Guidance Document
Risk-Based Corrective Action (RBCA)
For Residential and Commercial Heating Oil Systems

National Oilheat Research Alliance (NORA)

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Forward

Heating oil is used to heat many private homes as well as small commercial businesses. At private residences and commercial businesses heating oil can be stored in either underground or aboveground storage tanks in volumes generally equal to or less than 1000 gallons. The storage and handling of heating oil may result in releases to the environment. In many cases, these releases are small and can be addressed quickly. In other cases, additional actions may be needed. For releases of heating oil associated with a private residence or small business, the impacts to soil and groundwater are generally expected to be localized to the area of the heating oil system, in part due to the characteristics of heating oil, unless preferential pathways (e.g., sewers, drains) are present to direct the movement of the heating oil. In addition, while the specific composition of heating oil may vary, petroleum products other than heating oil are not expected to be present in a heating oil storage tank at a private residence or small commercial building. In general, the presence of a petroleum product other than heating oil will manifest itself in the performance of the oil burner equipment; allowing for its quick identification and removal.

Typically, regulations related to the installation and operation of heating oil storage and handling are found in state fire and building codes. Residential and commercial storage and handling of heating oil however, generally have been exempted from regulatory programs related to corrective action (e.g., federal and state underground storage tank regulations). As a result, the approaches for corrective action for releases from a heating oil system vary between states and, in some cases, within a state. These approaches range from specific requirements for releases from heating oil systems, to application of general corrective action requirements for hazardous substances, to case-by-case determinations. The variability and uncertainties associated with these different approaches underscores the need for a consistent and easily-implemented process for determining the need for and extent of corrective action for releases from a heating oil system.

NORA has developed this document based on experience with and review of the wide-range of different approaches to corrective action for releases from heating oil systems and considering the approaches to corrective action for petroleum releases from underground storage tanks.. It provides a consistent, technically-defensible and easily-implemented process. The outcome of a consistent process is one that reduces the financial and process uncertainties associated with corrective action. The process outlined in this document

considers the specific and unique circumstances associated with the physical and chemical characteristics of heating oil and the potential financial impacts on homeowners and small businesses. The process progresses from simple to more complex evaluations only as the circumstances warrant. It is designed to be simple and understandable, cost-sensitive and effective, and reflect the severity of the release, the environmental media (e.g., soil and groundwater) affected, and the potential impacts. In addition, the process focuses on the specific composition and characteristics of heating oil and supports use of natural attenuation processes, where appropriate, in remedial action decisions. It is anticipated that potential releases for many heating oil systems will be resolved during the screening process outlined in Chapter 1 of this document. For a smaller number of systems, the further investigation and remedial action outlined in Chapter 2 of this document may be appropriate.

Disclaimer

The operation and maintenance and removal of heating oil storage tanks are generally regulated under state or local fire codes and, in some case, state environmental regulations. Local building and fire departments or state environmental agencies may have specific requirements for the operation and maintenance, installation or removal of heating oil storage tanks, or investigation of releases from a heating oil storage tank and should be consulted prior to conducting any of these activities. Many state environmental agencies provide information for homeowners about heating oil tank operation, maintenance, and release detection. State regulatory agencies should be contacted for additional information. The information presented in this document is not intended to replace professional judgment or the need to consult a regulatory agency.

The information in this document is believed to be reliable and accurate; however, the implications of any information or guidance contained in this document may vary widely based on the specific facts involved and should not be used as a substitute for consultation with professional and competent advisors. It is expected that some of the activities described in this guidance can be implemented by the property owner and/or the oil supplier. Many components of the assessment and remedial action activities; however, will require the involvement of a trained environmental professional to assist with the data collection and analyses. In addition, and as noted earlier, some states have developed specific requirements for corrective action associated with releases from heating oil systems. The user is therefore encouraged to contact their state or local environmental agency or fire department for additional information and to determine what regulatory requirements may apply.

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Introduction

This guidance document provides a comprehensive approach for screening to determine if a release has occurred and, where further action is warranted, a comprehensive risk-based approach for corrective action for a release of heating oil. It applies to heating oil systems with heating oil storage of 1000 gallons or less located on a residential or commercial property. It does not apply where a release associated with a heating oil system is co-mingled with releases of other petroleum products or other hazardous substances.

The document is organized into two main chapters. Chapter 1 covers the steps and processes for screening for a potential release from a heating oil system. Based on experience, screening for a potential release is commonly performed after the removal of an underground storage tank and as part of an environmental assessment associated with a property transfer or release investigation. Chapter 1 also outlines the process and issues that would follow-up on these two screening scenarios.

Chapter 2 contains information on further investigations and remedial action where the screening conducted in accordance with Chapter 1 determines that corrective action is needed to resolve a potential release from a heating oil system. The process for risk-based corrective action for heating oil systems described in this document is modeled after the requirements in the Guide for Risk-Based Corrective Action at Petroleum Sites [ASTM E1739-05 (2002)], and is consistent with risk-based corrective action approaches included in many different corrective action programs implemented across the US.

All steps of the processes described in Chapter 1 or Chapter 2 of this document are not appropriate for all releases. A glossary that defines terms used in the document and a listing of sources of additional information are provided at the end of this document. Figure 1 provides a flow chart of the screening process for a potential release from a heating oil system.

1.0 Screening

The screening process outlined in this Chapter includes a series of activities to determine if a release has occurred and whether action is appropriate. Two screening processes are discussed in this Chapter. In both cases, the screening process begins with a visual inspection of the heating oil system and the area surrounding the heating oil system for the presence of water wells and surface water and obvious signs of a release. Information from the visual inspection is used to determine if abatement activities are warranted, and select the *action levels* appropriate for the property.

The first screening process is conducted as part of the removal of an underground storage tank. Considering information from the visual inspection, soil samples are collected from the excavation after the removal of the underground storage tank. The samples are sent to a laboratory and analyzed for chemicals indicative of a release of heating oil (referred to in this document as chemicals of concern). Concentrations of chemicals of concern in the excavation samples are compared to the action levels selected for the property (Figure 1). If concentrations of chemicals of concern are below the action levels, and no additional items from the visual inspection require follow-up, then no action is needed. If concentrations of chemicals of concern are above the action levels, then consideration is given to the selective removal of soil with concentrations of chemicals of concern above the action levels. If selective soil removal is not appropriate or concentrations of chemicals of concern are above the action levels after the selective soil removal has been completed then additional sample collection and analysis is conducted in accordance with the process outlined for the environmental assessment (See Section 1.5.2). Concentrations of chemicals of concern in the additional samples are compared to the action levels selected for the property. If concentrations of chemicals of concern are below the action levels, then no further action is needed. If concentrations of chemicals of concern are above the action levels then further investigation is conducted as described in Chapter 2. Figure 1 provides a flow chart for the screening process during an underground storage tank removal.

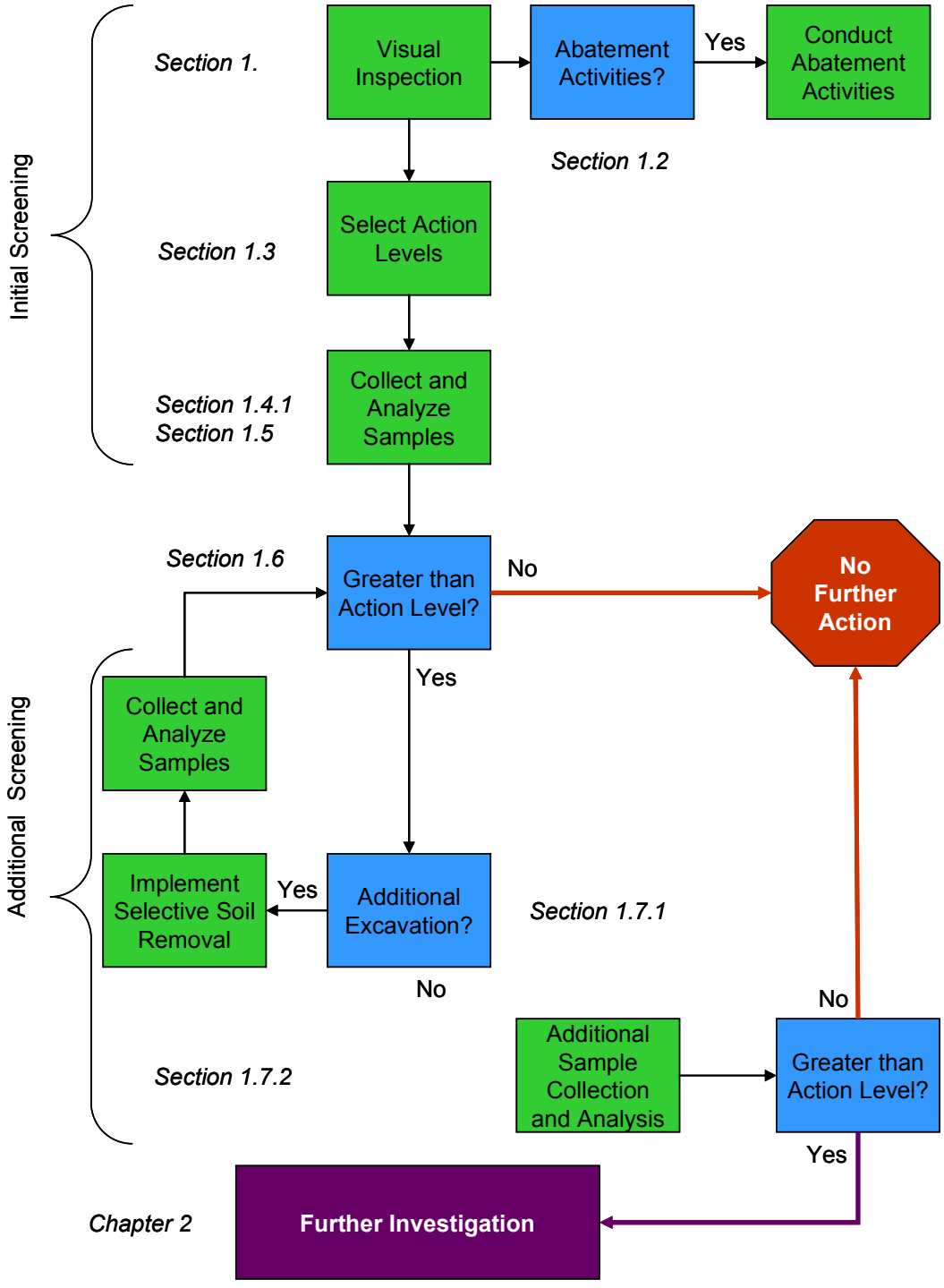

Figure 1 - Screening Process Flow Chart for Underground Storage Tank Removal

The second screening process is conducted as part of an environmental assessment. Considering information from the visual inspection, soil borings are installed and soil and groundwater samples are collected. The samples are sent to a laboratory and analyzed for

chemicals of concern. Concentrations of chemicals of concern in the soil boring samples are compared to the action levels selected for the property. If concentrations of chemicals of concern are below the action levels, and no additional items from the visual inspection require follow-up then no action is needed. If concentrations of chemicals of concern are above the action levels, then further investigation is conducted as described in Chapter 2. Figure 2 provides a flow chart for screening during an environmental assessment.

