

CORRECTIVE ACTION GUIDANCE DOCUMENT (CAGD)



July 2018
Revision 1

Leaking Aboveground (LAST) & Leaking
Underground (LUST) Storage Tanks

**West Virginia Corrective Action Guidance Document (CAGD) for Leaking Aboveground
Storage Tanks (ASTs) and Underground Storage Tanks (USTs)**

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ACRONYMS

AFVR – Aggressive Fluid Vapor Recovery

AS – Air Sparging

AST – Aboveground Storage Tank

ASTM – American Society for Testing and Materials

BTEX - Benzene, Toluene, Ethylbenzene, Xylene - Contaminants of Concern

CAGD – Corrective Action Guidance Document

CAP - Corrective Action Plan

CERCLA – Comprehensive Environmental Response Compensation and Liability Act

CLP – Contract Laboratory Program

COC – Chemical of Concern

CRNC – Confirmed Release Notice to Comply

CSM – Conceptual Site Model

DPE – Dual Phase Extraction

DPT – Direct Push Technology

DRO – Diesel Range Organics

EPA – Environmental Protection Agency

FID – Flame Ionization Detector

FPRR - Free Product Recovery Report

GC – Gas Chromatograph

GC/MS – Gas Chromatograph/Mass Spectrometry

GRO – Gasoline Range Organics

HVE – High Vacuum Extraction

ISCR – Initial Site Characterization Report

ISOC – *In Situ* Chemical Oxidation

LAST – Leaking Aboveground Storage Tanks

LEL – Lower Explosive Limit

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LTTD – Low Temperature Thermal Desorption

LUST - Leaking Underground Storage Tanks

MCL – Maximum Contaminant Level

MTBE – Methyl Tertiary Butyl Ether - Contaminant of Concern

NAPL – Non-Aqueous Phase Liquids

NCSM – NAPL Conceptual Site Model

NFA – No Further Action

NOD – Natural Oxidant Demand

OER - Office of Environmental Remediation

ORO – Oil Range Organics

PAH - Polycyclic Aromatic Hydrocarbons (also called polynuclear aromatic hydrocarbons or polyaromatic hydrocarbons) - Contaminants of Concern

PID – Photoionization Detector

PM – Project Manager - Position Classification

PPE - Personal Protective Equipment

QAPP – Quality Assurance Program Plan

RCRA – Resource Conservation Recovery Act

SCS –Soil Conservation Service

SIR – Site Investigation Report

SPCC- Spill Prevention Control and Countermeasures – Federal Regulatory Program

SVE – Soil Vapor Extraction

SVE/AS - Soil Vapor Extraction/Air Sparging

SVOCs- Semi-Volatile Organic Compounds

TBA - Tert-Butyl Alcohol - Contaminant of Concern

TCAU – Tanks Corrective Action Unit

TPH - Total Petroleum Hydrocarbons (i.e.: TPH-ORO, TPH-GRO, TPH-DRO)

UCL – Upper Confidence Level

UECA – Uniform Environmental Covenant Act

USCS – Unified Soil Classification System

USEPA – United States Environmental Protection Agency

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USGS – United States Geological Society

UST – Underground Storage Tank

VOCs – Volatile Organic Compounds

VRP – Voluntary Remediation Program

WVDEP - West Virginia Department of Environmental Protection

XRF- X-ray Fluorescence

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SECTION 1: INTRODUCTION

1.1 Overview

The “West Virginia Corrective Action Guidance Document” (CAGD) presents recommended data collection, data analysis, and data presentation methods to meet the requirements of the West Virginia Department of Environmental Protection’s (WVDEP) Tanks Corrective Action Unit (TCAU). The document is applicable to regulated Aboveground Storage Tanks (ASTs) as defined by W. Va. Code §22-30 and Underground Storage Tanks (USTs) subject to regulation by W. Va. Code §22-17 and 40 CFR 280. This document is intended as guidance; however, it does contain information such as reporting requirements, analytical methods, etc. that are regulatory requirements for the Leaking Aboveground Storage Tank (LAST) and Leaking Underground Storage Tank (LUST) programs. The guidance provided does not preclude the use of proven and accepted or new and innovative methods to quickly and accurately address environmental contamination at LAST and/or LUST sites. References made to copyrighted materials or trade names do not reflect the endorsement of the WVDEP and United States Environmental Protection Agency (USEPA). The WVDEP specifically reserves the right to deviate from this guidance document where circumstances may warrant such action.

To offer flexibility to the regulated community, while remaining protective of human health and the environment, the Agency has developed a new action level for soils at LAST and LUST sites that considers the depth of the contamination at a site and can consider the use of the property (residential or nonresidential) if certain conditions are met. The action levels incorporate a three-tiered approach to offer maximum flexibility while remaining protective (refer to Section 12 for additional information) of public health and the environment. By exercising these new choices, responsible parties for releases may reduce remediation costs, return more sites to productive use, hasten property redevelopment, and still fully comply with environmental laws and regulations.

Many LAST/LUST sites are petroleum contaminated sites; therefore, special emphasis was placed on development of soil action levels related to petroleum contamination utilizing current scientific information. In the development of the new soils standard it was determined that total petroleum hydrocarbons (TPH)/diesel range organics (DRO)/gasoline range organics (GRO)/oil range organics (ORO) would no longer be a required analytical parameter for closures or corrective action. Instead the individual chemicals most associated with the different TPH ranges would be required for analysis. However, be advised that TPH analysis is still required by WVDEP approved landfills for disposal of petroleum contaminated waste.

The objective of this process was to develop soil action levels for the petroleum sites that are protective of direct contact (ingestion, dermal contact, and inhalation of volatiles/particulates) and vapor intrusion exposure pathways (inhalation of volatiles). The newly established soil action levels developed are based on the most conservative exposure pathway (i.e. lower of the direct contact or vapor intrusion screening value). Tier 1 levels can be utilized at any site regardless of the depth of the contamination. Tier 2 levels offers more flexibility than Tier 1 provided certain site conditions are met. Tier 2 levels consider depth of the contamination and the presence or absence of preferential pathways. Tier 2 assumes the usage of the property is residential. Tier 3 levels consider depth of the contamination, the presence or absence of

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preferential pathways, and assumes the usage of the property is non-residential. Tier 3 can only be used if the property is zoned as non-residential and a deed restriction is placed upon the property where the contamination exists. The action levels are based on several assumptions that must be considered when performing remediation. Refer to Section 12 and the flowchart and instructions in Appendix A of this guidance document for additional information.

Groundwater contamination for the LAST/LUST program will continue to be compared to the West Virginia's Requirements Governing Groundwater Standards (Legislative Rule 47CSR12) and the Federal Drinking Water Standards. Groundwater standards must be achieved prior to issuance of a No Further Action letter for the site. Many chemicals do not have a groundwater or drinking water standard; however, they may still pose an environmental or health risk and will be evaluated as appropriate for a site/release.

1.2 Purpose of the Guidance

The overall purpose of the CAGD is to streamline the LAST/LUST site remediation process in West Virginia. It is intended that this guidance will provide a tool for the consistent implementation of the administrative and technical requirements of the LAST and LUST programs; however, deviations may be appropriate to protect public health and the environment. This guidance focuses on the processes and procedures for identifying and investigating suspected and confirmed releases, identifying appropriate clean up levels, selecting and conducting appropriate corrective actions, and establishing reporting requirements. Authority for providing this guidance may be found in the AST and UST Acts (WV State Code Chapter 22, Articles 30 and 17, respectively) and their associated rules.

The intent of the CAGD is to better articulate West Virginia's LAST/LUST program requirements, clarify what data must be collected, and improve the consistency and quality of required reports. Among the specific improvement goals of the guidance are:

- Providing for a Fast Track that will allow for a quick, efficient, and cost-effective clean-up for low impact sites;
- Reducing State staff time in report review and response and improving consistency of report reviews;
- Simplifying the review process by standardizing report formats and using checklists, where appropriate;
- Improving site investigation quality so that better designed corrective actions will be selected, thus expediting cleanups and reducing long term costs;
- Reducing report submittal requirements when possible to increase efficiency and cost effectiveness for both the State and the regulated community;

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- Increasing sensible use of interim measures to mitigate contaminant migration while full-extent site investigation and long-term corrective action efforts occur;
- Encouraging the use of presumptive remedies, where appropriate, in lieu of submitting Corrective Action Plans for review.

As previously noted, this guidance's primary focus are the requirements for addressing remediation after a release has occurred; however, the guidance also provides information on closure of ASTs and USTs since sample results from closures frequently result in the issuance of a leak number and the need for subsequent remediation. The Agency encourages tank owners/operators who are performing tank closures or replacing tank equipment to be prepared to take immediate action (such as soil removal) if they determine a release has occurred.

The standards utilized for traditional corrective action path at LAST/LUST sites are predetermined numeric standards. Alternatively, an owner/operator has the option of cleaning their sites up to a risk-based standard by entering the site into the Voluntary Remediation or the Uniform Environmental Covenant Act Programs administered by the WVDEP Office of Environmental Remediation (OER).

1.3 Form Templates

General checklist forms and analytical data sheets have been provided in Appendix B and presumptive remedies checklist have been provided in Appendix C. These forms shall be utilized when submitting reports requested by the Agency. A description of the forms and checklists are provided in the appendices with the forms.

The Agency believes the use of these forms will reduce costs for the regulated community associated with the preparation of the reports. Furthermore, these forms are being used to clarify the data that must be collected and to improve consistency in the data received which will lead to reduced staff time for report reviews by excluding what is often extraneous information found in reports. These forms and the required attachments shall be submitted to the Agency. If there is additional information about a site that a tank owner/operator believes is imperative for the Agency to know to fully understand the site conditions, nothing precludes them from submitting additional information as a supplement to these forms; however, any additional information provided needs to be concise.

SECTION 2: RELEASE REPORTING

2.1 Release Overview

A release may be “suspected” or “confirmed”. The definition differs slightly between the LAST and LUST programs.

Verification or “confirmation” of a release may be done in numerous ways, including but not limited to, detection by WVDEP staff, analytical data showing a release, visual observation of contamination, olfactory observation of contamination, etc. Once a release has been verified, it is considered a “confirmed release”; otherwise, it is considered a “suspected release”.

2.2 Suspected Releases

For an AST, a suspected release means a potential exists that an unplanned or unintentional discharge of a substance from the AST system may have occurred, or based upon information obtained from any source, may occur. Examples of a suspected release include, but are not limited to, the following: substance from the AST observed in the secondary containment structure, testing, sampling, monitoring results from a release detection method, or observed unusual operating conditions of an AST system. Suspected releases from AST systems must be reported within 24 hours in accordance with §47CSR63 6.2.b.

For an UST, a suspected release means a potential exists that an unplanned or unintentional discharge of substance from the UST system may have occurred, or based upon information obtained from any source, may occur. The discovery of a released regulated substance at the UST site in a sump or under dispenser containment, unusual operating conditions, unexplained presence of water in the tank, and monitoring results from a release detection method that indicate a release may have occurred are some examples of a suspected release. Suspected releases from UST systems must be reported within 24 hours in accordance with §40CFR280.50.

