. The elevation of the established and documented point on the top of each well casing correlated to Mean Sea Level (MSL).

2. The distance and angle from monitoring well four (MW-4) to the established and documented point on the top of each well casing shall be measured. All angles shall be measured from magnetic north. This data shall be used to establish the monitoring well location map.

G. Water Level Measurements

All water level measurements shall be referenced from the established and documented point on the top of the well casing. Measurements shall be to the nearest 0.01 foot.

Static water levels shall be measured using an electronic water level indicator. Measurements shall be taken no sooner than 24 hours after completion of well development, but prior to purging. Static water level measurements shall be taken prior to each sampling event.

If free product is encountered during water level measurements, then the thickness of the free product shall be measured to the nearest 0.01 foot.

H. Ground Water Sampling

All ground water monitoring wells shall be sampled. If free product is present, then a minimum of three well volumes shall be purged from the well prior to collecting a sample. A sample shall be collected as soon as a sufficient volume of ground water recharges into the well (If free product is present after purging, then contact the local environmental field office for further guidance). All monitoring well sampling shall follow the protocol as described below.

1. Purging

After determining the static water level of the well, but prior to collecting a sample, the total volume of water in the well shall be calculated. A minimum of three (3) well volumes shall then be purged from the well. If the well is purged to dryness before three (3) well volumes are obtained, then no further purging shall be required. The samples shall then be collected as soon as a sufficient volume of ground water recharges into the well.

2. Sample Containers and Preservation

All sample containers shall be pre-cleaned and sealed by the distributor or laboratory. Each sample bottle shall be properly preserved prior to sample collection in accordance with Table 4 below.

TABLE 4

Sample Containers and Preservatives		
Parameter	**Container**	**Preservative**
Volatile Organics	40 ml amber glass vials with Teflon lined septa	Four (4) drops of 1:1 Hydrochloric acid
PAHs	1 liter amber glass bottles with Teflon lined lid	None
Metals	1 liter plastic bottle	5 ml 70% Nitric acid

3. Collection Method

All samples from ground water monitoring wells shall be collected with a new, disposable bailer. To keep agitation of the sample to a minimum, the bailer shall be slowly lowered into the water column. When transferring the sample from the bailer to the sample container, care shall be taken to minimize agitation. When collecting volatile organic samples, the sample container shall be completely filled so that air bubbles are not trapped inside. Care shall also be taken to have minimal overflow so that the preservative is not lost.

Upon collection, samples shall be immediately labeled, placed in a cooler, and chilled to approximately 4°C. The samples shall be maintained at 4°C until delivered to the laboratory.

No sampling equipment shall be placed directly on the ground or other possibly contaminated surface prior to insertion into a well. A clean plastic sheet or other appropriate material shall be placed by each well for all sampling equipment.

I. Disposal of Purge and Development Water

All purge and development water shall be managed in a manner such that these materials will not cause pollution and disposal is in accordance with all applicable State and Federal Laws.

J. Analytical Methods

When analyzing water samples for Volatile Organics, the laboratory shall follow the procedures outlined in the Test Methods for Evaluating Solid Waste, SW-846. At a minimum, the following constituents shall be analyzed: benzene, toluene, xylenes, ethylbenzene, MtBE, and naphthalene. The samples shall be analyzed as follows:

1. The purge and trap procedures for the water samples in Method 5030B shall be performed; then

2. The actual constituent analysis shall be performed using gas chromatography with a mass spectrometer following Method 8260B.

The practical quantitation limit for benzene is 0.001 PPM, naphthalene is 0.002 PPM, and all others are 0.005 PPM using this method for ground water samples. All results shall be reported in PPM.