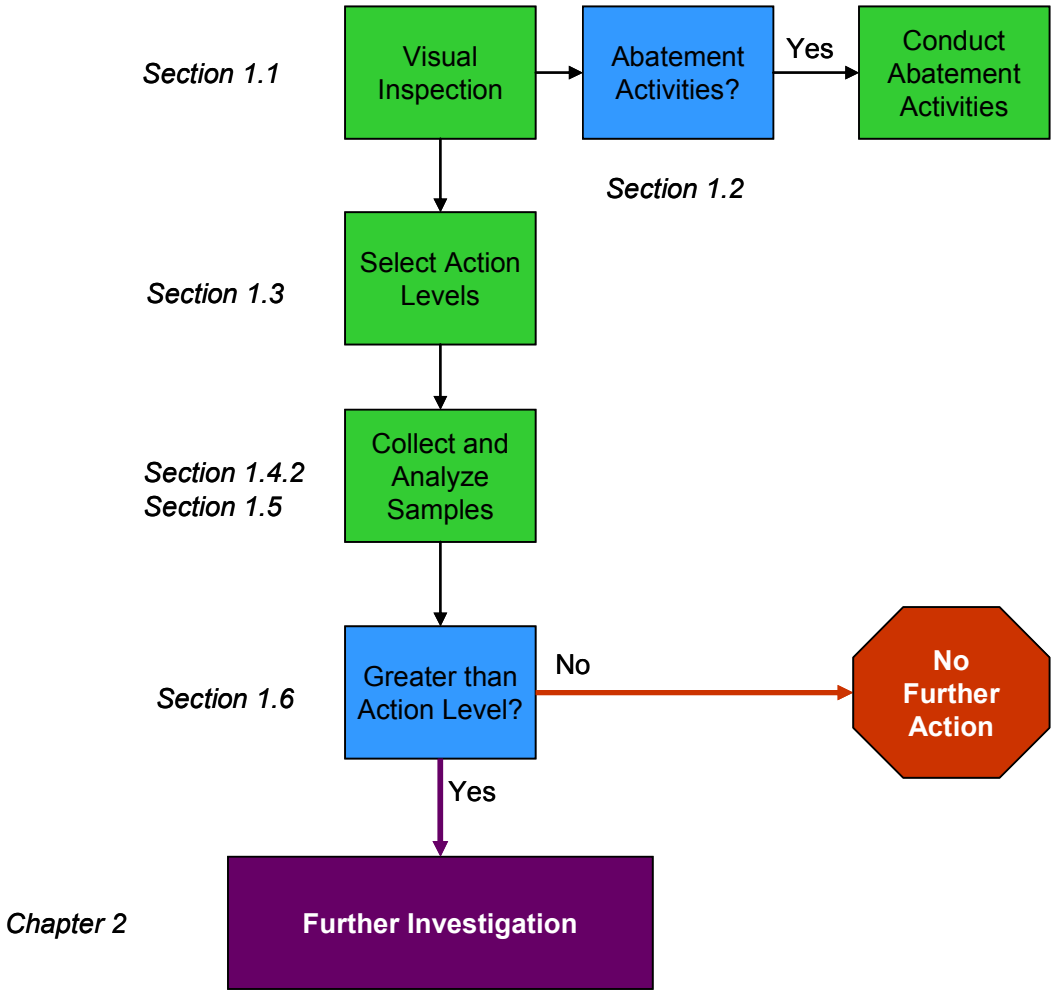

Figure 2 – Screening Process Flow Chart for Environmental Assessment

Forms for documenting the results of the screening process are provided in Appendix A for the visual inspection, Appendix B for the underground storage tank removal screening, and in Appendix C for the environmental assessment screening process.

1.1

1.2 Visual Inspection

The initial step in the screening process is a visual inspection of the heating oil system and the property where it is located. The visual inspection is conducted prior to the removal of a heating oil tank or the environmental assessment. This information is used to document observations about the operation and condition of the heating oil system, select action levels for the screening process, and identify potential situations which may require abatement activities. Information collected during the visual inspection is documented on the *Visual Inspection* form provided in Appendix A. The visual inspection consists of four parts:

Part 1 of the visual inspection documents information about the owner and location of the heating oil system and whether the heating oil system is associated with a residential and commercial activity.

Part 2 of the visual inspection documents information about the heating oil tank and piping.

Part 3 of the visual inspection documents information concerning the operation and setting of the heating oil system. The operational inspection includes, the furnace, exposed portions of the piping or storage tanks, and areas where heating oil is handled or stored. Evidence of spills or releases of heating oil should be noted and proper operation of the heating oil system confirmed. The setting includes the presence of water wells or surface water in close proximity to the heating oil system. It may be helpful to document observations made during the visual inspection with photographs.

Part 4 of the questionnaire identifies the information from the visual inspection that is used to select the action levels for the screening process.

1.3 Abatement Activities

Abatement activities are actions taken during the screening and investigation process prior to remedial action to mitigate safety or health hazards, including free product removal, vapor control, or containment measures or to reduce concentrations of chemicals of concern in soil, groundwater or air, or contain releases of free product.. If any evidence of an immediate impact (e.g., to a surface water or sewer) or imminent fire or safety hazard (e.g., to a building or its occupants) is identified during the visual inspection, appropriate local (e.g., fire

department) or state officials (e.g., environmental agency) should be contacted and appropriate action taken to mitigate the hazard. Appropriate abatement activities may include:

- Resolution of issues raised during the visual inspection (e.g., operational problems with the heating oil system).
- Removal of heating oil from the tank and taking the tank out of service. A temporary source of heating oil may need to be provided.
- The removal of free product (heating oil) from a sump or surface water.
- Installation of containment or diversion structures to minimize impacts to surface waters, storm drains or drainage ditches.
- The removal of free product in an excavation or monitoring well through the use of a vacuum truck, skimmers or other appropriate technology.
- The removal of saturated soil (i.e., concentrations of TPH above the saturated soil action level), where the removal is economically reasonable in light of alternative actions and the removal will not affect the structural integrity of a building or structure.
- The installation of a vapor abatement system (e.g., subsurface venting system) where vapors or odors are detected in a building or concentrations of chemicals of concern in soil or groundwater are above the RBSL for the indoor air exposure pathway. It may be appropriate to install a ventilation system similar to a radon abatement system to address vapors in a building.
- Provisions for an alternative water supply or treatment of an existing water supply where potable water has been impacted by a release of heating oil.

Further information about abatement activities is available from the state regulatory agency having responsibility for petroleum underground storage tank corrective action. Table 6 in Section 2.4 includes a partial listing of state documents that are relevant to response actions and remedial actions.

1.4 Action Levels

The action levels are conservative values so that where the concentrations of chemicals of concern in soil or groundwater are below the applicable action levels, there is a high degree of certainty that no action will be warranted. Two classes of action levels have been

developed for the screening process:

Class 1 action levels are applied to heating oil systems located where a water well or a surface water are within 300 feet of the heating oil system. If a water well is present on the property or adjacent properties (items 3a and 3b of the visual inspection form is checked) or a surface water is near the property (item 3c and 3d of the visual inspection form is checked) then the property is a Class 1 property.

Class 2 action levels are applied to heating oil systems that do not meet the Class 1 criteria.

The action levels for each class are provided in Table 1 and Table 2.

Table 1 – Soil Action Levels

Chemical of Concern	***Class 1***	***Class 2***	***Saturation***
Total Petroleum Hydrocarbons (TPH)	10,000	10,000	10,000
Benzene	0.05	0.6	400
Ethylbenzene	15	>SAT	200
Toluene	16	>SAT	90
Xylenes	74	74	150
Benzo(a)anthracene	0.6	0.6	8
Benzo(a)pyrene	0.1	0.1	7
Benzo(b)fluoranthene	0.6	0.6	1
Dibenzo(a,h)anthracene	0.1	0.1	2
Indeno(1,2,3-cd)pyrene	0.6	0.6	3,800
Naphthalene	8	16	60

All values in mg/kg

All values have been rounded.

>SAT = greater than saturation for the chemical of concern

Chemicals of concern included in this table are those where a concentration less than the saturation value was identified

Table 2 – Groundwater Action Levels

Chemical of Concern	*Class 1*	*Class 2*	*Solubility*
Benzene	5	160	1,700,000
Ethylbenzene	1,000	>SOL	530,000
Toluene	700	>SOL	160,000
Xylenes	10,000	20,100	175,000
Acenaphthene	2,190	>SOL	3,800
Acenaphthylene	2,190	>SOL	16,100
Benzo(a)anthracene	0.1	>SOL	11
Benzo(a)pyrene	0.2	>SOL	4
Benzo(b)fluoranthene	0.1	>SOL	1
Dibenzo(a,h)anthracene	0.01	>SOL	0.6
Fluorene	1,400	>SOL	1,900
Indeno(1,2,3-cd)pyrene	0.1	>SOL	60
Naphthalene	100	9,000	30,000

All values in ug/l

All values have been rounded.

NA – Not applicable

>SOL = greater than the solubility of the pure chemical of concern

Chemicals of concern included in this table are those where a concentration less than the solubility value was identified

(Note: Information concerning the equations, assumptions, and parameters used to develop the RBSL are provided in the Technical Documentation for Risk-Based Corrective Action for Residential and Commercial Heating Oil Systems.)

Action levels related to concentrations of chemicals of concern in groundwater are intended to be protective of surface water where groundwater discharges to surface water. Action levels are not specifically defined for surface water. Where surface water is directly impacted by a release of heating oil (e.g., free product on surface water), the state or local environmental agency should be contacted immediately for information and proper procedures for addressing releases of heating oil directly to surface water.

1.5 Sample Collection

The discussion of sample collection is divided into two sections. The first section (Section

1.5.1) deals with sample collection during the removal of an underground storage tank. The second section (Section 1.5.2) deals with sample collection during an environmental assessment.