RELEASE REPORTING

ALL Confirmed Releases must be Immediately reported by calling the WVDEP Spill Line at:

1-800-642-3074

ALL Suspected Releases must be reported to the Tanks AST Inspector or the Tanks Corrective Action Unit (TCAU) Project Manager for the county where the release occurred.

Note: See Section 2.4 for additional reporting requirements.

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2.3 Confirmed Releases

For an AST, a confirmed release means verification that a substance has escaped from secondary containment, or has been discharged from the AST system components into the waters of the State.

For an UST, a confirmed release means any spilling, leaking, emitting, discharging, escaping, leaching, or disposing from an UST into the ground water, surface water, or subsurface soils.

2.4 Release Reporting Requirements

2.4.1 ASTs

For ASTs, a **confirmed release** must **immediately** be reported upon discovery even when the owner/operator is taking immediate action to clean up the release. At a minimum, a confirmed release must be reported to the county or municipal emergency management agencies in the county where the AST is located and the WVDEP spill line at **1-800-642-3074**.

In the event of a confirmed release owners and operators must comply with the requirements of Section 7 (Corrective Action) of the AST rule (47CSR63). It is important to begin immediate actions to contain the release and mitigate fire, explosion, and safety hazards posed by the release.

For ASTs, a suspected release must be reported **within 24 hours** unless the owner is able to determine within that time period that the release was a false alarm. The tank owner/operator shall contact the Tanks AST Inspector or the TCAU PM for the county where the suspected release occurred, or you may make notification by calling 304-926-0499, ext. 1817. Alternatively, the tank owner or operator may call the WVDEP spill line at **1-800-642-3074**. If a person doesn't answer the call, leave a summary of the incident and a call back number. Suspected releases from AST systems must be reported within 24 hours in accordance with §47CSR63 6.2.b.

In the event of a suspected" release the owner or operator must comply with Section 6.3 of the AST rule to investigate whether a "confirmed" release has occurred or not. If a suspected release is identified as a "Confirmed" release, the owner or operator must immediately follow the requirements cited above for reporting a "Confirmed" release.

2.4.2 USTs

For USTs, a **confirmed release** must **immediately** be reported upon discovery even when the owner/operator is taking immediate action to clean up the release. The release report shall be made by calling the WVDEP spill line at **1-800-642-3074**.

RELEASE REPORTING

Be advised
Failure to Report a Release
may result in enforcement
action.

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In the event of a confirmed release, owners and operators must comply with the requirements of 40CFR280 Subpart F. It is important to begin immediate actions to contain the release and mitigate fire, explosion, and safety hazards posed by the release.

For USTs, a suspected release must be reported to WVDEP **within 24 hours** unless the owner/operator is able to determine within that time period that the release was a false alarm. The owner/operator shall contact the Tanks AST Inspector or the TCAU Project Manager for the county where the release occurred, or make notification by calling the WVDEP spill line at **1-800-642-3074**. If a person doesn't answer the call, leave a summary of the incident and a call back number.

In the event of a suspected release, the owner or operator must comply with 40CFR280.50 to investigate whether a confirmed release has occurred or not. If a suspected release is identified as a confirmed release, the owner or operator must immediately report to the WVDEP spill line at **1-800-642-3074**, and begin corrective action in accordance with the requirements of 40CFR 280 subpart F.

2.5 Incident Reports and Issuance of Leak Numbers

All "Confirmed Releases" from regulated USTs and ASTs will be issued an incident report and a leak number. This approach will provide consistency between how releases are handled within the AST and UST programs.

CONFIRMED RELEASES

ALL Confirmed Releases

must be reported by the tank owner/operator to the WVDEP even if the owner/operators are taking immediate corrective action (such as over excavation of impacted soil found during a tank closure, piping upgrade, replacement of a sump or spill bucket) to remediate the contamination. A leak number will be issued for all confirmed releases.

If the tank owner/operator can demonstrate that the corrective action was successful in reducing contaminants levels below action levels, the Agency may not require any additional site activities and may proceed with issuance of a **No Further Action** letter. Refer to FastTrack in Section 3.2 of this guidance document.

SECTION 3: REPORT REQUIREMENTS AND SUBMITTAL TIME FRAMES

3.1 Traditional Path

When a release is confirmed for a tank, the owner/operator must initiate investigations and submit reports as required by the TCAU. Both the AST and UST rules specify the types of actions and reports required and the timeframes for submittal of each report. Not all reports may be required for every site. The TCAU Project Manager (PM) will issue a Confirmed Release Notice to Comply (CRNC) specifying the required reports and specific dates for report submittals. Forms for reporting can be found in Appendix B. The required time frames for specific actions, plans, and reports are as follows, unless directed otherwise by the Agency:

- Tank Closure notification, closure plan, and closure report submittals shall be submitted as follows, when applicable:
 - ❖ AST: Intent to close an AST shall be made at least thirty (30) days prior to the intended closure date by submitting a closure plan for review and approval (refer to Appendix D for a closure template). Closure sampling shall be performed as soon as possible after the tank closure activities have begun. Sampling must be commenced within 48 hours of starting closure activities. Closure reports are due within sixty (60) days of the closure sampling.
 - ❖ UST: Intent to close an UST shall be made thirty (30) days prior to the intended closure date by submitting a request to the Tanks Inspector. A closure plan is not required for UST closure. Closure sampling shall be performed as soon as possible after the tank closure activities have begun. Sampling must be commenced within 48 hours of starting closure activities. Closure reports are due within sixty (60) days of the closure sampling. Refer to Appendix D for a copy of the UST Closure Memo Guidance.
- Initial Response
 - ❖ AST/UST: The Initial Response must be performed within twenty-four (24) hours of the confirmed release. The requirements of this reporting may be satisfied by notification to the WVDEP Spill Line and taking the steps to prevent and mitigate hazards associated with the release.

INITIAL RESPONSE

Regardless of the Corrective Action Path followed, ALL sites must perform the Initial Response activities;

1. Report the Release
1-800-642-3074

2. Take Immediate Action

3. Mitigate any Fire, Explosion, and/or Vapor Hazards.

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- Initial Abatement Measures and Site Check Report
 - ❖ AST: There is no requirement for submittal of this report.
 - ❖ UST: The report must be submitted within twenty (20) days after a release is confirmed.

- Initial Site Characterization Report (ISCR)
 - ❖ AST: There is no requirement for submittal of this report.
 - ❖ UST: The Initial Site Characterization Report (ISCR) must be submitted within forty-five (45) days after a release is confirmed.

- Free Product Recovery Report (FPRR)
 - ❖ AST: If free product is found, it must be recovered and properly disposed. Free product recovery reporting is required as part of the Corrective Action Plan progress quarterly reports.
 - ❖ UST: If free product recovery is necessary, a FPRR must be submitted within forty-five (45) days after a release is confirmed and monthly, quarterly, or semi-annually; thereafter, until measurable free product (thickness greater than 1/8 inch or .01 feet in a monitoring well) is no longer present. If measurable quantities of free product return; recovery and reporting must be restarted and continued until measurable free product is no longer present.

- The Site Investigation Report (SIR), which some may refer to as a site assessment or site characterization report, shall be submitted within the time frames provided below; however, the TCAU expects that in many cases the report shall be submitted in a more expeditious time frame.
 - ❖ AST: The SIR shall be submitted no later than one hundred twenty (120) days after a release is confirmed.
 - ❖ UST: The SIR shall be submitted no later than ninety (90) days after a release is confirmed.
 - ❖ Any Supplemental SIR shall be submitted in accordance with a compliance time frame established by the TCAU PM.

- Quarterly Groundwater Report
 - ❖ AST/UST: If required, the Quarterly Groundwater Report shall be submitted within 45 days of the sampling date.

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- The Corrective Action Plan (CAP) shall be submitted within the time frames provided below:
 - ❖ AST: The CAP shall be submitted no later than ninety (90) days after the approval of the SIR.
 - ❖ UST: The CAP shall be submitted no later than one hundred twenty (120) days after a release is confirmed.
 - ❖ The TCAU encourages the use of presumptive remedies, where appropriate, in lieu of submitting CAPs. Refer to Section 11.2 for additional information.

Where applicable and appropriate, the TCAU PM will make all efforts to streamline the above processes to increase efficiency. Streamlining may include, but not be limited to, combining some reporting requirements, not requiring some reports, and/or reducing the frequency of reporting requirements. If any of the deadlines cannot be met due to uncontrolled circumstances, a written request for an extension must be submitted to the TCAU PM for the county where the leak site is located. The owner/operator must document the “extenuating circumstances” which make compliance by the original deadline not attainable. Submittal of a single Electronic Copy of a report is preferred. Please submit electronic reports to dep.ast@wv.gov and “cc” the TCAU PM. If submitting hard copy reports, they must be submitted in duplicate: one copy is to be sent to the attention of the PM at the regional office for the county in which the leak site is located and the second copy is to be submitted to WVDEP Headquarters in Charleston.

3.2 FastTrack Path

The TCAU acknowledges that not all sites require the same level of reporting and that excessive reporting is costly, inefficient, and does not offer any more protection for human health, safety, water resources, and the environment. Therefore, for low impact sites we encourage tank owners/operators to utilize a path for the corrective action process called FastTrack. The purpose behind FastTrack is to deal with releases at low impact sites more efficiently and effectively while still protecting human health, safety, water resources, and the environment.

A low impact site is one with limited contamination, in the soils only, and based upon information gathered during the initial response and subsequent site investigation represents a minimal threat

FAST TRACK

- is meant for low impact sites
- offers flexibility
- reduces cost
- reduces report submittals
- leads to quicker clean-ups
- is still protective

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to public health. This guidance describes streamlined implementation of the AST and UST regulations on release response. By using management techniques, approved technologies, and innovative regulatory approaches to make cleanups faster.

Utilizing FastTrack, a tank owner/operator reports a release, performs the initial response requirements, and then moves directly to remediation of the site providing that the site/release meets certain conditions listed below. The Agency anticipates that this a viable option for certain types of releases such as releases from spill buckets, sumps, under dispenser containment, limited piping and tank releases encountered during tank closures and/or upgrades, etc. Furthermore, the Agency anticipates that the corrective action method most commonly employed in this instance is soil removal and disposal at an approved facility.