When extracting water samples for semi-volatile organics, the laboratory shall follow the procedures outlined in the Test Methods for Evaluating Solid Waste, SW-846, Method 3510C. The Division approves the use of either Method 8310 (preferred) or Method 8270C SIM (alternative) for PAH analysis. Refer to Reference 1 and Reference 2 in the appendices for assistance in determining the applicable COCs for laboratory analysis. **Lab analyses that report below detection levels (i.e. "BDL" or "ND") with MDLs above program MCLs or RBCLs will not be eligible for Fund reimbursement.**

K. Water Use Determination

The following steps shall be performed, **IN SEQUENCE**, to determine the water use in the vicinity of the site. **If at any point, the aquifer or water source is determined to be used as a drinking water supply, then no further steps shall be completed.**

If petroleum hydrocarbons are detected in any drinking water supplies, then the Division <u>and</u> the well user(s) shall be notified within seventy-two (72) hours of the receipt of the sample results. If the contaminant concentration exceeds the drinking water MCL for any COC (see Reference 3 in the appendices), then an alternate drinking water supply shall be supplied to the user(s) of any of these drinking water supplies within twenty-four (24) hours of the receipt of the sample results.

1. Water Use Survey

Perform a water use survey within a one-half (0.5) mile radius of the UST site. The following actions shall take place at a minimum:

a. Personally contact, by phone or in person, all water users within a one-tenth (0.1) mile radius of the site and complete the appropriate Water Use

Survey Sheet. These forms (private supply and public water supply) are located in the appendices;

b. Perform a field survey within a one-quarter (0.25) mile radius of the UST site to determine the existence of any water use supplies. If a potable drinking water supply is determined to be in use, then the user shall be personally contacted and the appropriate Water Use Survey Sheet completed for each water supply identified. All potable water supply wells within one-quarter (0.25) miles of the site shall be sampled for applicable COCs in accordance with Reference 1 and Reference 2 located in the appendices. Based on the results of the sampling, the Division may require additional sampling; and

c. Perform a records search within a one-half (0.5) mile radius of the UST site to determine the existence of any water use supplies. If a drinking water supply is identified, then the user shall be personally contacted and a Water Use Survey Sheet completed for each water supply identified. The Tennessee Division of Water Supply (DWS) and/or the authorized local government agency shall be contacted to determine if the UST site is located within a designated Wellhead Protection Area (WPA).

If any aquifer or water source is being used as a potable water supply by the citizens of the state, then the aquifer or water source shall be considered drinking water.

If any drinking water supply (well or spring) is found within a one-half (0.5) mile radius of the UST site or the UST site is located within a designated WPA as determined by the DWS and/or the authorized local government agency, then justification may be provided describing why the water supply should not be considered in determining if the impacted aquifer or water source is used for drinking water or the wellhead protection area is not applicable. The justification shall include, but not be limited to, the direction of ground water flow, the hydrogeologic characteristics (i.e. hydrologic boundaries), and the characteristics of the COC(s).

2. Karst Survey

Perform a karst survey within a one-half (0.5) mile radius of the UST site, if the site is located in an area with carbonate bedrock.

The following actions shall take place at a minimum:

a. Examine the appropriate portions of the 7.5 minute USGS topographic map(s) that are located within a one-half (0.5) mile radius of the site. This examination shall include the identification of all springs, sinkholes, sinking streams, and/or caves identified on the topographic map(s).

b. Perform a field survey within a one-quarter (0.25) mile radius of the UST site to determine if any springs, sinking streams, water supply wells, or caves are evident. This field survey shall be conducted concurrently with the ground water use survey.

If no karstic features are identified within a one-half (0.5) radius of the site during examination of the topographic map or completion of the field survey, then only perform section d.

c. Any bedrock spring within one-half (0.5) miles of the site at an elevation below that of the release, shall be visually inspected for indication of a petroleum release. Any spring with iron staining, petroleum sheen, petroleum odor, or other indication of petroleum contamination shall be sampled for the appropriate COCs in accordance with Reference 1 and Reference 2 located in the appendices.

d. All potable water supply wells within one-quarter (0.25) miles of the site shall be sampled for applicable COCs in accordance with Reference 1 and Reference 2 located in the appendices. Based on the results of the sampling, the Division may require additional sampling.

e. Any non-potable bedrock water well within one-tenth (0.1) miles of the site shall be sampled for applicable COCs in accordance with Reference 1 and Reference 2 located in the appendices. Based on the results of the sampling, the Division may require additional sampling.