1.5.1 Sample Collection during an Underground Storage Tank Removal

Sample collection during an underground storage tank removal is conducted after the tank has been removed from the ground. It is important that the removal of the underground storage tank be carefully conducted in a manner that minimizes spills or releases during the removal activities. In addition, observations during the tank removal are important to the screening process and remedial action, if needed. Once the tank is removed, soil samples are collected from the excavation for analysis and comparison to the action levels selected for the heating oil system.

1.5.1.1 Tank Removal

The local or state regulatory requirements for safe tank removal should be consulted. At a minimum, the following procedures should be followed during the removal underground storage tank:

- Remove heating oil from the underground storage tank to the extent practical.
- Excavate to the top of the tank to expose piping and other fittings. Be careful not to damage piping that may contain heating oil.
- Drain heating oil from the piping back into the tank or other containment and disconnect from the tank. Remove other fittings on the tank.
- Remove the underground storage tank and accessible piping, as appropriate, in accordance with state and local requirements.
- Inspect the tank for evidence of releases such as corrosion, corrosion holes, or other damage that could result in a release and note locations of holes. Note tank condition on Underground Storage Tank Removal form provided in Appendix B.
- Handle and dispose of the tank in accordance with state or local requirements.
- Remove remaining backfill from the excavation and scrape sidewalls and bottom of excavation (e.g., about 6 to 12 inches) back to native soil. If a distinction cannot be made between the backfill around the tank and the native soil, expand the bottom

and sidewalls of the excavation to approximately 18 inches to 24 inches beyond the edge of the tank. If free product is encountered in the excavation, free product should be removed to the extent practicable before scraping the sidewalls and bottom of the excavation back to native soil.

- Sample and test excavated backfill or soil before disposing or reusing in accordance with state and local requirements. If space is available, excavated soil can be stockpiled on the site for sampling and testing prior to disposal. If space is not available on the site or stockpiling soil is not desirable, soil samples can be collected from the tank excavation and tested prior to the tank removal. It is recommended that soil from the tank excavation not be reused on residential property. An alternative is to reuse the backfill or soil on the property only if the backfill or soil meets the state or local requirements for unrestricted use, or “clean fill”, if such requirements are available.

- After removal of the backfill, visually inspect the excavation and note any evidence of releases such as stains or oil in the excavation. Note any evidence of a release on Tank Removal Information Form provided in Appendix B.

(Note: For more information on removal and safety requirements for underground storage tanks see the "American Petroleum Institute Recommended Practice 1604-96; Removal and Disposal of Used Underground Petroleum Storage Tanks.")

1.5.1.2 Sample Collection

After the underground storage tank has been removed and prior to backfilling the excavation, the following sampling activities should be conducted:

- Collect one soil sample from the bottom and each of the side walls of the excavation. The sample collection should be biased towards the area of greatest evidence (e.g., visual or other) of a release. If evidence of a release is not present, the samples should be collected from the approximate center of the underground storage tank. If free product is encountered in the excavation, the free product should be removed before collecting soil samples. When sampling excavation sidewalls or floors, at least one foot of exposed soil should be removed prior to collecting the sample to ensure collection of a fresh sample. Cross-contamination should be minimized by using clean disposable sampling equipment for each sample collected or cleaning the sampling equipment before each use. Many state regulatory programs define procedures for

soil sample collection, and these should be consulted.

- Each of the soil samples should be split into two samples; one placed into a laboratory-supplied glass jar for possible laboratory analysis and the other into a jar or small, sealable plastic bag for field screening. The sample should be field-screened for organic vapors using a photo ionization detector (PID). The other half of the sample (the one in the glass jar) should be placed in a cooler under proper chain-of-custody and sample handling requirements. The PID readings from each soil sample should be recorded. The sample placed in the glass jar that corresponds to the field screened sample with the highest PID reading should be sent for laboratory analyses. Note information related to the soil samples on the Tank Removal Information form provided in Appendix B.

- If groundwater is present in the excavation, a water sample should be collected. To determine if water present in the excavation is groundwater, completely remove the water in the excavation by a vacuum truck or by pumping to a temporary storage tank. If water cannot be completely removed from the excavation or if water recharges to the excavation from the surrounding soil to a level sufficient for sample collection within three to four hours, a water sample should be collected. If water does not return to the excavation, then a water sample need not be collected. Water removed from the excavation should be handled and disposed of in accordance with state, and local regulations. Note information related to the groundwater sample on the Tank Removal Information form provided in Appendix B.

- If heating-oil-related taste or odor was observed in water supplied from a water well identified during the visual inspection, a sample should be collected from the water well at the well head prior to any treatment (e.g., softener). Note information related to the water sample on the Tank Removal Information form provided in Appendix B.

- If a sump is present in a basement or crawl space, sampling the water in the sump can provide an indication as to whether groundwater has been impacted by a release from a heating oil system. If a water well is within 100 feet of the heating oil system and water in the sump is likely to be groundwater, a water sample should be collected from the sump. If there are indications that the water in the sump has been impacted by a release from the heating oil system (e.g., petroleum sheen on the water), a water sample should also be collected from the sump. Prior to sampling, completely remove at least three sump volumes of water by pumping to a temporary storage tank. If

water cannot be completely removed from the sump or if water recharges to the sump from the surrounding soil to a level sufficient for sample collection, a water sample should be collected. Note information related to the water sample on the Tank Removal Information form provided in Appendix B.

(Note: State and/or local regulations may require permits, the use of certified contractors, or specific sampling and analysis for the removal of an underground heating oil storage tank. Contact the local building or fire department or the state environmental agency for more information.)

(Note: Collection of soil and groundwater samples should be accomplished by an environmental professional following procedures for proper collection, containers, handling, shipping, and documentation for laboratory samples. Some state environmental agencies have certified laboratory programs that determine which environmental laboratories may conduct analyses that will be accepted by the state.)

1.5.2 Sample Collection during an Environmental Assessment

Sample collection during an environmental assessment is accomplished using soil borings installed adjacent to the underground storage tank excavation. Collection of soil and groundwater samples for this type of release investigation should be accomplished by an environmental professional. If the environmental assessment is being conducted to investigate a suspected release samples should be collected from in the area of the suspected release. Information collected during the visual inspection should be used to determine the appropriate sampling locations. Soil borings should be installed using techniques such as direct push technologies (e.g., GeoProbe®) or hollow-stem auger drilling. The following actions should be taken during a release investigation:

- Install a minimum of three soil borings in an area around the underground storage tank as shown in Figure 3. If the environmental assessment is conducted to investigate a release the soil borings should be installed biased towards the area of greatest evidence (e.g., visual or other) of a potential release. Note information about the soil borings on the Environmental Assessment Information form provided in Appendix C.

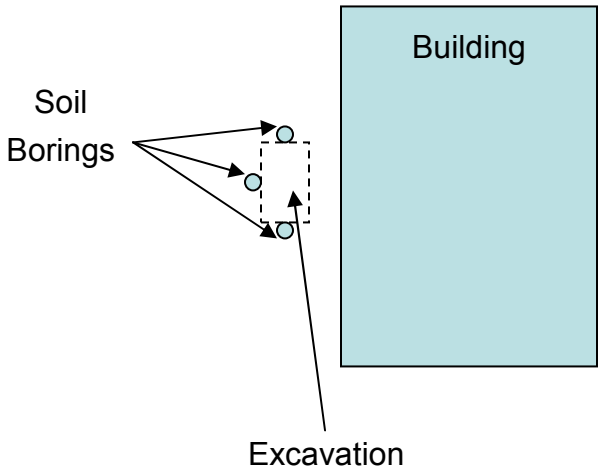

Figure 3 – Example Soil Boring Locations (not to scale)

- Extend the soil borings to the deeper of 10 feet, or 3 feet below the bottom of an underground storage tank, if present. If groundwater is encountered, the soil boring should be extended 5 feet into the saturated zone. If a water well is located within 100 feet of the underground storage tank or location of the suspected release, a soil boring should be placed between the tank or location of the release and the water well and extended to 25 feet, 5 feet into saturated soil (e.g., groundwater), or to auger refusal; whichever is shallower.

- Continuously screen soil during the installation of the soil boring for organic vapors using a field photo ionization detector (PID). If PID readings greater than 100 parts per million (ppm) are encountered at the bottom of the boring, the boring should be extended until PID readings are less than 100 ppm, 5 feet into saturated soil (e.g., groundwater), or to auger refusal; whichever is shallower. Note information related to the soil samples on the Environmental Assessment Information form provided in Appendix C.

- During drilling activities, identify and record characteristics of the subsurface including soil types, depth to groundwater, and observations such as visual evidence of heating oil in soil samples.

- Collect soil samples from regular intervals (e.g., every 2 feet) during drilling activities. Split the soil sample from each interval into two representative soil samples; one placed into a laboratory-supplied glass jar for possible laboratory analysis and the other into a jar or small, sealable plastic bag for field screening.

- For each soil boring, the soil sample placed in the laboratory-supplied glass jar that

corresponds to the field screened sample with the highest field screening result or the one closest to the water table if the field screening readings are not above background, should be sent for laboratory analysis. Note selected soil samples on the Environmental Assessment Information form provided in Appendix C.

- If groundwater is encountered, convert the soil boring into a groundwater monitoring well or install a groundwater sampler (e.g., direct push sampler). Procedures for monitoring well installation are typically governed by state or local water well regulations. Note information related to the groundwater monitoring well on the Environmental Assessment Information form provided in Appendix C.

- If a groundwater well is installed, measure the depth to the groundwater and check for the presence of free product (e.g., heating oil floating on groundwater). If free product is encountered, measure the thickness of free product in the well. Removal of free product to the extent practicable should be conducted. Information related to free product should be noted on the Environmental Assessment Information form provided in Appendix C.

- If free product is not encountered, collect a groundwater sample following procedures for proper collection, containers, handling, shipping, and documentation for laboratory samples.

- If heating-oil-related taste or odor was observed in water supplied from a water well identified during the visual inspection, a sample should be collected from the water well at the well head prior to any treatment system (e.g., softener).

(Note: Prior to installation of soil borings or conducting excavations, the location of underground storage tanks, underground piping, utilities (e.g., water lines, electrical lines) and other potential underground structures should be identified. Care should be taken during drilling activities to ensure that underground equipment or structures are not damaged.)

(Note: Collection of soil and groundwater samples should be accomplished by an environmental professional following procedures for proper collection, containers, handling, shipping, and documentation for laboratory samples. Some state environmental agencies have certified laboratory programs that determine which environmental laboratories may conduct analyses that will be accepted by the state.)