Conditions for use of the FastTrack procedures are:

- The release is relatively small and generally known or easily determined as part of the site activities (i.e. closures, repairs, upgrades, etc.). The vertical and lateral extent of contaminant plumes are confined to the site.
- There is no evidence or reason to suspect groundwater contamination including the presence of free product in the groundwater, contaminated soil in contact with the groundwater, or contaminated soil in close proximity (i.e. generally within 10 foot of the water table) to groundwater. WVDEP reserves the right to request further investigation regardless of proximity to water if potential impact to the waters of the State are a concern.
- There is no evidence or reason to suspect that surface water has been impacted.
- If present, free product is limited to the soil and has not migrated to groundwater, is not in close proximity (generally within 10 foot) to the groundwater, surface water, or wetlands. WVDEP reserves the right to require further investigation regardless of proximity to water if potential impact to the waters of the State are a concern.
- The free product in the soil is easily removed as part of the soil excavation.
- The source of the initial release (i.e. tank, piping, sumps, spill buckets, etc.) has been repaired or removed).
- Based upon the initial response to the release, the threat to human health and the environment has been determined to be minimal.
- The release is of refined petroleum products (gasoline, diesel, kerosene, heating oil, oil, etc.), crude oil, brine, natural gas condensate, sodium hydroxide, or sodium carbonate. Other chemicals may potentially be acceptable for the FastTrack path based upon prior approval by the Agency. Generally, this path would not be applicable to sites contaminated with chlorinated solvents, organic solvents, paint wastes, or similar chemicals.
- Confirmation sampling after clean-up must be performed. The number of samples, location of samples, and analytical parameters shall be discussed with the TCAU PM and approved prior to sample collection.

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If conditions are found to be different than those anticipated above, the tank owner/operator must notify the TCAU PM to obtain further direction on how to proceed. The owner/operator shall indicate their intent to proceed on the FastTrack path when they notify of a release or immediately thereafter. This would allow the tank owner/operator to move immediately forward with the corrective action to remove and properly dispose of the contaminated soil. The tank owner/operator shall work with the TCAU PM to ensure that proper confirmation sampling and reporting is performed.

SECTION 4: INITIAL RESPONSE

The tank owner/operator must perform initial response actions within twenty-four (24) hours of a confirmed release. Quick action is necessary to ensure protection of human health, safety, water resources, and the environment. The immediate initial response is important as it is an attempt to locate the source of the release, determine the seriousness of the release, and eliminate any life-threatening conditions that may result from the release.

The big picture view of this is “does an immediate emergency exist that threatens human health, safety, water resources, and the environment” and if it does, “what needs to be done immediately to be protective?” Attention shall be focused on preventing further releases from the tank system into the environment, determining the media affected by the release, and evaluating the need for and type of any response measures required to abate the release. Safety needs to be considered when performing an initial response.

Upon discovery of a confirmed release, owners/operators must perform the following initial response actions:

- Report the release to the WVDEP Spill Line at 1-800-642-3074, immediately. Additionally, If the release is from a regulated AST, tank owners/operators must report the release to the county or municipal emergency management agencies where the AST is located;
- Check adjacent structure to identify fire, explosion, and vapor hazards and mitigate these hazards if found;
- Investigate to determine the possible presence of free product at existing monitoring points and report the results to TCAU Project Manager via phone or email.
- If free product is present, control the spread of the contamination.
- Comply with all other provisions of the initial abatement measures and site check.

Additionally, for ASTs

- Identify and sample affected water supplies and water supplies with the potential to be affected in a reasonable and systematic manner if directed by the WVDEP. If required, sampling must be performed in consultation with the public water supplier (or owner of a private well), the WVDEP, and Bureau of Public Health.

INITIAL RESPONSE

Think “BIG PICTURE”

Do Life-Threatening Conditions Exist???

IF so, take IMMEDIATE Action To ELIMINATE the Threat

ALWAYS Notify WVDEP Spill Line

1-800-642-3074

West Virginia Corrective Action Guidance Document (CAGD) for Leaking Aboveground Storage Tanks (ASTs) and Underground Storage Tanks (USTs)

IF A WATER SUPPLY IS AFFECTED OR DIMINISHED, the owner or operator must do the following:

Sample the public and private water supply and provide laboratory results to the water supplier or supply owner and the Agency within five (5) days. If the supply is affected or diminished by the release it shall be restored or replaced with an alternate water supply. A temporary water supply shall be provided as soon as practicable but not later than forty-eight (48) hours after the release. A permanent water supply shall be provided within ninety (90) days after the release. The total time for providing a permanent water supply may not exceed two (2) years.

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SECTION 5: INITIAL ABATEMENT MEASURES AND SITE CHECK

The tank owner/operator must perform initial abatement measures, site check and submit a report within twenty (20) days after release confirmation unless directed to do otherwise by the Agency. Initial abatement measures and the site check are a continuation of the initial response activities. Whereas the initial response activities are more geared to determining if an emergency exists and taking immediate action for emergencies. The initial abatement measures are conducted to mitigate hazards of lesser severity than those requiring initial response actions, and/or to monitor the control of the initial response actions performed.

Following initial response actions, the owner and/or operator shall perform the following initial abatement measures as soon as practicable, but not later than twenty days (20) days after the release confirmation date:

- Remove as much of the regulated substance from the tank system as is necessary to prevent further release.
- Visually inspect for and mitigate further migration of any aboveground and exposed below ground release into surrounding soils, groundwater and surface water.
- Continue to monitor and mitigate any fire and safety hazards posed by vapors or free product.
- Check for the possible presence of free product and begin removal. Factors indicating the presence of free product may include, but are not limited to, free product in storm drains, free product observable as leachate into nearby bodies of surface water or dry surface basins, free product in existing wells located on or near the site.

USE the **Initial Abatement Measures and Site Check Form** to file this report when it is required. Submit the form and any required supplemental documentation electronically to the TCAU PM for the county where the release occurred and **dep.ast@wv.gov**.

SECTION 6: INITIAL SITE CHARACTERIZATION

6.1 UST

The tank owner/operator must perform the initial site characterization actions and submit a report within forty-five (45) days of release confirmation unless directed to do otherwise by the Agency. This is intended to provide an overview of the site and the release that occurred to assess potential environmental problems. It is used to gather background information and provide adequate information to determine if further action is warranted. The initial site characterization is not intended to completely define the nature and extent of contamination. A site investigation is necessary to completely define the nature and extent of contamination (refer to Section 9.0).

An owner and/or operator shall develop initial site characterization information on site-specific geology, hydrology, receptors, potential sources of the contamination, artificial pathways for contaminant migration, and occupancies of the facility and surrounding area. Additionally, if not conducted as part of the investigation of a suspected release, any site check information shall also be included such as the following:

- The nature of the release, the regulated substance released, and the estimated quantity of the release.
- An estimated time period when the release was occurring.
- The initial response and abatement actions performed, and any other corrective actions taken prior to the date of the submission.
- Estimated or known site-specific lithology, depth to bedrock, and groundwater depth, flow direction, and quality. The date and source of the information must be included.
- Location, use, and identification of all registered wells on and within 1/4 mile of the facility. Information on individual registered wells may be obtained from the West Virginia Bureau of Public Health (WVBPH). The WVBPH may be contacted via phone at 304-558-2971 or on line at <https://dhhr.wv.gov/bph/Pages/contact.aspx>.
- Description of water usage in the area of the site. As noted above, information on individual registered wells may be obtained from the WVBPH. Additionally, information on water usage can be obtained from the WVDEP Water Use Section. To contact the WVDEP's Water Use Section, email DEP.Water.Use@wv.gov.
- Location and type of receptors, other than wells, on and within 1/4 mile of the facility. A conceptual site model may be requested for a site if it is believed important for protection of public health and the environment.
- Current occupancy and use of the facility and properties immediately adjacent to the facility.
- Data on known sewer and utility lines, basements, storm drains and other artificial subsurface structures on and immediately adjacent to the facility.

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- A copy of the report of any tank test performed during the investigation of a suspected release, if applicable.
- Laboratory analytical results of samples analyzed and received as of the date of the summary.
- A site plan showing the location of the facility property boundaries, release, sample collection locations with laboratory analytical results submitted with this summary and identified receptors.
- Information on any discovered free product.

The Tanks Corrective Action Unit acknowledges that the use of direct push technology (DPT) can be an efficient and cost-effective sampling method for both soil and groundwater. As with any method or procedure it has its limitations, advantages, and disadvantages which shall be considered when it is utilized for site investigation sampling. Refer to Section 9 and Appendix F for more information on the use of DPT.

USE the **Initial Site Characterization Form** to file this report when it is required. Submit the form and any required supplemental documentation electronically to the TCAU PM for the county where the release occurred and **dep.ast@wv.gov**.

SECTION 7: FREE PRODUCT RECOVERY

If free product is found on the UST site, the tank owner/operator must perform free product recovery activities and submit a report within forty-five (45) days of a release unless directed to do otherwise by the Agency. If free product is found on an AST site, it must be removed and disposed of in accordance with all laws and regulations. The following guidance focuses on free product recovery by addressing what it is, identifying reporting requirements, discussing free product response measures, and providing a report format. Be advised, that site investigation and other remedial activities as appropriate must be continued in conjunction with free product recovery. In all cases, free product recovery must begin as soon as possible.

7.1 Free Product

Free product is any liquid material from a regulated AST or UST that is present as a non-aqueous phase liquid (i.e. not dissolved in water). Alternatively, the EPA document, *How To Effectively Recover Free Product at Leaking Underground Storage Tank Sites* (510-R-96-001, 9/96), refers to free product as a separate phase liquid in the subsurface that is present in an amount sufficient for the liquid to flow readily into wells or excavations. For example, oil floating on top of surface water, or on the top of groundwater, is considered free product. Materials of concern in free product situations for USTs are liquid petroleum, such as gasoline, kerosene, diesel fuel, oil, and any hazardous substance listed in Section 101(14) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or defined as such under the Resource Conservation and Recovery Act (RCRA). Materials of concern in free product situations for ASTs would be any liquid material that was stored in a regulated AST. If free product is found inside the secondary containment it must be removed and disposed of in accordance with all laws and regulations and reported as a suspected release.

7.2 Detecting the Presence of Free Product

The presence of free product is likely if information gathered during the site investigation indicates that a single large release or a long and continuous release of any size may have occurred at the site. Free product is most often detected as discreet phases, globules or sheens in water from wells, in streams, in ditches, in excavations, in runoff, or on cuttings or soil samples from excavations or boreholes. Screening monitoring wells across the water table may facilitate the detection of free product.

ORGANIC SHEENS ON SURFACE WATER

An organic (bacterial) sheen can usually be distinguished from a petroleum sheen by attempting to break up the sheen. When a stick is poked into a bacterial sheen or a stone is dropped into it, the sheen will typically break into small platelets. In contrast, a petroleum sheen will quickly try to reform after any disturbance.

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The concept of soil saturation is also relevant to determining whether free product may be present at a site. Soil saturation corresponds to the contaminant concentration in soil at which the adsorptive limits of the soil particles and the solubility limits of the available soil moisture have been reached. Contamination above this value suggests that free product is present in the soil. Therefore, the presence of high concentrations of contaminants in the soil may be indicative of the presence of free product at the site.