3. Analytical Sampling

Determine if the impacted aquifer or water source meets the primary and secondary drinking water standards of rule 1200-5-1, by collecting and analyzing a ground water sample from a monitoring well that has not been impacted by petroleum contamination. If all monitoring wells have been impacted by petroleum contamination, then collect and analyze a ground water sample from the monitoring well with the lowest petroleum contaminant concentration. The sample shall be analyzed for iron and manganese only. If the analytical results indicate that the iron and manganese concentrations are below the established secondary standard for both parameters, then a second sample shall be collected and analyzed for the remaining primary and secondary standards.

If the impacted aquifer or water source fails to meet any of the primary or secondary standards and is not a drinking water supply as determined in the water use survey, then it may be classified as a non-drinking water supply. Exceeding the primary and secondary Drinking Water Standards cannot be the result of petroleum contamination, unless the petroleum is naturally occurring. A list of the primary or secondary drinking water standards can be found in TGD - 002, Division of Water Supply - Primary and Secondary Drinking Water Standards.

4. Pump Test

If the ground water meets the criteria of the primary and secondary Drinking Water Standards, then the yield of the aquifer or water supply shall be determined. Prior approval shall be sought from the Division. A suitable pump test method shall be used to determine if the impacted aquifer or water source is capable of providing a yield of at least one-half (0.5) gallon per minute. The monitoring well considered to have the highest yield shall be the first well pump tested. If this first well does not yield at least one-half (0.5) gallon per minute, then all additional monitoring wells shall be tested until either all wells have been tested or one well yields at least one-half (0.5) gallon per minute. If the impacted aquifer or water source is

not capable of producing water at the rate of one-half (0.5) gallon per minute and is not a drinking water supply (as determined in the water use survey), then the aquifer may be considered as a non-drinking water supply.

L. Decontamination Procedures

Drill rigs and other equipment shall be inspected for lubricant or fluid leaks that could be potential contaminant sources. All "over-the-hole" portions of the drilling equipment shall be steam cleaned prior to use and as necessary between boring locations. All down hole equipment (i.e. augers, drill rods, tools, etc.) shall be steam cleaned prior to use and between all subsequent borings.

All sampling equipment which is not pre-cleaned and disposable and all monitoring equipment shall be properly decontaminated before each use by the following procedure:

1. Cleaned with a laboratory grade detergent wash;

2. Triple rinsed with distilled water; and

3. Allowed to air dry.

All black steel well casing used in well construction shall be decontaminated by steam cleaning prior to use.

M. Monitoring Well Abandonment Procedures

Upon completion of site investigations and/or corrective actions and as directed by the Division, all monitoring wells shall be properly abandoned by a licensed well driller. All local, county, state, and federal requirements shall be followed. Proper abandonment procedures are as follows:

1. For wells with risers, the casing shall be cut off at or below ground level.

2. The monitoring well casing shall be filled from bottom to top with a grout mixture consisting of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs/gal shall be used. The grout shall be placed using a tremie pipe.

III. QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

The following procedures shall be complied with for the purposes of QA/QC in accordance with rule 1200-1-15-.06(1)(b)3:

A. Before each use, all equipment that is not pre-cleaned and disposable shall be properly decontaminated.

B. Sampling personnel shall wear new, disposable sampling gloves while collecting all samples. Gloves shall be changed between each sampling point.

C. Sampling containers shall be laboratory prepared glass jars, glass bottles, or vials (i.e. meet analytical method requirements).

D. All samples shall be **immediately placed** in the appropriate containers in a manner to minimize headspace.

E. All samples collected for potential laboratory analyses shall be properly labeled and immediately stored at 4°C or less.

F. Each jar shall be sealed separately in an airtight container (sealing plastic bag).

G. A chain of custody form shall be completed for each soil and ground water sampling event. This form shall be signed by the individual collecting the sample, the laboratory receiving the sample(s), and all intermediary persons possessing the sample. Sample security shall be maintained during all phases of transport.

H. Sampling shall begin at the location where contamination is least likely to exist (background) and end at the location where the highest levels of contamination are most likely to exist (near the release).