1.6 Laboratory Analysis

Soil and groundwater samples collected for screening should be properly packaged, preserved, and shipped to a qualified analytical laboratory. The analytical methods for chemicals of concern with action levels identified in Table 1 and Table 2 are summarized in Table 3 and Table 4. Note the results of the laboratory analysis on the Tank Removal Information form provided in Appendix B or the Environmental Assessment Information form provided in Appendix C, as applicable.

Table 3 – Analytical Methods for Chemicals of Concern in Soil

Chemical of Concern		*Analytical Method*
TPH		USEPA Method 8015B
Benzene	Toluene	USEPA Method 8021B
Ethylbenzene	Xylenes	
Benzo(a)anthracene	Dibenzo(a,h)anthracene	USEPA Method 8310 or USEPA Method 8270
Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	
Benzo(b)fluoranthene	Naphthalene	

Table 4 – Analytical Methods for Chemicals of Concern in Groundwater

Chemical of Concern		*Analytical Method*
Benzene	Toluene	USEPA Method 8021B
Ethylbenzene	Xylenes	
Acenaphthene	Dibenzo(a,h)anthracene	USEPA Method 8310 or USEPA Method 8270
Acenaphthylene	Fluorene	
Benzo(a)anthracene	Indeno(1,2,3-cd)pyrene	
Benzo(a)pyrene	Naphthalene	
Benzo(b)fluoranthene		

1.7 Comparison of Concentrations of Chemicals of Concern to Action Levels

Concentrations of chemicals of concern are compared to the action levels provided in Table 1 and Table 2, as applicable. If the concentrations of chemicals of concern are below the applicable action levels and continued operation of abatement activities is not required, then

no additional action is warranted. During an underground storage tank removal, if the concentrations of chemicals of concern are above the applicable action levels, additional excavation and screening may be appropriate. During an environmental assessment, if the concentrations of chemicals of concern are above the applicable action levels, further investigations as described in Chapter 2 should be considered.

1.8 Additional Excavation and Screening During Underground Storage Tank Removal

In some cases, the distribution of chemicals of concern in soil can be limited to a small area below and around the underground storage tank excavation. In these cases, selective removal of additional soil may result in the removal of soil with concentrations of chemicals of concern above the action level and warrant no further action. If the selective removal of soil is not appropriate, then additional sample collection should be conducted.

1.8.1 Additional Excavation

Additional soil removal is appropriate during an underground storage tank removal when:

- The removal of saturated soil (i.e., concentrations of TPH above the saturated soil action level) is economically reasonable in light of alternative actions and the removal will not affect the structural integrity of a building or other structure.
- The removal of soil with concentrations of chemicals of concern above the applicable action level is expected to achieve a no further action, the removal is economically reasonable in light of alternative actions, and the removal will not affect the structural integrity of a building or other structure.

Where soil removal is considered, additional excavation should be limited to approximately 300 cubic feet of soil. If a larger volume of soil is to be removed additional soil sampling and analyses and comparison of other remedial actions should be considered to determine the course of action that is economically-reasonable. After the additional excavation, soil and groundwater samples should be collected as described in section 1.4.1.2.

Samples should be submitted to qualified analytical laboratory as described in Section 1.6. Concentrations of chemicals of concern should be compared to the applicable action levels as described in Section 1.7.

If the concentrations of chemicals of concern are below the applicable action levels and

continued operation of abatement activities is not required, then no additional action is warranted. If the concentrations of chemicals of concern are above the applicable action levels, then the excavation should be backfilled and additional sample collection as described in Section 1.8.2 should be conducted.

1.8.2 Additional Sample Collection During an Underground Storage Tank Removal

Additional sample collection during an underground storage tank removal involves the installation of soil borings and collection of soil and groundwater samples, as applicable, in accordance with the procedures outlined for an environmental assessment in Section 1.5.2. Soil borings should be placed in undisturbed soil around the tank excavation as shown in Figure 2 to determine if chemicals of concern have migrated beyond the excavation. To accomplish this, soil borings should be placed approximately two feet beyond the edge of the excavation, but not more than five feet, care should be taken to avoid drilling into utilities or other underground features. These distances may need to be modified based on property-specific conditions.

Samples should be submitted to qualified analytical laboratory as described in Section 1.6. Concentrations of chemicals of concern should be compared to the applicable action levels as described in Section 1.7. If the concentrations of chemicals of concern are below the applicable action levels and continued operation of abatement activities is not required, then no additional action is warranted. If the concentrations of chemicals of concern are above the applicable action levels, further investigations as described in Chapter 2 should be implemented.

1.9 Screening Documentation

The screening process is documented through the completion of the Visual Inspection form provided in Appendix A, the Tank Removal Information form provided in Appendix B or the Environmental Assessment Information form provided in Appendix C, as applicable. In addition to these forms, the following information should be attached, as appropriate:

- Sketch showing the tank location with respect to buildings, streets, and adjacent properties and location of water wells, surface water, drainage ditches, and other features identified during the visual inspection. The sketch should be to scale or provide distances between buildings and tanks and distances to water wells, surface water, drainage ditches, and other features identified during the visual

inspection.

- State and local permits
- Log of activities, dates, and names of contractors
- Documentation of the visual inspection
- Photographs of the excavated tank, the excavation, and the soil stockpile
- Soil boring logs
- Monitoring well construction diagrams
- Laboratory analytical reports
- Chain of custody forms
- Tank, soil, and groundwater disposal documentation including laboratory analytical reports
- Drill cutting disposal documentation including laboratory analytical reports
- Other site-specific information

The property owner should contact the state or local environmental agency to determine if any information should be submitted to the agency. Records of the activities conducted under this guidance document as described herein and copies of documents submitted to the state, should be retained by the property owner, as applicable.

2.0 Further Investigations

If the results of the screening process indicate that additional information is necessary, either to consider remedial actions or in order to support a determination that no additional action is appropriate, then a further evaluation should be initiated. The further evaluation is an iterative process that begins with an exposure pathway evaluation and moves towards more complex evaluations. It includes determining the exposure pathways that exist or potentially exist at a property, planning and implementing additional site characterization and comparing soil and groundwater concentrations to risk-based screening levels (RBSL) or site-specific target levels (SSTL). This iterative evaluation process consists of three tiers of evaluations.

(Note: The further investigation should be conducted by an environmental professional. The state environmental agency having authority for petroleum UST corrective action should also be contacted, if they or another department of the state environmental agency is not already involved in the project.)

2.1 Tier 1 Evaluation

The purpose of the Tier 1 evaluation is to identify specific exposure pathways for the property, identify potentially complete exposure pathways by comparing exposure pathway-specific RBSL to measured concentrations of chemicals of concern, and understand the distribution of chemicals of concern in soil and groundwater for potentially complete exposure pathways.

During the Tier 1 evaluation, the following investigation activities are conducted:

- Identify the potentially complete exposure pathways based on the action level class (See Section 2.1.1).
- Identify the RBSL that correspond to the identified exposure pathways for the property (See Section 2.1.2).
- Based on the soil and groundwater samples collected during the screening process compare concentrations of chemicals of concern to the exposure pathway-specific RBSL. Potentially complete exposure pathways are those pathways where concentrations of chemicals of concern are above the exposure pathway-specific RBSL.
- Conduct additional soil and groundwater sampling to determine the distribution of chemicals of concern in environmental media associated with the potentially complete exposure pathways.

- If groundwater is associated with potentially complete exposure pathways (e.g., drinking water, groundwater to indoor air) then additional groundwater monitoring wells should be installed to define the distribution of chemicals of concern in groundwater to the lowest applicable groundwater RBSL. This will involve the installation of sufficient additional groundwater monitoring wells to determine the direction of groundwater flow and extent of concentrations above the lowest applicable RBSL.
- If soil is associated with potentially complete exposure pathways (e.g., soil leaching to groundwater, soil to indoor air), then additional soil borings should be installed to determine the vertical and horizontal distribution of concentrations of chemicals of concern in soil.
- If soil leaching to groundwater is a potentially complete exposure pathway and a groundwater sample was not collected during the initial investigation, at least one soil boring should be installed to collect a groundwater sample.

- Additional activities as needed based on site-specific conditions or state regulatory agency requirements.

2.1.1 Potentially Complete Exposure Pathways

A potentially complete exposure pathway requires that concentrations of a chemical of concern be above the RBSL or SSTL in the environmental medium (e.g. soil, groundwater, or air) and a person can come in contact with the environmental medium. Exposure pathways identified for each action level class are shown as shaded areas in Table 5

Table 5 - Exposure Pathways for Each Action Level Class

Exposure pathway	*Class 1*	*Class 2*
Ingestion of chemicals of concern in groundwater		
Direct contact with chemicals of concern in soil		
Inhalation of chemicals of concern in indoor air volatilized from soil		
Inhalation of chemicals of concern in indoor air volatilized groundwater		
Inhalation of chemicals of concern in outdoor air volatilized from soil		
Inhalation of chemicals of concern in outdoor air volatilized from groundwater		
Leaching of chemicals of concern in soil to groundwater for ingestion		
Leaching of chemicals of concern in soil to		

Exposure pathway	*Class 1*	*Class 2*
groundwater to volatilization to indoor air		

Property-specific circumstances may indicate that some or all of the identified exposure pathways are not appropriate or additional exposure pathways can be identified.

The following discussion provides information to assist in determining if an exposure pathway is potentially complete:

- The groundwater ingestion exposure pathway is potentially complete if concentrations of chemicals of concern are above (or are expected to be above) the RBSL, the potable water for a residence or commercial building is supplied by a water well, and the water well is within 300 feet of the heating oil system.

- For purposes of evaluating impacts to surface water, the groundwater to surface water exposure pathway is potentially complete if concentrations of chemicals of concern in groundwater are above (or are expected to be above) the RBSL, a surface water is located within 300 feet of the heating oil system, and groundwater flow is determined to be in a direction that will intersect with the surface water.

- The soil direct contact exposure pathway is potentially complete if concentrations of chemicals of concern are above (or are expected to be above) the RBSL in surface soil. An individual can come in contact with surface soil through contact with the skin, inhalation of vapors volatilized from soil, inhalation of air-borne particles (dust) from soil, or incidental ingestion during yard work or other activities outside of a residence or commercial building in the area of the heating oil system. The definition of surface soil can vary from a depth of two feet below the ground surface to a depth of 15 feet below the ground surface, depending on state or local regulations.

- The groundwater or soil to indoor air exposure pathways are potentially complete if the concentrations of chemicals of concern are above (or are expected to be above) the RBSL within 30 feet of an occupied building (ITRC, 2007). An individual can inhale vapors from chemicals of concern in soil or groundwater under a building that have moved into a building through cracks and seams in the foundation. Since concentrations of chemicals of concern can move with groundwater, the direction of groundwater flow with respect to the location of a building should be considered when evaluating this exposure pathway.