7.3 Reporting Presence of Free Product

The discovery of measurable free product (thickness greater than 1/8 inch or .01 feet in a monitoring well) or a free product release must be reported to the WVDEP. Reporting free product may be done by contacting the following:

- WVDEP Spill Hotline 1 (800) 642-3074

NOTE: A report may also be made to local fire departments, emergency response units, etc., if necessary.

7.4 Recovery of Free Product

One must recover free product because it is a Federal and State requirement. The removal of free product prevents its spread and minimize its change from liquid to other phases (i.e. free product may dissolve into ground or surface waters, become adsorbed onto soils, and volatilize into a vapor). Once free product changes to these other phases, cleanup becomes much more difficult. In preventing free product from spreading, one minimizes future recovery costs and danger to human health, safety, water resources, and the environment. Human health, safety, and water resources are threatened by the spread of free product because of the potential for vapors in confined spaces, explosions, and contamination of drinking water.

Also, if allowed to spread to other phases, the remediation of free product and its degraded components “will become more complex.

FREE PRODUCT

In NO SITUATION is free product discharge allowed to a sanitary sewer, storm sewer, surface water body, into groundwater, or onto the ground surface.

INTERIM RESPONSE

An Interceptor Trench may be necessary if free product is migrating or threatens to migrate offsite posing an immediate threat to streams or other sensitive receptors.

7.5 Permits Required for Storage and Disposal of Free Product

No permits are required to remove free product from subsurface soils, groundwater, or surface water bodies; however, storage and disposal of free product and/or water must be conducted according to appropriate regulations which may or may not require a permit. Refer to Section 7.10 for free product reporting requirements.

In situations where water recovered as part of the free product removal operation is discharged, compliance with the West Virginia National Pollutant Discharge Elimination System (WVNPDES) is required. Recovered water may, in some cases after treatment, be discharged to a sanitary sewer, storm sewer, ground surface, or surface water body. Contact WVDEP staff in the NPDES permit program for more information.

7.6 Safety Considerations

All work must be done in compliance with applicable OSHA requirements and Fire Codes.

7.7 Free Product Recovery Techniques

Federal and State regulations require that free product removal be conducted in a manner that minimizes the spread of contamination into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site. Also, abatement of free product migration must be the minimum objective for the design of the free product removal system.

Several factors influence the rate at which free product will migrate from the source of the release including the type and permeability of soils, the amount of product lost and/or thickness of product on the water table, properties of the chemical released, and the groundwater gradient. Free product removal shall be initiated as soon as possible and continue until virtually all product is removed. Manual bailing may be used to initiate free product recovery (until a more permanent system may be installed) or in very low permeability soil conditions when the recharge rate of free product into a well or other collection point is very slow. Nearly all large volume releases will require automated free product removal.

7.8 Free Product Response Measures

A free product recovery operation is triggered by the discovery of free product and involves the notification of the proper authorities, initial response measures, actual free product recovery, storage of

FREE PRODUCT

Just gauging wells is insufficient to deal with Free Product.

Free product removal shall be initiated as soon as possible and continue until virtually all product is removed.

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free product, proper disposal, and required reporting. The recovery, storage, treatment, and disposal of free product are subject to various safety and environmental regulations.

Once a release is discovered, notification to the WVDEP must be completed as previously noted. Furthermore, the release may be required to be reported to the National Response Center at (800) 424-8802 due to federal regulatory programs such as Spill Prevention, Control, and Countermeasures (SPCC) and Emergency Planning and Community Right-to-Know Act (EPCRA).

In conducting free product recovery, it is important to keep in mind that, even if the situation appears stabilized, free product may return at any time. If free product returns in a well then free product recovery must begin again. Once a well no longer contains free product, compliance monitoring sampling shall be performed. After free product is no longer observed in the well, a minimum of four (4) quarters at or below groundwater standards are required prior to the issuance of a “No Further Action” (NFA) status for the site.

7.9 Free Product Measurement and Sampling

The frequency of site visits to monitor and recover free product will vary with the removal technique in use. Manual bailing may require daily visits for some period of time to reduce free product thickness. Likewise, filter canisters may also require frequent visits, although depending on the storage capacity and/or the type of product removal (manual vs. automated), these would not require visits as frequent as manual bailing. Many filter canisters must be manually adjusted to be sure the free product layer contacts the screened portion of the canister. Automated recovery systems may only require monthly visits to ensure proper operation. However, on-site personnel shall be available to ensure the system is operational.

At a minimum, measurements of depth to product, depth to water, and thickness of product shall be made at least twice a month. The data shall be reported per the submittal schedule in Section 7.10. Measurements shall be made to the nearest 0.01 foot.

- Free product thickness shall be measured with an interface probe, or if not available, use best available technology. If an interface probe is used, rigorous decontamination procedures shall be employed between well measurements. If a clear bailer is used, it needs to be eased into the product interface very gently to minimize splash or disturbance of the floating product and care shall be taken not to overfill the bailer. Dedicated or disposable bailers are also recommended for free product measurements.
- Measurements of free product thickness in a monitoring well can be misleading. Fluctuating groundwater levels can result in measurements that do not reflect the thickness in the surrounding formation. Therefore, recent or suspected fluctuations in water table levels shall be noted with the free product measurement data if the investigator considers them to be significant. Free product fingerprinting via gas chromatograph (GC) or gas chromatograph/mass spectrometry (GC/MS) is encouraged wherever the potential exists for multiple sources of contamination. The tank owner/operator will need to utilize a WVDEP

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approved laboratory as appropriate, ensure that the laboratory utilized has the proper equipment, capability, and experience to perform the work. This information shall be evaluated against product specific standards in suspected releases.

- If measurable free product is present in a well, the well does not need to be sampled for dissolved-phase contamination in the groundwater until the well no longer has free product. Wells with a sheen on the groundwater surface must be sampled after proper purging.

7.10 Reporting Procedures

For ASTs, owners or operators shall formulate a Non-Aqueous Phase Liquids (NAPL) Conceptual Site Model (CSM) to determine the most efficient and environmentally protective remedial approach for addressing the presence of free product. The free product shall be removed and remediated to the maximum extent practicable. At a minimum, the free product recovery reporting shall be submitted quarterly as part of the corrective action progress for the site.

Within forty-five (45) days of the discovery or release of free product from an UST, an initial written report shall be submitted to the assigned TCAU PM, unless directed otherwise by the Agency. Further reports are required to be submitted in accordance with the following schedule:

- Monthly reports, on or before the 10th day of the month following the initial report, for any site having measurable free product with a thickness of five tenths (5/10th) of a foot or greater in any monitoring well.
- Quarterly reports, on or before the 10th day of the quarter following the initial report, for any sites having measurable free product with a thickness of less than five tenths (5/10th) of a foot.

The free product reports are to be submitted electronically to the TCAU PM for the county where the release occurred and dep.ast@wv.gov. The monitoring information shall be reported in tabular form. A graph of product thickness over time shall also be included. The reports must continue to be submitted until free product recovery is complete, a remediation system is installed and operational, and/or the TCAU PM indicates that a free product recovery report is no longer necessary. Use the Free Product Recovery Report form in Appendix B to file this report.

FREE PRODUCT REPORTING

The Frequency of Reporting only is being streamlined to lessen the paperwork burden.

Be Advised that while the frequency of submitting reports is being reduced, this does not reduce the requirement for actual removal of the free product.

Free product recovery must be performed on an ON-GOING BASIS to minimize the spread of contamination. Failure to do so may result in enforcement action.

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The report shall contain any comments on unusual conditions (i.e., recovery wells being pumped dry, suspicion of additional sources of free product, potential surface infiltration, etc.). Also, if the planned future activities differ from those laid out in the initial report, this shall be clearly stated. Any changes to the initial recovery plan shall be brought to the attention of the assigned TCAU PM, as well as being clearly outlined in the free product recovery report.

Be advised that these reporting requirements are being streamlined to lessen the paperwork burden associated with free product recovery reports. However, do not interpret this to mean that a tank owner/operator is only required to be actively recovering free product according to this reporting schedule. Free product recovery must be performed continuously to minimize the spread of contamination into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site.

Reports must clearly identify the efforts performed by providing, at a minimum, a monthly summary within the report on the free product recovery efforts. Failure to perform free product recovery in a manner to minimize the spread of contamination may result in enforcement action.

USE the **Free Product Recovery Report Form** to file this report when it is required. Submit the form and any required supplemental documentation electronically to the TCAU PM for the county where the release occurred and **dep.ast@wv.gov**.

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SECTION 8: INTERIM MEASURES

Interim measures are actions, efforts, or responses to spills or releases that are undertaken after the initial emergency response, but before long-term corrective action. Interim measures may be needed to control current impacts while the site evaluation effort proceeds. These measures shall be practical and reliable control actions which can be promptly implemented by the owner and/or operator. Interim measures, which usually overlap with emergency response actions, are initiated:

- After emergency response (or as a continuation of an emergency response)
- During the initial site characterization
- During a full-extent site investigation, prior to implementation of a long term Corrective Action Plan.

Interim measures are conducted to achieve one or more of the following goals:

- To mitigate the threat of contaminant migration to potential receptors
- To reduce risk to the environment and the public
- To reduce the amount of contamination and long-term liability (with pending long-term corrective action)
- To contain the contamination

This section discusses issues associated with interim measures such as health and safety, source removal, monitoring of receptors, vapor threats, and surface impacts. Various remediation techniques including interceptor trenches, horizontal wells, passive wells, and disposal are also briefly discussed. For greater detail on free product recovery, which may be an interim measure, see Section 7.

8.1 Health and Safety Considerations

A danger of fire or explosion is a potential safety concern at tank releases especially when dealing with a release of gasoline, other petroleum products, or volatile organic compounds. Therefore, health and safety measures are required for all phases of release remediation: free product recovery, site investigation, and long-term corrective action. During any of these phases, the health and safety regulations outlined under the Occupational Safety and Health Administration (OSHA) requirements in 29 CFR Part 1910 apply.

8.2 Source Removal

Source removal procedures are implemented to eliminate a “continuing source” and further migration of the spilled or released product. Source removal or source mitigation is an important part of the West Virginia Groundwater Protection Act, Article 22-12 of the State Code. Source

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removal typically takes place before any other response action and is usually short in duration. Source removal as an interim measure may involve free product recovery by interceptor trenches, grossly contaminated soil removal, etc.

8.2.1 Interceptor Trench

An interceptor trench may be necessary if product or vapor is present in the tank pit after tank excavation or if free product threatens to migrate off site through soils, and thus poses an immediate threat to streams or other sensitive receptors. As an interim measure to intercept or contain free product migration or even highly contaminated groundwater migration, an interceptor trench may be employed. An interceptor trench is commonly dug using a backhoe or in the case of an open excavation, it may be the down-gradient sidewall of the excavation. Primary considerations of the location include the assumed or known direction of contaminant migration and the relative position of potential receptors, which may need to be protected. In addition, the depth of the horizon where contaminants (either vapor or liquid) are targeted is a key consideration, in that practical limits do exist for excavation depth. As in any other excavation, soils from the trench will most likely need to be sent for disposal. Sand or pea gravel is the preferred material suitable for backfill for an interceptor trench.