I. All field instruments shall be calibrated daily and the calibration records maintained.

J. When sampling monitoring wells, one (1) duplicate sample shall be collected during each sampling event.

K. When sampling monitoring wells, one (1) trip blank sample shall be required for each sampling event.

IV. SITE SAFETY PLAN

A Site Safety Plan shall be developed and kept on site at all times work is being performed. It shall be written to avoid misinterpretation. All personnel shall be familiar with all information contained in the Site Safety Plan. All personnel on site shall sign the Site Safety Plan. At a minimum the plan shall contain the following:

A. Description of Known Hazards and Risks

This shall include all known or suspected physical and chemical hazards. It is important that all health related data be kept up-to-date. As air, water, soil, or hazardous substance monitoring and sampling data becomes available, it shall be evaluated, significant risk or exposure to workers noted, potential impact on the public assessed, and changes made in the plan. These evaluations need to be repeated frequently since much of the plan is based on this information.

B. Designation of Key Personnel and Alternatives

The plan shall identify the incident manager, as well as the site safety and health officer (and alternate), and any other personnel responsible for the site safety. It shall also identify key personnel assigned to various site operations.

C. Designation of the Levels of Protection

The levels of protection to be worn at the locations, either on-site or by work functions, shall be designated. This includes the specific types of respirators and type of chemical protective clothing to be worn for each level. No one shall be permitted in the areas requiring personnel protective equipment unless they have been trained in its use and are properly wearing it.

D. Delineation of the Work Area

Work areas need to be designated on the site map, which is posted. The size of the zone, the zone boundaries, and access control points into the zone shall be marked and made known to all site workers.

E. Description of Control Procedures

Control procedures shall be implemented to prevent unauthorized access. Procedures shall be established to control authorized personnel entering work zones where personnel protection is required.

F. Requirements for an Environmental Surveillance Program

A program to monitor site hazards shall be implemented. This shall include air monitoring and sampling, other types of media sampling at or around the site that shall identify chemicals present, their hazards, possible routes of migration off-site, and associated safety requirements.

G. Requirements for Routine and Special Training

Personnel shall be trained not only in general safety procedures and use of safety equipment, but in any special work they may be expected to do.

H. Procedures for Weather-Related Problems

Weather conditions can affect site work. Temperature extremes, high winds, storms, etc. impact personnel safety. Work practices shall be established to protect workers from the effects of weather and shelters provided, when necessary. Temperature extremes, especially heat and its effect on people wearing protective clothing, shall be considered and procedures established to monitor for and minimize heat stress.

I. Determination of Site Specific Medical Requirements

Specialized medical requirements due to unusual hazards expected or known to be encountered shall be determined.

J. On-site Emergencies

The plan shall address site emergencies/occurrences that require immediate actions to prevent additional problems or harm to responders, the public, property, or the environment. Unpredictable events such as fire, chemical exposure, or physical injury may occur and shall be anticipated. The plan shall contain detailed information for managing these contingencies.

To accomplish this, the contingency plan shall:

1. Establish site emergency procedures

a. List the names and emergency functions of on-site personnel responsible for emergency actions along with the special training required.

b. Post the location of the nearest telephone (if none are present on the site).

c. Provide alternative means for emergency communications.

d. Provide a list of emergency services organizations that may be needed. Names, telephone numbers, and locations shall be posted. Arrangements for using emergency organizations may need to be made beforehand. Organizations that might be needed are:

i. Fire and Rescue Agency

ii. Police Department

iii. Local hazardous material response units

iv. Emergency Services Offices

e. Address and define procedures for the rapid evacuation of workers. Clear, audible warning signals shall be established. Well marked emergency

exits shall be located throughout the site. Internal and external communications plans shall be developed.

f. A complete list of emergency equipment shall be attached to the safety plan. This list shall include emergency equipment available on-site, as well as all available medical, rescue, transport, firefighting, and mitigating equipment available off-site.

2. Address emergency medical care

a. Determine the location of the nearest hospital or emergency care facility and determine their capability to handle chemical exposure cases.

b. Post the location of medical or emergency care facilities, travel time, directions, and telephone numbers.

c. Determine nearest ambulance service and post the telephone number.

d. Maintain accurate records of any exposure or potential exposure of site workers during an emergency (or routine operations).

e. Advise workers of their duties during an emergency. In particular, it is imperative that the site safety officers practice emergency procedures.

f. Establish procedures, in cooperation with local and state officials if appropriate, for evacuating residents who live or work near the site.