- The groundwater or soil to outdoor air exposure pathways are potentially complete if concentrations of chemicals of concern are above the RBSL in an area where there is a pervious surface such as exposed soil or landscaping. An individual can inhale vapors from chemicals of concern in soil or groundwater that have moved to the ground surface and mixed with the outdoor air.

- The soil leaching to groundwater for the groundwater ingestion exposure pathway is potentially complete if concentrations of chemicals of concern are above (or are expected to be above) the RBSL and the groundwater ingestion exposure pathway is present for the site.

- The soil leaching to groundwater for the groundwater to indoor air exposure pathway is potentially complete if concentrations of chemicals of concern are above (or are expected to be above) the RBSL and groundwater to indoor air exposure pathways is present for the site.

2.1.2 Comparison of Concentrations of Chemicals of Concern to RBSL

Concentrations of chemicals of concern from samples collected during the screening process or additional investigations conducted under the Tier 1 evaluation are compared to the RBSL for the exposure pathways applicable to the action level class. RBSL are provided in Appendix E for the exposure pathways provided in Table 5.

(Note: Information concerning the equations, assumptions, and parameters used to develop the RBSL are provided in the Technical Documentation for Risk-Based Corrective Action for Residential and Commercial Heating Oil Systems.)

2.1.3 Tier 1 Decision

If concentrations of chemicals of concern are below the RBSL for all exposure pathways applicable to the action level class, concentrations are not expected to increase over time, and continued operation of abatement activities is not required, then no further action is warranted. It is recommended that the information collected during the Tier 1 evaluation be assembled and documented as described in section 2.1.4 and that the state regulatory agency having authority for petroleum storage tanks be contacted to determine if a copy of the Tier 1 documentation should be submitted.

If concentrations of chemicals of concern are above one or more applicable exposure pathway-specific RBSL for a potentially complete exposure pathway, one or a combination of

the following actions may be warranted:

- Conduct abatement activities, see section 1.3
- Conduct a Tier 2 evaluation, see section 2.2 to develop site-specific target levels (SSTL) as appropriate, or
- Conduct remedial action based on the exposure pathway-specific RBSL as appropriate for the property, see section 2.4.

2.1.4 Tier 1 Documentation

In addition to the information compiled earlier for the screening assessment (section 1.8), complete the Tier 1 Investigation Form provided in Appendix D and attach the following, as appropriate:

- Scaled map showing the soil borings, monitoring wells, and the source areas with respect to buildings, streets, and adjacent properties
- Log of activities, dates, and names of contractors
- Soil boring logs
- Monitoring well construction diagrams
- Laboratory analytical reports
- Chain of custody form
- Drill cutting disposal documentation including laboratory analytical reports
- Other site-specific information

2.2 Tier 2 Evaluation

The purpose of the Tier 2 evaluation is to identify site-specific target levels (SSTL) and points of exposure for exposure pathways identified as potentially complete during the Tier 1 evaluation. Tier 2 evaluations should be conducted by environmental professionals and in consultation with the state regulatory agency having authority for storage tank corrective action. A brief description of the activities and decisions associated with the Tier 2 evaluation is provided in this section.

2.2.1 Tier 2 Investigation

The Tier 2 evaluation may require:

- Development of a conceptual site model for the free product in the subsurface.

(ASTM 2006).

- Selection of appropriate site-specific parameters and development and application of site-specific target levels (SSTL). Information concerning the equations, assumptions, and parameters used to develop the RBSL are provided in the Technical Documentation for Risk-Based Corrective Action for Residential and Commercial Heating Oil Systems.

- The identification of points of exposure that are beyond the tank or piping excavation or source of the release.

- For the volatilization to indoor air exposure pathway, the calculations for the RBSL are conservative. The transport pathway is complex enough that a site-specific calculation may be difficult to collect data for and to implement. It is suggested in Tier 2 that the vapor intrusion pathway be evaluated based on soil gas sampling (see API 2005, USEPA 2003, and ITRC 2007 for more information).

- Additional soil and groundwater sampling and analysis to:

    - implement statistical methods to evaluate the representative concentrations for comparison to the RBSL

    - select the parameters to calculated the SSTL (e.g., soil moisture content, fraction organic carbon, and hydraulic conductivity)

    - determine concentrations of chemicals of concern at site-specific points of exposure.

2.2.2 Tier 2 Decision

If concentrations of chemicals of concern are below the applicable exposure pathway-specific SSTL or representative concentrations of chemicals of concern are below the applicable RBSL or SSTL, and concentrations are not expected to increase over time, then no further action is warranted. It is recommended that the information collected during the Tier 2 evaluation be assembled and documented as described in section 2.2.3 and that the state regulatory agency having authority for petroleum storage tanks be contacted to determine if a copy of the Tier 2 evaluation documentation should be submitted.

If concentrations of chemicals of concern are above, or are expected to increase over time to

levels that are above, one or more applicable exposure pathway-specific SSTL or representative concentrations of chemicals of concern are above the applicable RBSL or SSTL, one or a combination of the following actions may be warranted:

- Conduct abatement activities, see section 1.3, and re-evaluate the site, or
- Conduct a Tier 3 evaluation, see Section 2.3 to develop site-specific target levels (SSTL) as appropriate, or
- Conduct remedial action based on the exposure pathway-specific RBSL or SSTL, as applicable and appropriate for the property, see section 2.4.

2.2.3 Tier 2 Documentation

The Tier 2 evaluation documentation will by necessity be specific to the property being investigated. In addition to the information compiled for the screening documentation (section 1.8) and the Tier 1 documentation (section 2.1.4), it is recommended that the following information be included in a Tier 2 report:

- Summary of potentially complete exposure pathways evaluated during the Tier 2 evaluation.
- Concentrations of chemicals of concern at points of exposure compared to RBSL or SSTL, as appropriate
- Monitoring well gauging information
- Property-specific geotechnical data where SSTL have been calculated
- Scaled map showing the location of soil borings and monitoring wells
- Scaled map showing concentrations in soil and groundwater
- Scaled map showing groundwater elevations and flow contours
- Soil boring logs
- Monitoring well construction diagrams
- Laboratory analytical report
- Chain of custody documentation
- Documentation for the points of exposure
- Geotechnical laboratory report
- Slug test / pump test results
- Site specific target level development
- Monitoring plan
- Other site-specific information

2.3 Tier 3 Evaluation

A Tier 3 evaluation is a complex evaluation that is generally only appropriate for heating oil properties with an extensive distribution of chemicals of concern and significant exposure issues. The purpose of the Tier 3 evaluation is to develop SSTL based on modeling or statistical evaluation. It will typically require additional soil and groundwater data to develop and calibrate the models or conduct the statistical evaluations. Tier 3 evaluations should be conducted only by environmental professionals and in consultation with the state regulatory agency having authority for storage tank corrective action.

The Tier 3 evaluation may include:

- More detailed understanding for the conceptual site model for the free product. (ASTM 2006)
- Statistical analysis of the source area to demonstrate that the representative concentrations are not above the applicable RBSL or SSTL.
- More sophisticated (as compared to those that are used to develop RBSL and Tier 2 SSTL) evaluation of the behavior and movement of chemicals of concern in soil, groundwater or air (e.g., fate and transport modeling), and data collection and analyses where offsite impacts and impacts to drinking water resources are present.
- Aquifer studies (e.g., pumping tests).

2.3.1 Tier 3 Decision

If concentrations of chemicals of concern are below the applicable exposure pathway-specific SSTL or representative concentrations of chemicals of concern are below the applicable RBSL or SSTL, and concentrations are not expected in increase over time, then no further action is warranted. It is recommended that the information collected during the Tier 3 be assembled and documented as described in Section 2.3.2 and submitted to the state regulatory agency having authority for storage tanks corrective action.

If concentrations of chemicals of concern are above, or are expected to increase over time to levels that are above, one or more applicable exposure pathway-specific SSTL or representative concentrations of chemicals of concern are above the applicable RBSL or SSTL, one or a combination of the following actions may be warranted:

- Conduct abatement activities, see section 1.3 , and reevaluate the site, or

- Conduct remedial action based on the exposure pathway-specific RBSL or SSTL, as applicable and appropriate for the property, see section 2.4.

2.3.2 Tier 3 Documentation

The Tier 3 Evaluation documentation will by necessity be specific to the property being investigated. Documentation should include the information described in Section 2.2.3 for the Tier 2 evaluation and additional information as appropriate to the evaluations conducted and as requested by the regulatory agency.

2.4 Remedial Action

Remedial action is the process by which exposures are reduced or eliminated to achieve the appropriate RBSL or SSTL. Typically, a remedial action is a process by which concentrations of chemicals of concern are reduced in soil or groundwater, or free product is recovered. Depending on the potentially complete exposure pathways for a property, more than one remedial action method may be needed. The kinds of remedial action that are most often implemented to address a heating oil release are discussed in this section.

If remedial action is to be implemented, environmental professionals should be integrally involved in the process and the state agency having authority for petroleum storage tank corrective action should be consulted. Table 6 includes state resources for remedial action that may be helpful.

Table 6 – Selected State Guidance

State	*Agency*	*Document*	*Date*
Connecticut	Department of Environmental Protection	"Guidance for Residential Underground Fuel Tank Releases"	September 2005
Maryland	Department of Environment	"Maryland Environmental Assessment Technology for Leaking Underground Storage Tanks"	February 2003
Massachusetts	Department of Environmental Protection	"Homeowners Oil Spill Cleanup Guide"	January 2004

State	*Agency*	*Document*	*Date*
New Jersey	Department of Environmental Protection	"Homeowner's Guide to Cleaning Up Heating Oil Discharges."	November 2007
New York	Department of Environmental Conservation	"Underground Heating Oil Tanks: A Homeowner's Guide."	
Pennsylvania	Department of Environmental Protection	"Land Recycling Program Technical Guidance Manual"	June 2002
Virginia	Department of Environmental Quality	"Investigation and Characterization of Discharges from Heating Oil Tanks"	March 2007

2.4.1 Soil Removal

The removal of soil with concentrations of chemicals of concern above the action level for the applicable property classification is appropriate where the removal is economically reasonable in light of alternative actions and the removal will not affect the structural integrity of a building or other structure. It can be completed in conjunction with the removal or replacement of a storage tank, when maintenance work is conducted on the tank or piping, or after a storage tank has been removed to further reduce concentrations in soil.