8.2.2 Soil Removal

Among the many considerations in excavating contaminated soils, the following items are recommended:

- Targeting specific “hot spots” instead of excavating the entire area may reduce the volume of soil for treatment or disposal. Careful segregation of soils may take more time during excavation activities but may reduce long-term treatment or disposal costs significantly.
- During excavation, proceed with caution so as not to undermine structures such as buildings, utilities, canopy footers, etc.
- If soil contamination is found to be extensive and large quantities of soil are being excavated, it may be necessary to reevaluate the situation to determine if further excavation is practical.
- For media/debris exempted from the hazardous waste regulation via 40 CFR 261.4(b)(10), the tank owner must obtain preapproval at a landfill for disposal of soils prior to excavation with transportation of the soil to the landfill immediately upon its removal from the ground. For potentially hazardous waste soils (i.e. releases from ASTs), these soil soils must be containerized, profiled, and properly disposed of at an approved facility.
- If excavated soils are stored onsite, they must be properly stockpiled on and covered with plastic (minimum 6-millimeter thickness for short term storage of less than 72 hours, minimum 40-millimeter thickness for long term storage) to prevent rain infiltration and

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possible runoff. Soils saturated with free product shall be stockpiled in a manner that allows free product to seep into a contained area or “pool” for later removal. Long term storage of soil in the excess of 18 cubic yards must be preapproved by the WVDEP.

Any such soil pile shall be constructed incorporating the following considerations:

- The containment berm may consist of hay bales or a soil berm that the plastic liner covers.
- The soil pile must be located away from the flood plain if site constraints allow.
- The contractor shall have adequate supplies of plastic on-site and ready for use during excavation and stockpiling (including any appropriate perforated piping).
- Vapor vent pipes may be configured in the soil to facilitate aeration or the pile shall be manually mixed.
- Upon approval by the TCAU PM other materials may be added to enhance the bioactivity (e.g. to provide a more conducive pH or to provide additional “dietary” nutrients to stimulate microbial population growth).

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SECTION 9: SITE INVESTIGATION

The tank owner/operator must perform a site investigation (i.e. site assessment or site characterization) and submit a site investigation report within ninety (90) days of a UST release and one hundred and twenty (120) on an AST release, unless directed otherwise by WVDEP. The site investigation is performed to determine the full extent and magnitude of contamination and to evaluate actual or potential exposure to human health, safety, water resources and the environment. In performing site investigation activities, the TCAU acknowledges that the use of direct push technology (DPT) can be an efficient and cost-effective sampling method for both soil and groundwater. As with any method or procedure it has its limitations, advantages, and disadvantages which must be considered when it is utilized for site investigation sampling.

Characterizing the site through a site investigation is one of the early steps in the corrective action process. This typically involves the investigation of soil and groundwater to define the lateral and vertical zone impacted by a release to develop an effective remediation strategy. Surface water and/or sediment may also be investigated as part of the site investigation, as applicable. Site investigation activities must be planned and carried out to meet the following objectives:

- Characterize the type(s) of contaminants resulting from the release(s).
- Develop an accurate understanding of the site geology and hydrology.
- Delineate the distribution of contamination resulting from the release(s).
- Determine potential and actual migration pathways of the contamination.
- Identify and assess existing and potential adverse effects to receptors.
- Aid in developing an effective and appropriate corrective action plan.

In general, use a biased sampling strategy to collect samples in the areas where contamination is most likely to occur. Sampling where contamination is most likely to occur is a requirement of both the UST and AST rule. If sample locations cannot be biased, then use of a random or a grid pattern sampling scheme may be appropriate. A random pattern may be more suitable when the site appears to be homogeneous, while a grid pattern may be more appropriate when the site appears to be heterogeneous. Additional information on sampling strategies can be found in Appendix E.

The full extent of contamination from a release must be determined by conducting a site investigation(s) and submitting the findings and conclusions of the investigation(s) to the TCAU. If the extent of contamination is defined during the primary site investigation, only the Site Investigation Report will need to be submitted for site investigation purposes. If additional investigation is required to determine the full extent of contamination, it must be noted in the Recommendations Section of the Site Investigation Report. Compliance time frames for Supplemental Site Investigation Report will be established by the TCAU PM and will be determined

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on a site-by-site basis. If an owner/operator does not take immediate steps to initiate the site investigation, enforcement action may be taken.

The tank owner/operator at the time of the release is responsible for the remediation will need to obtain access to all areas that are impacted by a release. It is understood that access negotiations may sometimes be protracted and will be taken into consideration when developing the project schedule. It is recommended that if a signed access agreement is not obtained, a certified letter requesting off-site access shall be sent to the off-site property owner(s) with a 14-day response deadline. If there is no response to the certified letter, submit to the TCAU a copy of the off-site access request letter with the signed certification of delivery card, and a detailed description of all attempts to directly contact the property owner. After the responsible party has done all they can to gain off site access, the TCAU may attempt to intercede to gain access to the property for investigation. Be advised it is possible that some off-site property owners may never grant access to their properties; however, this does not absolve a responsible party for their release and required corrective action. In such situations, the responsible party is encouraged to work with the TCAU to find a resolution of the situation.

9.1 Field Screening

Field screening methods supplement and guide traditional site investigation work and can provide real-time information to target problem areas and make real time decisions, saving time and money in the site investigation. Field screening methods will yield qualitative information which can still be useful in guiding the site investigation to areas where contamination is located.

A wide variety of field screening methods and equipment are available. Be advised that not all screening methods work for all contaminants and that some methods are more useful and accurate than other methods. Furthermore, field screening shall never be used as a replacement for the collection of samples for laboratory analysis. The following are brief descriptions of just some of the potential screening methods. The TCAU encourages the use of any reasonable field screening method that can assist the tank owner/operator in properly characterizing a contaminated site.

9.1.1 Visual and Odor Screening

Visual screening consists of inspecting the soil for stains or dead vegetation which is usually indicative of contamination. Visual screening is not useful for all sites and types of contaminants. Visual screening can be used at petroleum releases but is generally more effective when contamination is related to heavy petroleum hydrocarbons such as used motor oil, hydraulic fluids, or bunker fuels, or when hydrocarbon concentrations are high. Patches of dead vegetation, particularly if adjacent to healthy vegetation, may indicate areas of contamination.

FIELD SCREENING

Field Screening is a useful tool to assist in the investigation of releases. However, field screening is unacceptable as confirmation sampling.

Laboratory analysis is required for confirmation sampling and will be required prior to the issuance of a “No Further Action letter.”

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The most common odors indicative of contamination will be from volatile organic chemicals, such as gasoline, fuel oils, and solvents. Gasoline has an odor familiar to most people and aging generally gives other petroleum products a musty odor. Some other contaminants that may give soil a noticeable odor include halogens, ammonia, turpentine, phenols, cresols, and some pesticides. Exercise caution in observing soil odors.

9.1.2 Sheen Test

Water sheen screening involves placing about one tablespoon of soil in a pan of water and observing the water surface for signs of a sheen. Sheen screening is most effective at detecting middle distillate (diesel) and heavy end fuels and oils with low solubility. It will not detect low levels of volatile contaminants or soluble compounds and thus shall not be used by itself to screen for these contaminants.

9.1.3 Colorimetric Test Kits

There are a variety of test kits for qualitative contamination evaluation. These methods are relatively easy to use and have a low cost per sample. The methods can be used on a variety of chemicals. In general, these methods extract a soil sample using a solvent and then a subsequent chemical reaction which creates a color. The intensity of the color is then measured to estimate the sample concentration.

9.1.4 Fiber Optic Chemical Sensors

Fiber optic chemical sensors can be used as a tool to screen soil, vapors or water for hydrocarbon contamination. This method measures the intensity of light from a light emitting diode passing through a fiber optic cable to a probe. Hydrocarbons adsorbed onto the probe affect the intensity of the light, which is converted to a measurable electrical current and concentration.

9.1.5 Organic Vapor Monitors

Typical organic vapor monitors utilize a flame ionization detector (FID) or photoionization detector (PID). Organic vapor screening generally is only effective in detecting volatile hydrocarbons.

Some heavier petroleum products do not give off sufficient vapors to register and some chemicals ionization potential may be higher than the ionization potential of the lamp used in the PID.

Various techniques exist for performing headspace vapor analysis. In one technique, soil is placed in a plastic bag. Air is captured in the bag, and it is sealed. The bag is shaken to volatilize contaminants in the soil. The probe of an instrument designed to measure vapors is then inserted into the bag and the vapor concentration is measured. In another technique, a

FID & PID

FID

Useful for gasoline and other volatiles

Wide detection range

Must have abundant oxygen supply to avoid flame out

Concentration readings depend on instrument flow rate

Must fully purge the instrument between sample analyses

PID

Useful for gasoline and other volatiles, but less useful for diesel or weathered fuel

Water vapor can suppress responses to organic vapors

The proper UV lamp must be selected to detect the chemical of concern

For both FID and PID, it is important to follow the manufacturer's guidance and to properly calibrate the instruments.

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jar is partially filled with soil or water, and then covered with aluminum foil. Vapors are then measured by poking the probe of a FID or PID detector through the aluminum foil. Regardless of whether one of these techniques or another technique is used, it is important to use a consistent technique for all samples at a site as there are a number of factors that can cause the results to vary.

9.1.6 X-Ray Fluorescence (XRF)

XRF is applicable to field screening of a variety of metals in surface and subsurface soils. XRF is a nondestructive technique used to determine the chemical composition of samples. This is a field screening method used for profiling an area, locating sources of contamination, determining the horizontal and vertical extent of contamination, and/or collecting preliminary data that may be used to design a sampling plan.

XRF uses a flux of high energy x-rays to bombard the sample causing elements in a sample to emit characteristic wavelengths. The instrument separates the elements' wavelengths into a spectrum. Concentration of elements present is directly proportional to energies being produced. XRF can be used to screen soil and water samples; however, preparation of water samples is not very practical in the field. As much as possible, soils shall be reduced to finer grains (ground, pulverize, etc.) to obtain the best readings with an XRF.

9.1.7 Conductance Meter

A conductance meter can be utilized for field screening for chlorides and is often used to field screen sites with brine tanks. The specific conductance of a sample is measured by use of a self-contained conductivity meter, generally a Wheatstone bridge-type.

9.1.8 pH

There are three basic methods of pH measurement: pH indicator paper, liquid colorimetric indicators, and electronic meters. The use of pH indicator paper is simple and inexpensive, but the method is not very accurate and requires a subjective evaluation of color by the user. Liquid colorimetric indicators change color in accordance with the pH of the water with which they are mixed. The color that develops can then be compared with a printed card. Colorimetric methods are simple and accurate to about 0.2 pH units. Their main disadvantage is that physical or chemical characteristics of the soil or water being tested may interfere with the color developed by the indicator and lead to an incorrect measurement. The third method, electrometric pH measurement, is accurate and generally free from interferences. Pocket-sized, battery-powered, portable meters that give readings with an accuracy of ± 0.05 pH unit are suitable for field use. Larger, more sophisticated models of portable meter can attain an accuracy of ± 0.01 pH unit.