APPENDICES

Appendix 1

PRIVATE SUPPLY - WATER USE & RECEPTOR SURVEY SHEET

Facility ID Number: _____ Facility Name:_____

Interviewer Information:

Interviewer:
Company:
Telephone Number: ( )
Method of contact: ☐ Telephone ☐ In person ☐ By letter
Date and time of actual contact:

User Information:

Person providing information:
Address: _____
Telephone number: ( )
Time user has lived at address (years):
Address of water supply (if different than above):

Water Use Information (check all that apply):

☐ City water supply	
☐ Drinking/cooking	☐ Irrigation
☐ Washing	☐ Livestock
☐ Bathing	☐ Commercial
Other (specify):	Year installed:

☐ Private water supply	Water source (check one): ☐ Well ☐ Spring
☐ Drinking/cooking	☐ Irrigation
☐ Washing	☐ Livestock
☐ Bathing	☐ Commercial
Other (specify):	Year installed:

Well Information: (complete if water is from a well)

TN well registration number	
Indication of petroleum contamination? (taste, odor, etc.) ☐ Yes ☐ No	
Driller:	
Well logs available? ☐ Yes ☐ No	
Well depth (feet):	Well diameter (inches):

Pump type: ☐ Jet ☐ Submersible ☐ Other	
Casing size (inches):	Casing depth (feet):
Screen location (feet):	
Has quality changed? ☐ Yes ☐ No If yes, how?	
Recent repairs to lines, pump, etc.? ☐ Yes ☐ No If yes, explain in additional remarks, below.	

Karst Survey:

Are any springs located on the property? ☐ Yes ☐ No
Is there evidence of petroleum contamination associated with a karst feature? ☐ Yes ☐ No
Are any sinkholes located on the property? ☐ Yes ☐ No
Are any sinking streams located on the property? ☐ Yes ☐ No

If personal interview fails, answer the following:

Was a well identified on the property? ☐ Yes ☐ No
Was a water meter identified on the property? ☐ Yes ☐ No
If a meter is present, did the local utility district confirm that water is currently used? ☐ Yes ☐ No

Receptor Survey:

Type of dwelling/structure on property? ☐ Residential ☐ Commercial

Type of foundation for dwelling/structure? ☐ Basement ☐ Crawl space ☐ Slab-on-grade

Additional Remarks:

Does the user know of other wells in the area? (If yes, provide names and addresses on a separate sheet)

PUBLIC WATER SUPPLY - WATER USE & RECEPTOR SURVEY SHEET

Facility ID Number: _____ **Facility Name:** _____

Interviewer Information:

Interviewer:
Company:
Telephone number: ( )
Method of contact: ☐ Telephone ☐ In person ☐ By letter
Date and time of actual contact:

User Information:

Person providing information:
Address: _____
Telephone number: ( )
Time this water supply in service (years):
Address of water supply (if different than above):

Water Source (check one):

☐ Well ☐ Spring ☐ Water body (lake, river, etc.)	Has quality changed? ☐ Yes ☐ No If yes, how?
Distance and direction of water source from UST system:	Recent repairs to lines, pump, etc.? ☐ Yes ☐ No If yes, explain in additional remarks, below.

System Information (complete if water is from a well):

Utility district name:	TN public water identification number:
Driller:	Casing size (inches): / Casing depth (feet):
Well logs available? ☐ Yes ☐ No	Screen location (feet):
Well depth (feet): / Well diameter (inches):	Are the last VOA sample results available? ☐ Yes ☐ No

Karst Survey:

Are any springs located on the property? ☐ Yes ☐ No	Are any sinkholes located on the property? ☐ Yes ☐ No
Is there evidence of petroleum contamination associated with a karst feature? ☐ Yes ☐ No	Are any sinking streams located on the property? ☐ Yes ☐ No

Receptor Survey:

Type of dwelling/structure on property? ☐ Residential ☐ Commercial	Type of foundation for dwelling/structure? ☐ Basement ☐ Crawl space ☐ Slab-on-grade

Additional Remarks:

Does the user know of other wells in the area? (If yes, provide names and addresses below)

Additional information:

Appendix 3
Reference Table 1

Product Released	Chemicals to Sample Drinking Water	Chemicals To Sample Non-Drinking Water	Chemicals To Sample Surface Drinking Water***	Chemicals To Sample Surface Non-Drinking Water***
Gasoline	Benzene Ethylbenzene Toluene Total Xylenes MtBE Naphthalene	Benzene Ethylbenzene Toluene Total Xylenes MtBE Naphthalene	Benzene Ethylbenzene Toluene Total Xylenes	Benzene Ethylbenzene Toluene
Diesel* Jet Fuel Kerosene	Benzene Ethylbenzene Toluene Total Xylenes MtBE PAHs	Benzene Ethylbenzene Toluene Total Xylenes MtBE Naphthalene	Benzene Ethylbenzene Toluene Total Xylenes Benzo(a)pyrene	Benzene Ethylbenzene Toluene Modified PAHs****
Waste Oil* Used Oil	PAHs Cadmium Chromium, Total Lead, Total Silver Zinc	Naphthalene	Benzo(a)pyrene Cadmium Chromium, Total Lead, Total	Modified PAHs****
Aviation Fuel*	Benzene Ethylbenzene Toluene Total Xylenes MtBE EDB***** EDC PAHs Lead, Total	Benzene Ethylbenzene Toluene Total Xylenes MtBE Naphthalene EDB EDC	Benzene Ethylbenzene Toluene Total Xylenes EDB***** EDC Benzo(a)pyrene Lead, Total	Benzene Ethylbenzene Toluene EDC Modified PAHs****
Unknown**	Aviation + Waste Oil	Aviation + Waste Oil	Aviation + Waste Oil	Aviation + Waste Oil

*EPH to be sampled only during closure and analyzed by TN Extractable Petroleum Hydrocarbons (EPH) Method, GRO is no longer required

**Tanks with unknown contents will be required to analyze all COCs

***Chemicals to be sampled **only** at the surface water receptor

****Modified PAHs - Reference 2 list minus Acenaphthylene, Benzo(g,h,i)perylene, Naphthalene, and Phenanthrene. Include these COCs in all ground water sample analysis if a surface water is a potential receptor. Do NOT add to soil analysis.

*****EDB ground water samples shall be analyzed by EPA method 8011

BTEX, MtBE, Naphthalene, EDB, and EDC shall be analyzed by EPA method 8260B

PAHs in water shall be analyzed by either EPA method 8270C SIM or EPA method 8310 (water samples shall be field filtered using a 4 micron filter); PAHs in soil use 8270C

Metals shall be analyzed by EPA method 200.7 for water and EPA method 6010/3050 for soil

Appendix 4

REFERENCE 2

TENNESSEE PAH LIST

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-c,d)pyrene
Naphthalene
Phenanthrene
Pyrene

Appendix 5

REFERENCE 3

Risk Based Clean-up Levels

Resident Child

CHEMICALS OF CONCERN	SUB-SURFACE SOIL	GROUND WATER	GROUND WATER
	Indoor Inhalation of Vapor Emissions Resident Child (ppm)	Indoor Inhalation of Vapor Emissions Resident Child (ppm)	Ingestion of Water Resident Child (ppm)
Benzene	7.29E-02	7.20E-02	5.00E-03
Toluene	6.78E+00	4.31E+00	1.00E+00
Ethylbenzene	1.43E+02	1.03E+01	7.00E-01
Xylenes (Total)	9.60E+00	3.57E+00	1.00E+01
MtBE	3.96E+01	1.75E+02	2.00E-02
Acenaphthene	NA	NA	9.39E-01
Acenaphthylene	NA	NA	9.39E-01
Anthracene	NA	NA	4.34E-02
Benzo(a)anthracene	NA	NA	1.17E-03
Benzo(a)pyrene	NA	NA	2.00E-04
Benzo(b)fluoranthene	NA	NA	1.17E-03
Benzo(g,h,i)perylene	NA	NA	7.00E-04
Benzo(k)fluoranthene	NA	NA	8.00E-04
Chrysene	NA	NA	1.60E-03
Dibenzo(a,h)anthracene	NA	NA	1.17E-04
EDB	1.80E-01	8.55E-02	5.00E-05
EDC	7.55E-03	2.67E-02	5.00E-03
Fluoranthene	NA	NA	2.06E-01
Fluorene	NA	NA	6.26E-01
Indeno(1,2,3-c,d)pyrene	NA	NA	1.17E-03
Naphthalene	1.35E+02	9.81E+00	2.00E-02
Phenanthrene	NA	NA	4.69E-01
Pyrene	NA	NA	1.35E-01
Cadmium	NA	NA	5.00E-03
Chromium	NA	NA	1.00E-01
Lead	NA	NA	1.50E-02
Silver	NA	NA	1.00E-01
Zinc	NA	NA	5.00E+00