When soil is to be removed as part of a remedial action, a plan should be developed by the environmental professional that includes the following information:

- An estimate of the amount of soil to be removed and the dimensions or extent of the proposed excavation
- Stockpiling, sampling and disposal plans and procedures
- Field screening and sampling for monitoring the success of the soil removal
- Confirmation sampling for laboratory analyses to be completed at the end of the soil removal
- Additional site-specific and state-specific information.

Following completion of the soil removal and receipt of all of the results, an assessment can be made about the success of the remedial action and whether additional actions are needed.

Soil removal can be an effective and efficient method for remedial action when the extent of chemicals of concern in soil is fairly well-known and is understood to be relatively small. It can be accomplished in a relatively short period of time, relative to other remedial action methods. Conversely, it is possible to begin an excavation and determine that the soil impacts are greater than anticipated or that there are obstructions to completion of the excavation that were unknown. It can also be more disruptive and intrusive than some other remedial actions.

2.4.2 Natural Attenuation

Natural attenuation is the name given to the natural process by which concentrations of petroleum hydrocarbons are reduced in the environment through processes such as biodegradation, dispersion, and dilution. In order to use natural attenuation as a remedial action, a plan for monitoring and evaluating concentrations in soil or groundwater in space and in time must be developed. Typically natural attenuation is used when the concentrations in soil and groundwater of chemicals of concern are close to the RBSL or SSTL, following the removal of a source by soil excavation, or following the operation of an active remediation system such as soil venting or free product recovery.

Part of the planning process for natural attenuation as a remedial action is making a demonstration through laboratory analyses over time and space that the concentrations of chemicals of concern are decreasing or are stable. The process requires on-going sampling and analysis of groundwater, and sometimes soil or soil gas, in order to demonstrate progress. Natural attenuation as a remedial action has the advantage of not being intrusive, except for the periodic sampling and maintenance of groundwater wells, or soil gas monitoring points. It often requires more time to complete than other remedial actions, its appropriateness as a remedial action may be dependent on the plans for the property. Along with the state guidance noted above in Table 6, the ASTM and USEPA have developed guidance for using natural attenuation as a remedial action (see ASTM 2004, USEPA 2004 for more information).

2.4.3 Vapor Mitigation Systems

If the volatilization from soil or groundwater to indoor air exposure pathway is determined to be complete and soil gas sampling or transport modeling has shown that concentrations

entering the building are above acceptable levels, an appropriate remedial action for a property could be the installation of a building ventilation system. Building ventilation systems are installed to reduce the amount of petroleum hydrocarbon vapors originating from the soil and groundwater that could enter into the building basement or through the foundation into a living space. A common application of building ventilation systems is to address high levels of naturally-occurring radon gas. These systems are installed in an existing home without significant disruption to the people living in the home. Similar systems can be used to address petroleum hydrocarbon vapors. Additional information about vapor abatement systems is available from the Table 6 references and in ITRC 2007, USEPA 2003.

2.4.4 Point-of-Use Treatment

If groundwater is impacted and there is potable use of groundwater for drinking water the quickest solution usually is to provide a carbon or other treatment system on that water well to eliminate the groundwater ingestion exposure pathway. This type of remedial action may be used as an interim solution while a groundwater treatment system is operating, or it may be a long-term solution until natural attenuation can sufficiently cleanup the groundwater. The installation of a new potable well in a location where groundwater impacts will not affect the potable water supply or connection to a public water supply can provide a more permanent water supply solution.

2.4.5 Treatment Systems

There are a number of different types of treatment systems that might be considered for soil and groundwater remediation from a heating oil release. The most common systems would be:

- Free product pumping or skimming
- Groundwater recovery and treatment
- Soil vapor extraction
- Groundwater and soil treatment through a combination of air-sparging and soil vapor extraction.

All of theses systems require significant planning and design by environmental professionals and likely require environmental permits. The regulatory agency should be involved if any of these types of systems are contemplated. Treatment systems such as these are usually

implemented when there are significant impacts to soil and groundwater and there are people and resources that need to be protected. The systems can be installed and operated over a period of time and can be in-place while the property is in normal use. The systems require monitoring and maintenance by environmental professionals. In addition, groundwater (and sometimes soil or soil gas) sampling is conducted during the operation of the systems to confirm that the applicable RBSL or SSTL are being met. Often the operation of treatment equipment continues for a period of years. Following the active operation of the treatment equipment, a period of monitoring and sampling is conducted to ensure that the RBSL or SSTL have been achieved. The documents in Table 6 and USEPA 1996, USEPA 2004a and API 1996, provide further information about treatment systems.

2.5 Monitoring

Monitoring is the process of collecting and evaluating soil, soil gas and groundwater concentrations and measurements over time. Monitoring is typically required to confirm the progress of remedial action and verify that concentrations of chemicals of concern in soil and groundwater have achieved the appropriate RBSL or SSTL. Where monitoring is required, a monitoring plan should be developed to include the:

- Objectives of the monitoring program
- Types and frequencies of samples to be taken
- Laboratory analyses to be completed
- Indicators of success of the remedial action and monitoring results that would require changes to the remedial action

During remedial action, either through abatement systems, cleanup systems or natural attenuation, collection of soil, soil gas, and groundwater data in accordance with a monitoring plan can assist in ensuring that the remedial action is successful. The references in Table 6 and USEPA 1996, USEPA 2004a, and API 1996, include information about monitoring programs.

2.6 Site Completion

If concentrations of chemicals of concern are determined to be below the applicable RBSL or SSTL, or once all of the aspects of a remedial action or monitoring program have been completed, a project can be closed and the corrective action considered complete for a

property. The circumstances for the completion will depend on the specific actions taken at a property and the involvement of the state regulatory agency. In some cases vapor mitigation systems, or water well treatment systems will continue to be operated, but other aspects of the project may be closed. In other situations the project will be closed, unless there is a change in the use of the property that would require a re-evaluation of the exposure pathways.

The property owner should retain the records of the activities conducted under this guidance document as described in Sections 1.9, 2.1.4, 2.2.3 and 2.3.2, as applicable. In addition, copies of the documents submitted to the state, copies of permits, disposal records, and the documentation discussed in Sections 1.9, 2.1.4, 2.2.3 and 2.3.2 should be retained by the property owner, as applicable.

Sources of Additional Information

American Petroleum Institute (API) 1996. *Publication Number 1628, A Guide to the Assessment and Remediation of Underground Petroleum Releases – Third Edition*. American Petroleum Institute, Manufacturing, Distribution, and Marketing Department, , Washington DC. July.

API 1996. *Recommended Practice 1604-96; Removal and Disposal of Used Underground Petroleum Storage Tanks.* American Petroleum Institute, Manufacturing, Distribution, and Marketing Department,., Washington DC.

API 2005. *Publication Number 4741, Collecting and Interpreting Soil Gas Samples from the Vadose Zone - A Practical Strategy for Assessing the Subsurface Vapor-to-Indoor Air Migration Pathway at Petroleum Hydrocarbon Sites*. American Petroleum Institute, Regulatory Analysis and Scientific Affairs, , Washington DC . November.

ASTM 2002. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. ASTM E-1739-95 (2002), Philadelphia, PA. Reauthorized in 2002.

ASTM 2004. *Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites*. ASTM E1943-98. American Society for Testing and Materials, West Conshohocken, PA.

ASTM 2006. *Standard Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids Released to the Subsurface.* ASTM E2531-06. American Society for Testing and Materials, West Conshohocken, PA.

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USEPA 2003 - *User's Guide For Evaluating Subsurface Vapor Intrusion Into Buildings.* Office Of Emergency And Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.. June.

USEPA 2004. Performance Monitoring of MNA Remedies for VOCs in Ground Water. U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Ada, OK. April.

USEPA 2004a. *How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers.* (EPA 510-B-94-003; EPA 510-B-95-007; and EPA 510-R-04-002). U.S. Environmental Protection Agency, Office Of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. May.

Virginia Department of Environmental Quality (VADEQ), 2001. "Storage Tank Program Technical Manual." October.

VADEQ 2007. "Investigation and Characterization of Discharges from Heating Oil Tanks." March.

Glossary

Abatement Activities – Actions implemented to mitigate safety or health hazards, including free product removal, vapor control, or containment measures. Abatement activities may be implemented to reduce the concentration of chemicals of concern in soil, groundwater or air, or contain releases of free product.

Action Level – A concentration of a chemical of concern in an environmental medium, above which additional investigation or remedial action is warranted.

Chemical of Concern - The specific chemical components of heating oil that are identified for evaluation during the screening and assessment process.

Corrective Action – The process by which releases to the environment of oil or hazardous substances are investigated and cleaned-up.

Environmental Medium - Soil, groundwater, air or surface water.

Exposure Pathway – The description of the events or activities by which a person may be in contact with concentrations of a chemical of concern in an environmental medium.

Free Product – Heating oil that exists in a liquid phase on the surface of the groundwater, surface water or in soil. Free product is often defined as a measurable thickness in a groundwater well or in a basement sump.

Heating Oil System – the underground or above ground storage tank used to store heating oil for a residence or small business including fittings on the tank and piping between the tank and the furnace.

Natural Attenuation - The name given to the natural process by which concentrations of petroleum hydrocarbons are reduced in the environment through processes such as biodegradation, dispersion, and dilution.

Release - Any spill or leak of heating oil, detection of free product in the environment, or detection of concentrations of a chemical of concern in environmental media (e.g., concentrations in soil or groundwater).

Remedial Action - Activities conducted to reduce or eliminate exposures to achieve the appropriate RBSL or SSTL. These activities include soil removal, natural attenuation, vapor mitigation systems, point of use treatment systems on water wells, provision of new wells or

connections to public water systems, and ground water or soil treatment systems.

Risk-Based Screening Level (RBSL) - Risk-based concentrations for chemicals of concern in environmental media utilized during the Tier 1 evaluation. The RBSL are based on generic assumptions about the site properties, the exposure pathways and the soil and groundwater. The development of the RBSLs is discussed further in the Technical Documentation.

Site-Specific Target Level (SSTL) - Risk-based concentrations for chemicals of concern in environmental media developed for a particular heating oil system release under the Tier 2 or Tier 3 evaluations that address the potentially complete exposure pathways.

Surface water – Surface water includes streams, ponds or lakes. Surface waters are often defined by individual state regulation.