9.1.9 Field Screening Considerations

When utilizing field screening to assist in the characterizing a site, consider the following:

- Field screening equipment must be calibrated properly and be appropriate for the materials being screened. For example, screening for the presence of volatile organic compounds (VOCs) shall be performed by using a properly calibrated Photo Ionization Detector or Flame Ionization Detector (PID/FID) and metals may be screened by an XRF.

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- Screening soils at the uppermost water-bearing zone is considered critical, and in general, the TCAU fully expects soil screening to occur where “contamination is most likely to occur” as in strata directly below the tank, leaking piping, or at the water soil interface.
- If field screening in all borings indicate non-detectable levels of contaminants, the soil sample closest to the source of contamination and/or the soil sample taken at the soil/bedrock or soil/water interface immediately adjacent to the suspected source shall be submitted for laboratory analysis.
- When sampling for VOCs, potential soil samples to be sent to the lab shall be placed on ice and a separate portion of the soil sample must be utilized for field screening.
- A description of field screening methods and all field screening test results shall be included in the Site Investigation Report.

9.2 Laboratory Selection, Sample Preservation and Analytical Parameters

West Virginia currently has a laboratory certification program. Regulations governing environmental laboratories certification and standards of performance may be found in 47CSR32. Samples must be submitted to a WVDEP certified laboratory for analysis, including subcontracted laboratories. Failure to utilize a WVDEP certified lab will result in rejection of laboratory data. A list of WVDEP certified labs may be found at <http://dep.wv.gov/WWE/Programs/lab/Pages/default.aspx>. The TCAU encourages tank owners/operators and/or their consultants to be familiar with the requirements and guidance provided in WVDEP’s EPA approved Quality Assurance Program Plan (QAPP). Refer to the Table (Appendix E) for information on sample collection, typical containers, preservation methods, and holding times for various common analytical methods. Additional information on preservation and holding times may be found in 40CFR136 Table II and in EPA’s SW-846 manual. WVDEP recommends that tank owners/operator work with the certified lab to obtain the proper containers with preservatives. The WV certified labs are required to adhere to preservation and holding times set forth in 40CFR136. Hold times begin from the time the sample is collected. The most recently promulgated version of the analytical method shall be utilized by the laboratory.

After collection, samples must be properly preserved until analyzed. Be advised that materials used for field screening cannot be retained for laboratory analysis. Volatile samples must be kept cool and tightly sealed. Note that SW-846 method 5035 utilizing vials with preservatives for collection of VOCs is required when collecting soil samples for VOCs. The Minimum Detection Limits (MDL’s) for each method of analysis must be below the action levels used to determine whether corrective action is necessary. Samples shall be delivered to the laboratory performing the analyses as immediately as possible and within the holding time for each analytical method. If delays occur, the samples must be properly stored and kept refrigerated (at specific temperatures) as appropriate.

9.3 Soil Investigation

Sampling of non-soil like backfill materials such as rocks or gravel shall not be performed. Sampling must be performed in native soils. Soil contamination must be delineated both

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laterally and vertically. An adequate number of soil samples must be taken to fully characterize the extent of contamination and the range of concentrations present at the site. Borings must extend both laterally and vertically until clean soils (as determined by documented field screening and confirmed by laboratory analytical data) are encountered.

Responsible parties should consider that Tier 2 and Tier 3 (see section 12.4) soil action level differ with differing vertical depths, when developing a sampling plan for soil investigation purposes. To use Tiers 2 and 3 for volatiles where the action level is based upon inhalation, there must be a minimum of 5-foot of vertical separation between contamination and a receptor utilizing a soil similar to silt loam or one with less hydraulic conductivity than silt loam. Samples need to be collected from the areas of highest contamination in each of the depth ranges to take advantage of the flexibility offered by having different action levels based upon the depth of contamination. This does not necessarily impose requirements for sampling at multiple vertical depth ranges, but certainly encourages the collection of a sample from the area of highest contamination in several vertical depth ranges. An owner/operator may choose to collect a single sample in a soil boring from the area of highest contamination and submit for analysis. However, if samples are not collected from the areas of highest contamination in each of the depth ranges (0-8 feet and greater than 8 feet) then the data collected from the single sampling point within the soil boring will be compared against the more conservative Tier 1 action level or the Tier 2 action level for the 0-8' range, as appropriate. The Agency believes that this approach is reasonable and essential to protect public health and the environment. If the potential exists for the site to enter a risk-based program for corrective action, it is highly recommended that surface soil samples (0-2 feet) be collected as these would be required in those programs. All samples collected and analyzed at a site shall be included in the report to WVDEP.

Furthermore, site investigation sampling for corrective action to address a confirmed release is different for AST and UST closure. AST and UST closures are described in Section 10.0 and Appendix D of this document and need to be referenced when performing a tank closure.

Adequate investigation of soil contamination in the source area is critical to a proper site investigation. The investigation of the source area must include sampling within, or as close as possible to, the source area to determine the highest concentration for each chemical of concern. The locations selected shall consider the potential source areas, and the distribution and variations in chemical of concern concentrations in soil and ground water. The number of samples necessary will depend upon the contaminant source, but sufficient samples to fully characterize and delineate the extent of contamination will be necessary. It is recommended that at least one sample be collected every eight (8) linear feet of drilling and retained for analysis, when conditions indicate variability and contaminant presence in the soil column. The following conditions need to be considered when selecting soil samples for laboratory analysis:

- Field screening results indicate the presence of contaminants
- Significant changes in lithology

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Owners/operators must measure for the presence of a release where contamination is most likely present. In selecting sample types, sample locations, and analytical methods, owners/operators must consider the nature of the stored substance, the nature of the release, the type of backfill, and the depth to ground water. Furthermore, when selecting sampling locations, it must be taken into consideration that pathways for released product can also be created by sanitary and storm sewers, water lines, and other buried utility lines and utility trenches. These pathways allow released product, either liquid or vapor, to migrate in directions not anticipated by site soil characteristics or site hydrogeological conditions.

Field investigation of the vertical extent of a chemical of concern (COC) shall continue until one of the following occurs:

- Field screening data and/or laboratory analytical results reveal that the vertical extent of contamination was determined. This will require a soil boring to extend beyond the point of contamination to show that the extent of contamination has been determined. Soil borings must be advanced a minimum of five (5) feet below the last detectable contamination. However, advancing soil borings deeper than 5 feet past the last field-detectable evidence of contamination may be appropriate for some site-specific conditions (such as when borings are advanced in non-soil like materials like sand) and certain chemicals of concern.
- Groundwater is reached. (If encountered, groundwater sampling will be required).
- Bedrock is encountered.

9.3.1 Soils Classification

For the TCAU to adequately review site investigation reports, qualitative descriptions of the surface gradient and soils at the sites need to be provided. To ensure that site investigation reports use consistent language for characterizing soils, the terminology shown in the Unified Soil Classification System (USCS), U.S. Department of Agriculture's Soil Conservation Service (SCS), or other nationally recognized method shall be used when performing soil borings and/or installing groundwater monitoring wells. Field logging of borings must be performed by a qualified environmental professional who has competency in and has received training in soil classification and logging of borings. Field logs using the Unified Soil Classification System (ASTM D 2487) must be interpreted in terms of the U.S Department of Agriculture's Soil Conservation Service (SCS) classifications as the action level for volatiles were determined using the Johnson and Ettinger model which utilizes the SCS soil classification.

A narrative must also be provided on the boring logs to further describe observations like staining, odor, or sheen. Additionally, soil characteristics such as color, texture, moisture content, reason for termination of a boring, etc. need to be provided.

9.3.2 Soil Sampling Methods

WVDEP recommends that direct push, hollow stem auger, sonic, or cable tool methods be used for soil investigations. Test pits may be useful for shallow soil investigations, enabling direct observation of soil layers and contaminated zones, but could end up generating significant quantities of contaminated soil requiring disposal. Air rotary drilling is not recommended where soil sampling is being conducted

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unless site geologic conditions don't allow the use of other methods. Air rotary drilling can strip volatiles from the soil during the drilling process. Furthermore, drilling fluids shall not be used unless no other reasonable alternative exists as these fluids can influence chemical and physical analysis.

Discrete grab samples shall be collected and analyzed, unless otherwise indicated in this section. The collection of discrete samples minimizes potential problems associated with contaminant loss through volatilization. When sampling from an open excavation, a minimum of six inches of soil must be removed to obtain soil samples from an unexposed area to minimize the loss of volatile contaminants. Depending on site conditions, soil samples can be collected by one or more of the sampling techniques, such as but not limited to:

- Direct push technology uses rigs that are hydraulically powered and are generally mounted on a customized four-wheel drive vehicle. The base of the sampling device is positioned on the ground over the sampling location and the vehicle is hydraulically raised on the base. As the weight of the vehicle is transferred to the probe; the probe is pushed into the ground. A built-in hammer mechanism allows the probe to be driven through dense materials. Maximum depth penetration under favorable circumstances is around one-hundred (100) feet. Soil samples can be collected using specially designed sample tubes. The sample tube is pushed and/or vibrated to a specified depth. Various soil sampling methods can be performed using direct push technology. WVDEP recommends the use of a dual-tube rod system with closed-barrel samplers when utilizing DPT for soil sampling. Contaminated soil cuttings may not be placed back into the ground. They must be properly disposed of an approved facility.
- Hand Auger/Soil Corer. A hand auger or soil corer may be used for collecting soil samples if site conditions permit the use of hand tools. The presence of large rocks, cemented soil layers, or extremely deep sample collection points may prevent the use of hand tools. The use of hand tools reduces the chance of puncturing tanks or piping systems and is likely to be less expensive than using drill rigs and other power tools. Once the sampling location has been reached, a liner can be inserted inside a soil corer for collecting the sample. Liners are useful for collecting relatively undisturbed samples. The use of a liner is not mandatory, and care must be taken to choose the correct liner so as not to influence results of analyses. Contaminated soil cuttings may not be placed back into the ground. They must be properly disposed of an approved facility.
- Split Spoon/Shelby Tube. Split spoon/Shelby tube sample collection devices require the use of drill rigs. There are two significant disadvantages to using a drill rig to collect soil samples. First, this method makes identifying the backfill/native soil interface, or other specified sampling depth, difficult. Second, the risk of puncturing the UST and/or delivery piping is much higher with a drill rig than with hand tools. Before operating drilling rigs and other excavating equipment near known underground utilities, Miss Utility must be contacted determine the location of buried utilities. As appropriate, other utility companies may need to be contacted to determine the location of buried utilities. When using either the split spoon sampler or Shelby tube, sample collection devices shall be driven ahead of the auger flights in order to collect

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a relatively undisturbed sample. Use of liners for the split spoon sampler is recommended to ensure a representative sample. After the split spoon or Shelby tube has been tripped back out of the boring, the desired sample section must be removed from the sampling device, capped, taped, and labeled immediately. When taping, care shall be exercised as taping can introduce minute quantities of some solvents into the sample. Contaminated soil cuttings may not be placed back into the ground. They must be properly disposed of an approved facility.