Commercial/ Industrial Worker

CHEMICALS OF CONCERN	SUB-SURFACE SOIL	GROUND WATER	GROUND WATER
	Indoor Inhalation of Vapor Emissions Commercial/Industrial Worker (ppm)	Indoor Inhalation of Vapor Emissions Commercial/Industrial Worker (ppm)	Ingestion of Water Commercial/Industrial Worker (ppm)
Benzene	3.80E+00	3.75E-01	5.00E-03
Toluene	6.22E+01	3.96E+01	1.00E+00
Ethylbenzene	1.31E+03	9.48E+01	7.00E-01
Xylenes (Total)	8.80E+01	3.27E+01	1.00E+01
MtBE	3.64E+02	1.61E+03	2.00E-02
Acenaphthene	NA	NA	9.39E-01
Acenaphthylene	NA	NA	9.39E-01
Anthracene	NA	NA	4.34E-02
Benzo(a)anthracene	NA	NA	1.17E-03
Benzo(a)pyrene	NA	NA	2.00E-04
Benzo(b)fluoranthene	NA	NA	1.17E-03
Benzo(g,h,i)perylene	NA	NA	7.00E-04
Benzo(k)fluoranthene	NA	NA	8.00E-04
Chrysene	NA	NA	1.60E-03
Dibenzo(a,h)anthracene	NA	NA	1.17E-04
EDB	1.05E+00	4.99E-01	5.00E-05
EDC	1.66E-02	5.87E-02	5.00E-03
Fluoranthene	NA	NA	2.06E-01
Fluorene	NA	NA	6.26E-01
Indeno(1,2,3-c,d)pyrene	NA	NA	1.17E-03
Naphthalene	4.03E+02	3.10E+01	2.00E-02
Phenanthrene	NA	NA	4.69E-01
Pyrene	NA	NA	1.35E-01
Cadmium	NA	NA	5.00E-03
Chromium	NA	NA	1.00E-01
Lead	NA	NA	1.50E-02
Silver	NA	NA	1.00E-01
Zinc	NA	NA	5.00E+00

Surface Waters

CHEMICALS OF CONCERN	Domestic Water Supply Use* (ppm)	Water and Organisms Use* (ppm)
Benzene	5.00E-03	5.10E-01
Toluene	1.00E+00	2.00E+02
Ethylbenzene	7.00E-01	2.90E+01
Xylenes (Total)	1.00E+01	N/A
MtBE	N/A	N/A
EDB	5.00E-05	N/A
EDC	5.00E-03	3.70E-01
Acenaphthene	N/A	9.90E-01
Acenaphthylene	N/A	N/A
Anthracene	N/A	4.00E+01
Benzo(a)anthracene	N/A	1.80E-04
Benzo(a)pyrene	2.00E-04	1.80E-04
Benzo(b)fluoranthene	N/A	1.80E-04
Benzo(g,h,i)perylene	N/A	N/A
Benzo(k)fluoranthene	N/A	1.80E-04
Chrysene	N/A	1.80E-04
Dibenzo(a,h)anthracene	N/A	1.80E-04
Fluoranthene	N/A	1.40E-01
Fluorene	N/A	5.30E+00
Indeno(1,2,3-c,d)pyrene	N/A	1.80E-04
Naphthalene	N/A	N/A
Phenanthrene	N/A	N/A
Pyrene	N/A	4.00E+00
Cadmium	5.00E-03	N/A
Chromium	1.00E-01	N/A
Lead	5.00E-03	N/A
Silver	N/A	N/A
Zinc	N/A	N/A

* General Water Quality Criteria - Rule 1200-4-3-.03