Appendix A – Visual Inspection Questionnaire

Heating Oil System
Visual Inspection

1) Location Information:

Address: _____

City: _____ State: _____ Zip: _____

Owner Name: _____ Owner Phone: _____

Is this location: □ Residential □ Commercial

2) Tank and Piping Information:

a) Tank is: □ Underground □ Aboveground

b) Piping is: □ Underground □ Aboveground

c) Tank is located: □ Inside building □ Outside Building

d) Depth from ground surface to bottom of underground storage tank: _____

e) Tank size (gallons): _____ Tank age (years): _____

f) Tank material: □ Steel □ Fiberglass □ Other _____

3) Visual Inspection Results: describe in comments as applicable

a) □ A water well is located (*check all that apply*):

- □ on the property where the heating oil system is located
- □ within 300 feet of the heating oil system (e.g. storage tank)

b) □ There are heating-oil-related taste or odor problems reported in potable water

c) □ A surface water (e.g., stream, lake, pond) is located (*check all that apply*):

- □ on the property where the heating oil system is located
- □ within 300 feet of the heating oil system (e.g. storage tank)

d) □ There is evidence of oil in drainage ditches or storm drains that discharge to a surface water

e) □ The building has a basement or crawl space

f) □ There are oil stains in the basement, crawl space, or around the furnace or tank area

g) □ The building has a sump

h) □ There is a sheen or free product on the water in a sump

i) □ There are operating problems of the heating oil system including the oil burner

j) □ There is staining in soil around an aboveground tank or underground tank

k) □ There have been spills or other losses of heating oil of 25 gallons or more

i) Where did the spill or loss occur: _____

ii) When did the spill or loss occur: _____

iii) What was the approximate amount spilled or lost: _____

l) Comments and Other Observations: _____

_____

_____

_____

_____

4) Action Levels: *Check the appropriate classification*

- ☐ Class 1 - 3a, 3b, 3c, or 3d are checked
- ☐ Class 2 - 3a, 3b, 3c, or 3d are not checked

Appendix B - Tank Removal Information

Heating Oil System
Tank Removal Information

1) Location Information:

Address: _____

City: _____ State: _____ Zip: _____

Owner Name: _____ Owner Phone: _____

2) Inspection Information: Check as appropriate and note any additional observations.

- ☐ Holes or other evidence of leaks from the tank?
- ☐ Stained soil remains in the excavation after removal of backfill?
- ☐ Groundwater present in the excavation?
- ☐ Free product identified in the tank excavation,

  If "Yes" complete the following:
  i) Measured thickness of free product: _____
  ii) Describe:_____
  _____
- ☐ Saturated soil identified in the tank excavation

Additional Observations:

3) Sample Information:

Sample ID	Medium	PID Reading	Location

Heating Oil System
Tank Removal Information

Sample ID	Medium	PID Reading	Location

4) ***Sample Analytical Results:*** *Circle applicable classification number at the top of the table for soil and groundwater (if a groundwater sample was collected). Record the laboratory results for each chemical of concern in the table in the units noted at the top of the table. Results below the laboratory detection limit should be recorded using a less than symbol with the detection limit (e.g., <5 mg/kg). If more than one sample was collected, record the maximum concentration for each chemical of concern.*

Chemical of Concern	Soil (mg/kg)			Groundwater (ug/l)		
	Class RBSL		Result	Class RBSL		Result
	1	2		1	2	
TPH	10,000	10,000				
Benzene	0.05	0.6		5	160	
Toluene	15			1,000		
Ethylbenzene	16			700		
Xylenes	74	74		10,000	20,100	
Acenaphthene				2,190		
Acenaphthylene				2,190		
Benz(a)anthracene	0.6	0.6		0.1		
Benzo(a)pyrene	0.1	0..1		0.2		
Benzo(b)fluoranthene	0.6	0.6		0.1		
Dibenzo(a,h)anthracene	0.1	0.1		0.01		
Fluorene				1,400		
Indeno(1,2,3-CD)pyrene	0.6	0.6		0.1		
Naphthalene	8	16		100	9,000	

Heating Oil System
Tank Removal Information

5) *Further Action:*

- ☐ No further action is appropriate - analytical results are below the RBSL for the class assigned to the property.
- ☐ Further action is appropriate - analytical results are above the RBSL for the class assigned to the property.

6) *Additional Information:* *Attached the following additional information, as appropriate*

Attachment A – Sketch showing the tank location with respect to buildings, streets, and adjacent properties

Attachment B - Log of activities, dates, and names of contractors

Attachment C - Photographs of the excavated tank, the excavation, and the soil stockpile

Attachment D - Laboratory analytical reports

Attachment E - Chain of custody form

Attachment F – Tank, soil, and groundwater disposal documentation including laboratory analytical reports

Attachment G – Other site-specific information including state and local permits

Appendix C –Environmental Assessment Information

Heating Oil System
Environmental Assessment Information

1) Location Information:

Address: _____

City: _____ State: _____ Zip: _____

Owner Name: _____ Owner Phone: _____

2) Soil Boring Information:

☐ Free product identified in a soil boring,

If "Yes" complete the following:

i) Measured thickness of free product: _____

ii) Describe:_____

_____

☐ Saturated soil identified in a soil boring

Soil Boring ID	Install Date	Location	Install Method [1]	Total Depth	Depth to GW	Screened Interval [2]

Identify Other: _____

Note 1: HSA/SS – hollow stem auger/split spoon, DP – direct push, HA – hand auger, OTH - other
Note 2: Identify screened interval if a monitoring well was installed

3) Sample Information:

Sample ID	Sample Date	Sample Depth [1]	Medium	PID Reading	Location

Note 1: Identify sample depth for soil samples

Heating Oil System
Environmental Assessment Information

4) ***Sample Analytical Results:*** *Circle applicable classification number at the top of the table for soil and groundwater (if a groundwater sample was collected). Record the laboratory results for each chemical of concern in the table in the units noted at the top of the table. Results below the laboratory detection limit should be recorded using a less than symbol with the detection limit (e.g., <5 mg/kg). If more than one sample was collected, record the maximum concentration for each chemical of concern.*

Chemical of Concern	Soil (mg/kg)			Groundwater (ug/l)		
	Class Action Level		Result	Class Action Level		Result
	1	2		1	2	
TPH	10,000	10,000				
Benzene	0.05	0.6		5	160	
Toluene	15			1,000		
Ethylbenzene	16			700		
Xylenes	74	74		10,000	20,100	
Acenaphthene				2,190		
Acenaphthylene				2,190		
Benz(a)anthracene	0.6	0.6		0.1		
Benzo(a)pyrene	0.1	0..1		0.2		
Benzo(b)fluoranthene	0.6	0.6		0.1		
Dibenzo(a,h)anthracene	0.1	0.1		0.01		
Fluorene				1,400		
Indeno(1,2,3-CD)pyrene	0.6	0.6		0.1		
Naphthalene	8	16		100	9,000	

5) Further Action:

- ☐ No further action is appropriate - analytical results are below the RBSL for the class assigned to the property.
- ☐ Further action is appropriate - analytical results are above the RBSL for the class assigned to the property.

Heating Oil System
Environmental Assessment Information

6) Additional Information: *Attached the following additional information, as appropriate*

Attachment A – Sketch showing the soil borings and source area with respect to buildings, streets, and adjacent properties

Attachment B - Log of activities, dates, and names of contractors

Attachment C - Soil boring logs

Attachment D - Monitoring well construction diagrams

Attachment E - Laboratory analytical reports

Attachment F - Chain of custody form

Attachment G – Drill cutting disposal documentation including laboratory analytical reports

Attachment H – Other site-specific information including state and local permits

Appendix D – Tier 1 Evaluation Information Form

Heating Oil System
Tier 1 Evaluation Information

1) Location Information:

Address: _____

City: _____ State: _____ Zip: _____

Owner Name: _____ Owner Phone: _____

2) Sample Analytical Results: *Circle applicable classification number at the top of the table for soil and groundwater. Record the maximum concentration for each chemical of concern in the table in the units noted at the top of the table. Results below the laboratory detection limit should be recorded using a less than symbol with the detection limit (e.g., <5 mg/kg). The applicable classifications for each exposure pathway are identified below the exposure pathway.*

Media	*Soil (mg/kg)*						*Groundwater (ug/l)*			
Exposure Pathway	*Direct Contact*	*Indoor Air*	*Ambient Air*	*Leaching to Indoor Air*	*Leaching to Drinking Water*	*Result*	*Ingestion*	*Indoor Air*	*Ambient Air*	*Result*
Applicable Classification	*1 or 2*	*1 or 2*	*1 or 2*	*1 or 2*	*1*		*1*	*1 or 2*	*1 or 2*	
Benzene	11.10	9.49	0.61	0.05	1.51		5.0	163	555,000	
Toluene	>SAT	>SAT	>SAT	15.10	>SAT		1000	>SOL	>SOL	
Ethylbenzene	>SAT	>SAT	>SAT	15.70	>SAT		700	>SOL	>SOL	
Xylenes	>SAT	>SAT	74.10	>SAT	>SAT		10000	20,100	>SOL	
Acenaphthene							2,190	>SOL	>SOL	
Acenaphthylene							2,190	>SOL	>SOL	
Benz(a)anthracene	0.62	>SAT	>SAT	2.58	>SAT		0.1	>SOL	>SOL	
Benzo(a)pyrene	0.06	>SAT	>SAT	>SAT	>SAT		0.2	>SOL	>SOL	
Benzo(b)fluoranthene	0.62	>SAT	>SAT	>SAT	>SAT		0.1	>SOL	>SOL	
Dibenzo(a,h)anthracene	0.06	>SAT	>SAT	1.33	>SAT		0.01	>SOL	>SOL	
Fluorene							1,400	>SOL	>SOL	
Indeno(1,2,3-CD)pyrene	0.62	>SAT	>SAT	229	>SAT		0.1	>SOL	>SOL	
Naphthalene	>SAT	>SAT	16.0	7.96	>SAT		100	9,000	>SOL	

Heating Oil System
Tier 1 Evaluation Information

3) Potentially Complete Exposure Pathways: *Check box below exposure pathway if the concentration of one or more chemicals of concern is above the RBSL for that exposure pathway.*

Media	Soil (mg/kg)						Groundwater (ug/l)			
Exposure Pathway	Direct Contact	Indoor Air	Ambient Air	Leaching to Indoor Air	Leaching to Drinking Water		Ingestion	Indoor air	Ambient Air	
Applicable Classification	1 or 2	1 or 2	1 or 2	1 or 2	1		1	1 or 2	1 or 2	
Potentially Complete										

4) Additional Soil Borings:

Soil Boring ID	Install Date	Location	Install Method [1]	Total Depth	Depth to GW	Screened Interval [2]

Identify Other: _____

Note 1: HSA/SS – hollow stem auger/split spoon, DP – direct push, HA – hand auger, OTH - other
Note 2: Identify screened interval if a monitoring well was installed