- **Backhoe and Hand Tools.** In areas where subsurface soils are very rocky or large quantities of debris are present, a backhoe may be needed to excavate to the desired depth for sample collection. The backhoe is a useful tool for collecting samples to depths of up to twelve (12) feet below the surface. As with the use of a drill rig, extreme caution must be exercised when using a backhoe to avoid puncturing the tank or piping system. Soil samples may be collected directly from the backhoe bucket. To collect samples in this manner, the backhoe bucket must be cleaned prior to sampling. An excavation is then made to the desired depth and a bucket full of soil is removed from the desired sampling interval and brought to the surface. The sample must be collected from the soil in the middle of the bucket, away from the metal sides of the bucket. Surface soil shall not be incorporated into the sample. Contaminated soil may not be placed back into excavation pit. Contaminated soil must be properly disposed of an approved facility.

9.4 Capillary Fringe Investigation

The capillary fringe (smear zone) is created by groundwater being drawn up from the water table due to capillary forces within the subsurface formation. The thickness of the capillary fringe is dependent upon the site-specific lithology. A smear zone is created when groundwater contamination exists, and the water table elevation fluctuates. The thickness of the smear zone is dependent upon the amount of the site-specific water table fluctuation. The capillary fringe and the smear zone may occur within a zone of overlap or it may exist as distinctly separate zones. The investigation of the extent of either the capillary fringe or smear zone contamination is usually not necessary for sites requiring only soil investigation but may be useful for determining the remedial system design and longevity for contaminated groundwater or free product recovery.

9.5 Groundwater Investigation

A site investigation of groundwater is required at all sites where there is the potential that groundwater has been contaminated. When determining if there is a potential that groundwater has been contaminated the investigator must consider the following:

- Potential receptors (i.e., potable wells, occupied structures, or surface water) may have been impacted by contaminants from the site;
- Free or residual product is detected;

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- The potential discharge is close to or beneath the water table (i.e. a release from a UST in an area where the water table is shallow);
- Any contamination detected in soil within ten (10) feet of the water table or bedrock;
- The soil at a site has a high permeability, or little adsorptive capacity; or
- Contamination has had time to migrate through the unsaturated zone to the water table based on contaminant and soil transport properties and the estimated date of discharge.

Where groundwater is not sampled during the investigation of a potentially contaminated site, and a groundwater investigation may be warranted based on the above considerations or other site-specific data, the technical justification for not performing a groundwater site investigation must be provided in the site investigation report for consideration by the TCAU PM. After evaluation, the Agency may require groundwater investigation if it is believed that impact to groundwater may have occurred.

Water sampled directly from inside a tank excavation is not necessarily representative of normal groundwater conditions and shall not be evaluated as a groundwater sample. However, such samples will be used to document the existence of a confirmed release and would indicate that groundwater investigation is necessary. Refer to Section 10 for guidance on how to handle pit water. The goal of the groundwater investigation is to obtain reliable and representative information regarding aquifer characteristics, groundwater flow directions, groundwater chemical and physical characteristics, and groundwater samples. Generally, the purpose of a monitoring well is to document the presence or absence of contamination or establish long-term groundwater contaminant trends and to confirm that cleanup levels have been met in a known contaminated aquifer. The two major types of groundwater monitoring are:

- Site investigation which relates to assessing and delineating the extent of a potential contaminant groundwater plume. This type of monitoring can be achieved through the collection of groundwater samples via grab samplers, DPT wells, or permanent conventional wells.
- Compliance monitoring which is related to on-going sampling of the ground water to assess the effectiveness of the remediation method and to determine when compliance with the standards have been met. This type of monitoring is long term; therefore, permanent monitoring wells must be installed.

DPT -VS- RIGS

Comparison studies between direct push and hollow-stem auger drilled wells performed by BP Corporation North America Inc. and the UST Programs of the USEPA Regions 4 and 5 (2002) and Kram et al. (2001) found that water-level elevations and contaminant concentrations were statistically comparable between the two well types.

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Permanent wells are installed utilizing drilling rigs. Several methods can be utilized such as hollow stem augers, solid augers, sonic methods, and various rotary methods. The preferred methods are those that case the hole during drilling.

One of the most often used drilling rigs for contaminated site investigation is the hollow-stem auger. The hollow-stem auger allows for continuous soil recovery and monitoring well installation. The American Society for Testing and Materials (ASTM) standard D6151 and 5784 provides detailed information on the use of hollow-stem augers for soil sampling and installation of monitoring wells, respectively. Direct push technology (DPT) can be utilized to install wells at a lower cost; however, these wells are used for a short time period and cannot be utilized for long term compliance monitoring. As with drilling rig methods, DPT wells can be installed using several techniques. The preferred method for DPT wells uses a pre-packed filter screen. ASTM standards D6724 and D6725 provide detailed guidance on the installation of direct push monitoring wells. Additionally, DPT groundwater grab samplers can be utilized to collect groundwater as part of a site investigation.

If groundwater is found to be contaminated at a level near or above the groundwater standards and action levels utilizing DPT, then permanent monitoring wells will be required for long term compliance monitoring. Data from DPT wells or DPT grab samplers may not be used when routine compliance monitoring is required due to exceedances of the groundwater action levels or standards. Furthermore, if the tank owner/operator is considering entering a risk-based program (UECA or VRP) in the future they need to understand that groundwater sample data collected by DPT may not be acceptable for use in those programs. Refer to Appendix F for more information on the use of DPT for groundwater sampling.

Monitoring well (DPT and permanent) construction and decommissioning in West Virginia must follow the State Monitoring Well Regulations found in 47 CSR 59 & 60. All monitoring wells must be installed and abandoned by a Certified Monitoring Well Driller in accordance with the requirements of 47CSR59. Proper well design and installation is important to ensure that groundwater samples and water level measurements characterize discrete stratigraphic intervals. Well design and installation must prevent the introduction of surface contaminants into the groundwater and prevent leakage of groundwater or contaminants between stratigraphic intervals in the well bore or along the well annulus. All well construction logs with soil boring information are required to be submitted with the site investigation report.

9.5.1 Number and Location of Monitoring Wells/Grab Sampler Collection Points

In general, enough ground water samples need to be taken to fully characterize the extent of contamination and the range of concentrations present at the site. Sample locations shall consider anticipated groundwater flow direction and vertical delineation (i.e. typically reflected in surface slope or directed toward the nearest surface water body for shallow water tables in unconsolidated materials).

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9.5.1.1 Permanent Monitoring Wells

When groundwater sampling is required for compliance monitoring, and the direction of groundwater flow is known, a minimum of three (3) groundwater samples must be collected, one upgradient and two downgradient of the potential contamination source. The three monitoring wells must be installed in a triangular formation on the site to determine groundwater flow direction, the hydraulic gradient, and to ensure that the area of the most contaminated soil/groundwater is sampled. If more than three wells have been installed on site, water level elevations from the additional wells must also be used to determine flow direction. Monitoring wells and survey data from adjacent sites may be used but is not required. All groundwater level measurements must be collected on the same date and must represent the static water level (i.e. well is under non-pumping conditions). Static water levels must be measured to the nearest 0.01 foot and ground surface elevations must be measured to the nearest 0.1 foot. When the direction of groundwater flow is unknown additional groundwater wells will need to be installed.

9.5.1.2 Direct Push Wells and Groundwater Grab Samplers

A major advantage of utilizing DPT is the cost effectiveness of the method to install wells or collect groundwater grab samples. Groundwater samples collected from DPT wells or grab samplers cannot be used for quarterly compliance monitoring, but it is useful for screening for detecting the presence of ground water contaminants; assessing the relative concentrations of contaminants; and guiding the installation of permanent monitoring wells, if necessary. DPT wells are generally considered temporary wells that must be properly abandoned within one hundred and twenty (120) days. Refer to Appendix F for additional information and explanation on DPT wells and DPT groundwater grab samplers.

While the data quality from the DPT sample may not be as of high quality as a corresponding sample from the permanent conventionally installed well, the increased number of sampling locations can lead to confidence in the overall representation of contamination for the site. Therefore, it is recommended that if DPT is used for initial groundwater investigation to determine the presence of contaminants, a minimum of six (6) DPT wells (pre-packed screens are preferred) be installed or a minimum of nine (9) grab samplers be used to collect groundwater. The number of sampling points may be decreased or increased based upon field conditions. However, failure to install a sufficient number of wells or sampling points may result in the Agency deeming the site investigation incomplete and requiring additional investigation. Even though DPT temporary wells may be utilized on a site for site investigation purposes, permanent conventional monitoring wells will be required if contamination above the action levels is detected.

WELL DATA QUALITY

Permanent Well – High Quality

DPT Well – Lower Quality

Grab Samplers – Lowest Quality

Data quality from a DPT groundwater sample is not as of high quality as a corresponding sample from a permanent monitoring well, but the increased number of samples/sampling locations gained by using DPT can lead to greater confidence in the overall investigation for the site.

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9.5.1.3 Additional Monitoring Wells

The installation of additional monitor wells may be required under any of the following circumstances:

- The down-gradient well does not define the contaminant plume.
- The analytical data from the cross-gradient well do not provide adequate information to develop an accurate conceptual site model.
- The groundwater flow direction is not consistent or cannot be adequately determined based on the three monitor wells.
- The extent of groundwater contamination needs to be determined between the contaminant plume and receptors, such as supply wells or springs.
- For large plumes, additional cross-gradient wells may be required to develop an accurate conceptual site model.
- The water table has risen above the top of or fallen below the well screen, such that groundwater samples representative of the aquifer contamination at that location of the plume cannot be obtained during sampling events.
- Multiple up-gradient and cross-gradient release points have impacted groundwater, and the effect of these impacts upon the release site have not previously been investigated.

Rationale for groundwater sampling locations must be documented in the Site Investigation report and must be consistent with state and federal guidance and industry standards.

9.5.2 Well Depths and Screening

Drilling must continue until soil samples indicate non-detectable levels of contamination or until bedrock or groundwater are encountered. Guidance on bedrock wells will be provided on a site-specific basis – particularly given the diversity of bedrock aquifers across West Virginia (including those areas of rapid groundwater flow in limestone/carbonate (karst) aquifers in the southeast and eastern Panhandle). Vertically extensive drilling may be warranted in some unconsolidated settings (i.e. areas of the Ohio River flood-plain), where contaminants have been found at depths of up to 60 feet while little or no indication of their presence was suggested in shallower horizons.