5) Soil Boring Information

Sample ID	Sample Date	Sample Depth [1]	Medium	PID Reading	Location

Note 1: Identify sample depth for soil samples

6) Further Action:

- ☐ No further action is appropriate - analytical results are below the RBSL for all exposure pathways.
- ☐ Further action is appropriate - analytical results are above the RBSL for one or more exposure pathway.
- ☐ Remedial action is appropriate – remedial action to RBSL to address potentially complete exposure pathways

7) Additional Information: *Attached the following additional information, as appropriate*

Attachment A – Sketch showing the soil borings and source area with respect to buildings, streets, and adjacent properties
Attachment B - Log of activities, dates, and names of contractors
Attachment C - Soil boring logs
Attachment D - Monitoring well construction diagrams
Attachment E - Laboratory analytical reports
Attachment F - Chain of custody form
Attachment G – Drill cutting disposal documentation including laboratory analytical reports
Attachment H – Other site-specific information including state and local permits

Appendix E - RBSL Information

RBSL for Soil Exposure Pathways

Chemical of Concern	*Direct Contact*	*Volatilization to Outdoor air*	*Volatilization to Indoor Air*	*Groundwater Leaching to Ingestion*	*Leaching to Groundwater to Indoor air*	*Leaching to Groundwater to Outdoor air*	*Saturated Concentration*
Units	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Benzene	11.10	9.49	0.61	0.05	1.51	>SAT	437
Toluene	>SAT	>SAT	>SAT	15.10	>SAT	>SAT	211
Ethylbenzene	>SAT	>SAT	>SAT	15.70	>SAT	>SAT	94
Xylenes	>SAT	>SAT	74.10	>SAT	>SAT	>SAT	146
Benz(a)anthracene	0.62	>SAT	>SAT	2.58	>SAT	>SAT	8
Benzo(a)pyrene	0.06	>SAT	>SAT	>SAT	>SAT	>SAT	7
Benzo(b)fluoranthene	0.62	>SAT	>SAT	>SAT	>SAT	>SAT	1
Dibenzo(a,h)anthracene	0.06	>SAT	>SAT	1.33	>SAT	>SAT	2
Fluorene	>SAT	>SAT	>SAT	>SAT	>SAT	>SAT	30
Indeno(1,2,3-CD)pyrene	0.62	>SAT	>SAT	229	>SAT	>SAT	3,844
Naphthalene	>SAT	>SAT	16.0	7.99	>SAT	>SAT	60

>SAT – the calculated value is greater than the calculated saturated soil concentration

RBSL for Groundwater Exposure Pathways

Chemical of Concern	*Ingestion*	*Volatilization to Indoor air*	*Volatilization to Outdoor air*	*Solubility*
Units	*ug/l*	*ug/l*	*ug/l*	*ug/l*
Benzene	5.0	163	555,000	1,780,500
Toluene	1,000	>SOL	>SOL	532,400
Ethylbenzene	700	>SOL	>SOL	161,000
Xylenes	10,000	20,100	>SOL	175,000
Acenaphthene	2,190	>SOL	>SOL	3,800
Acenaphthylene	2,190	>SOL	>SOL	16,100
Benz(a)anthracene	0.1	>SOL	>SOL	11
Benzo(a)pyrene	0.2	>SOL	>SOL	3.8
Benzo(b)fluoranthene	0.1	>SOL	>SOL	1.2
Dibenzo(a,h)anthracene	0.01	>SOL	>SOL	0.6
Fluorene	1,400	>SOL	>SOL	1,900
Indeno(1,2,3-CD)pyrene	0.1	>SOL	>SOL	62
Naphthalene	100	9,000	>SOL	30,000

> SOL – the calculated value is greater than the chemical solubility

Appendix F - Table of State Action Levels

Select Soil Exposure Pathway State Action Levels

Chemical of Concern	*Comments*	*Min*	*Max*	*RBSL*	*NY*	*CT*	*MA*	*VA*[1]	*PA*	*Region 3*	*VT*	*RI*	*NH*	*ME*	*NJ*
TPH	Action Level	10	200	NV	NV	NV	200	100	NV	NV	NV	NV	NV	10	NV
TPH	Saturation Fuel oil #2	10,000	13,000	10,000	NV	NV	NV	13,000	NV	NV	NV	NV	10,000	NV	NV
TPH	Cleanup Standard	400	30,000	NV	NV	500	NV	NV	NV	NV	NV	30,000	NV	400	NV
TPH	Soil to Indoor Air	800	800	NV	NV	NV	800	NV	NV	NV	NV	NV	NV	NV	NV
Benzene	Soil to GW - ingestion	0.0007	2	0.05	0.06	0.02	2	NV	0.5	0.0019	0.03	0.2	0.3	NV	0.0007
	Soil to Indoor Air	0.3	30	0.42	NV	0.78	30	NV	0.37	NV	NV	NV	0.3	NV	NV
Toluene	Soil to GW - ingestion	1.5	100	14.87	1.5	20	30	NV	100	8.8	12	32	100	NV	7
	Soil to Indoor Air	42	300	>SAT	NV	42	300	NV	76	NV	NV	NV	100	NV	NV
Ethylbenzene	Soil to GW - ingestion	5.5	140	15.43	5.5	10.1	80	NV	70	15	13	27	140	NV	8
	Soil to Indoor Air	5.7	500	>SAT	NV	9.3	500	NV	5.7	NV	NV	NV	140	NV	NV
Xylenes	Soil to GW - ingestion	1.2	1,000	>SAT	1.2	19.5	400	NV	1,000	170	210	540	500	NV	12
	Soil to Indoor Air	38	1,000	52.65	NV	38	300	NV	55	NV	NV	NV	1,000	NV	NV
Naphthalene	Soil to GW - ingestion	0.15	84	7.93	13	5.6	4	NV	25	1.50E-01	84	0.8	5	NV	15
	Soil to Indoor Air	5	64	22.08	NV	NV	40	NV	64	NV	NV	NV	5	NV	NV

Chemical of Concern	*Comments*	*Min*	*Max*	*RBSL*	*NY*	*CT*	*MA*	*VA[1]*	*PA*	*Region 3*	*VT*	*RI*	*NH*	*ME*	*NJ*
Benzo(a)pyrene	Soil to GW - ingestion	0.37	240	>SAT	11	1	2	NV	46	0.37	8	240	0.7	NV	0.1
	Soil to Indoor Air	0.7	46	>SAT	NV	NV	2	NV	46	NV	NV	NV	0.7	NV	NV

All values in mg/kg

NV = No value available

>SAT = greater than saturation for the chemical of concern

Note 1 - Soil TPH concentrations above this level are deemed confirmed releases. It is possible for soil TPH concentrations to be above this level and Virginia require no action

Values were researched in available state regulations and guidance documents. The specific application of the values to particular circumstances, including the quantity and quality of site information and data that are required to use the screening values listed in the table vary by regulatory program. Efforts were made to use the most up to date information for each state; however, if values are need for a specific application, the original state source should be consulted, as values are often updated. It also should be noted that different risk and exposure assumptions, and assumptions about the level of regulatory oversight available are made by the different regulatory agencies when issuing these screening or action levels. Direct comparison of the values should be made with caution and an eye for the range of values for each chemical of concern and exposure pathway rather than a focus on the explicit, quantitative differences in the numbers.

Values current as of January 2007.

Select Groundwater Exposure Pathway State Action Levels

Chemical of Concern	*Pathway*	*Min*	*Max*	*RBSL*	*NY*	*CT*	*MA*	*VA*[1]	*PA*	*Region 3*	*VT*	*RI*	*NH*	*ME*	*NJ*
Benzene	Groundwater Ingestion	0.32	5	5	1	1	5	5	5	0.32	5	5	5	5	0.20
	Groundwater to Indoor Air	130	3,500	194.2	NV	130	2,000	NV	3,500	NV	NV	NV	2,000	NV	15
Toluene	Groundwater Ingestion	5	1,000	1,000	5	1,000	1,000	1,000	1,000	750	1,000	1,000	1,000	NV	1,000
	Groundwater to Indoor Air	7,100	50,000	>SOL	NV	7,100	8,000	NV	10,000	NV	NV	NV	50,000	NV	310,000
Ethylbenzene	Groundwater Ingestion	5	1,300	700	5	700	700	700	700	1,300	700	700	700	NV	700
	Groundwater to Indoor Air	2,700	50,000	>SOL	NV	2,700	30,000	NV	27,000	NV	NV	NV	50,000	NV	61,000
Xylenes	Groundwater Ingestion	5	12,000	10,000	5	530	10,000	10,000	10,000	12,000	10,000	10,000	10,000	NV	1,000
	Groundwater to Indoor Air	8,700	130,000	11,334	NV	8,700	9,000	NV	130,000	NV	NV	NV	30,000	NV	7,000
Naphthalene	Groundwater Ingestion	7	280	100	10	280	140	NV	100	7	20	20	20	NV	300
	Groundwater to Indoor Air	1,000	25,000	12,184	NV	NV	1,000	NV	25,000	NV	NV	NV	2,000	NV	NV

Chemical of Concern	*Pathway*	*Min*	*Max*	*RBSL*	*NY*	*CT*	*MA*	*VA*[1]	*PA*	*Region 3*	*VT*	*RI*	*NH*	*ME*	*NJ*
Benzo(a)pyrene	Groundwater Ingestion	0.002	10.00	0.20	0.00	0.20	0.20	0.20	0.20	0.01	0.20	0.20	10.00	NV	0.50
	Groundwater to Indoor Air	3.80	3.80	>SOL	NV	NV	NV	NV	3.80	NV	NV	NV	NV	NV	NV

All values in ug/l

NV = No value available

>SOL = greater than solubility of pure chemical of concern

Note 1 - State Action Levels listed for Virginia are only applicable for certain classes of regulated water supplies. The state has a no-tolerance practice for petroleum constituents in unregulated water supplies.

Values were researched in available state regulations and guidance documents. The specific application of the values to particular circumstances, including the quantity and quality of site information and data that are required to use the screening values listed in the table vary by regulatory program. Efforts were made to use the most up to date information for each state; however, if values are need for a specific application, the original state source should be consulted, as values are often updated. It also should be noted that different risk and exposure assumptions, and assumptions about the level of regulatory oversight available are made by the different regulatory agencies when issuing these screening or action levels. Direct comparison of the values should be made with caution and an eye for the range of values for each chemical of concern and exposure pathway rather than a focus on the explicit, quantitative differences in the numbers.

Values current as of January 2007.