Vertical components of groundwater flow will need to be examined if water quality tests indicate that more than the uppermost aquifer has been impacted. This will require installation of monitoring wells in both the shallow and deeper aquifers at the site and may require placement of piezometers in closely spaced well clusters. There must be no cross-contamination of deeper aquifers. Double cased wells with a surface casing sealing off upper saturated zones will be required if drilling

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proceeds below a surficial aquifer. WVDEP may allow the use of dyes or tracers in karst in lieu of wells on a site-by-site basis. However, unless prior approval is obtained from the PM, wells are still required in those environments.

Groundwater samples must be collected from a properly screened well. All wells must be installed in such a way that the top of the well screen lies above the water table and the bottom of the well screen lies below the water table. The well screen interval shall be such that the water table is encountered even during the highest water table conditions (i.e. typically in spring). In areas of large water table fluctuations, large screen lengths may need to be installed in the wells.

9.5.3 Monitoring Well Development

The importance of well development in monitoring wells cannot be overestimated; all too often development is not performed or is carried out inadequately. The primary function of a monitoring well is to provide a representative sample of groundwater as it exists in the formation. The goal of well development is to repair the damage caused during drilling or direct-push well installation to the area immediately adjacent to the well, ensuring proper hydraulic connection to the aquifer. Well development removes the fine-grained material to improve the hydraulic efficiency of the well. ASTM D5521 is a standard guide for development of groundwater monitoring wells and shall be referenced when monitoring well development questions arise.

Well development methods most often include mechanical surging with bailing or pumping, over pumping, air lift pumping, and jetting. Well development must proceed slowly and systematically to prevent the movement of more material than the development method can effectively remove.

The time interval between well installation and development is a function of the well construction, type of grout, and conditions under which the grout is installed. Well development shall not be performed until the seal has cured. Type 1 cement generally cures within 48 hours and bentonite-based grouts tend to set within 24 to 48 hours.

Prior to performing groundwater sampling, sufficient time must be allowed for equilibration within the formation after development of a new well or redevelopment of an existing well. A minimum of forty-eight (48) hours must be allowed for stabilization after well development (or redevelopment), prior to collecting groundwater samples.

9.5.4 Groundwater Sampling

The purpose of groundwater sampling is to collect data for adequate site investigation and for planning remediation. During the site investigation process, the depth to groundwater needs to be measured quarterly to ensure that the complete seasonal variation of the groundwater elevation, flow direction and

WELL DEVELOPMENT

The time between well installation and development is **Critical** to obtaining a Representative Groundwater Sample

48 Hours must be allowed for stabilization after well development prior to sampling.

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gradient is documented. All available groundwater monitoring data shall be included in the Site Investigation Report (SIR).

Once groundwater contamination above the groundwater standard has been confirmed at a leaking tank site, quarterly groundwater sampling must continue until site closure, unless directed otherwise by the agency. All contaminated wells (except those with free product) must be sampled along with those wells defining the perimeter of the plume. Results of quarterly sampling must be sent via email to the PM and to Charleston at DEP.AST@wv.gov within 45 days of the sampling date. A summary of the sampling procedures and significant findings must also be included. All reports must reference the WV ID Number (UST facility ID number or the AST unique Tank ID number) and Leak Number.

9.5.4.1 Groundwater Sampling Methods

The goal of groundwater sampling is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. There are numerous groundwater sampling methods. These methods can have varying affects upon the physical and chemical alterations of a sample; therefore, choosing the most appropriate sampling methods and equipment for the chemical of concern and site conditions is very important. Refer to Appendix E for a brief discussion of some groundwater sampling equipment.

Low flow sampling procedures (or equivalent) must be utilized when sampling for VOCs, polynuclear aromatic hydrocarbons (PAHs, also called polycyclic aromatic hydrocarbons or polyaromatic hydrocarbons) and/or metals. The EPA and United States Geological Society (USGS) have documented their concerns with the use of the peristaltic pumps to collect water samples for VOC analysis. EPA and USGS recommend bladder or centrifugal pumps as a better choice for obtaining more accurate results. Furthermore, EPA and USGS indicates if minor differences in groundwater concentrations could affect the decision on whether to continue or terminate groundwater cleanup, then a peristaltic pump is not recommended to be used for sampling (EPA Low Flow Sampling, September 2017).

9.5.4.2 Filtering of Groundwater Samples

Filtering of groundwater samples shall not be performed on samples for volatiles and semi-volatile compounds, except for PAHs. Questions often arise regarding filtering groundwater samples that may contain PAHs and/or metals. It is true that particulates may carry undissolved PAHs and/or metals, artificially raising contaminant levels found in the sample, but filtering may artificially lower contaminant levels. For this reason, low flow sampling techniques is recommended. In general, unfiltered samples must always be submitted for analysis unless it can be demonstrated that filtered samples provide a more representative measure of groundwater quality. If a tank owner/operator believes that filtered samples would be more representative of the groundwater, they need to discuss this with the TCAU PM and present documentation to support their position. The information will be reviewed and given due consideration; however, the Agency believes the cases where a filtered sampled would be more representative of groundwater quality will be extremely limited.

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9.5.4.3 Collection of Groundwater Samples from Treatment, Recovery, Supply, or Observation Wells

Collection of compliance monitoring groundwater samples from treatment, recovery, supply, and observation wells shall be avoided. If groundwater is sampled from these wells, the data shall be considered for screening purposes only. Conditions inside or in the immediate vicinity of a treatment or recovery well location have been preferentially altered by the treatment and will provide data that is not representative of subsurface contaminant conditions. Groundwater needs to be collected from alternate locations, if possible. If not practical, then compliance samples shall not be collected until, at a minimum, one (1) month after a treatment has occurred in the well. Additional sampling may be required to ensure that rebound does not occur at the site when wells used for treatment are also used for compliance sampling. Supply wells, or potable drinking water wells, generally are not to be used for compliance monitoring sampling. Frequently, the construction of these wells, particularly the screening of the wells, is not known, not in the proper location, and/or screened over to large of an interval. Observation wells are installed for observation purposes, related to performing leak detection for tanks, and are not to be used for compliance sampling. The water in these wells is rarely, if ever, reflective of the groundwater aquifer. The presence of contaminants in an observation well may be used to indicate a release, but, the absence of a contaminant in the well is not indicative of whether contamination has adversely affected groundwater.

9.5.4.4 Monitoring Well Purging

Monitoring wells must be properly purged before collecting groundwater samples. Purge volumes will be depended upon the sample collection method. Regardless of the volume of water purged from the well, samples must not be collected until stabilization of certain indicator parameters such as temperature, specific conductance, pH, redox potential, dissolved oxygen are reached. It is highly recommended that you consult the Groundwater Well Sampling Procedures (SOP-OER-0110) in the WVDEP QAPP for further information on groundwater sampling. The stabilization criteria presented below are from that document.

Stabilization Criteria

Parameter	Criteria
pH	+/- 0.1 standard units
Conductivity	+/- 3% of readings
Temperature*	+/- 1.0 degree Celsius
Dissolved Oxygen	+/- 0.3 mg/l or 10% of readings, whichever is greater
Turbidity*	+/- 10% of readings (less than 10 nephelometric
Eh/OORP	+/- 10 millivolts
<p><i>*Turbidity, which is not an actual water quality indicator, must be measured at the start and end of pumping – low levels are desired, but stabilization isn't necessary. Temperature must be measured, but it is not a water quality indicator, so stabilization isn't necessary.</i></p>	

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After purging the well and allowing the water level to equilibrate, the groundwater sample must be collected and transferred to a sample container with a minimum of disturbance or agitation to prevent loss of volatile organic compounds. All purged water shall be carefully collected, containerized, and stored for proper disposal pending evaluation of groundwater sample analyses. The results of the analyses and applicable federal, state, and local water quality regulations dictate the method for disposal of the purge water.

9.6 Surface Water and Sediment Sampling

Surface water and sediment sampling may be necessary if there is a possibility that contamination from the site potentially migrated to a nearby surface water body (e.g., stream, spring, lake). The unpermitted release of pollutants is a violation of 47 CSR 10 – NPDES System and may potentially cause “Conditions not Allowable” which is a violation of 47 CSR 2. Values for surface water and sediment action level benchmarks shall be found in the *Requirements Governing Water Quality Standards Rule - Title 47CSR2* and EPA Region III Biological Technical Assistance Group (BTAG) Screening Benchmarks, as appropriate.

It is recommended that owner/operators consult with the TCAU PM prior to the initiation of investigation of surface water and/or sediments. In general, samples must be collected downgradient but near the known or predicted locations where contaminants have entered and/or are entering the water body. The number of samples needs to be sufficient to characterize the extent of any potential contamination. A sample needs to be collected from an upstream location and non-impacted “background” station, if possible.

9.6.1 Surface Water

Surface water samples can be collected from different depths (e.g. surface, vertical mid-point, near bottom, etc.) as appropriate. There are several types of sampling equipment and sampling techniques that can be used to collect water samples. The New Jersey Field Sampling Procedure Manual (NJDEP, 2005) contains a thorough description of sampling techniques/equipment, along with advantages and disadvantages of each. A few of the more common sampling techniques/equipment are as follows:

- Pond Sampler
- Weighted Bottle Sampler
- Wheaton Dip Sampler
- Kemmerer Depth Sampler
- Van Dorn Sampler
- Beacon Bomb Sampler
- Pump

In cases where there are active monitoring wells on a site and surface water sampling is also planned, it is highly recommended that groundwater samples be collected at the time of the surface water

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sampling. This can be important if a responsible party is trying to show that groundwater from the site is not negatively impacting the surface water.

9.6.2 Sediment Sampling

Sediment sampling may be appropriate when:

- Contaminant properties suggest they may be present in only trace levels in the water column, but could accumulate to high concentrations in sediments;
- Sediments may act as a reservoir and source of contaminants to the water column;
- Sediments may accumulate contaminants over time, while contaminant levels in water are more variable; or
- Sediment contaminant levels could affect benthic organisms or other receptors of concern in aquatic ecosystems.

The sediment samples can be collected near the surface or at depth, as appropriate. There are several types of sampling equipment and sampling techniques that can be used to collect sediment samples. A few of the more common sampling techniques/equipment are as follows:

- Scoop/Trowel
- Ponar Dredge
- Box Corer
- Van Veen Grab
- Hand Corer
- Split Core Sampler
- Gravity Corer
- Swing Jar Sampler
- Sludge Judge

Sampling equipment which minimizes or eliminates the loss of fine-grained material is preferred over such equipment as scoops/trowels, which tend to result in the loss of fine-grained material. The New

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Jersey Field Sampling Procedure Manual (NJDEP, 2005) contains thorough descriptions of sampling techniques/equipment, along with advantages and disadvantages of each and may be consulted for additional information.

9.7 Background Sampling

During an investigation, there may be contaminants found in the soil or groundwater at a site which exceed an applicable soil or groundwater remediation action level. These contaminants may be related to the release being investigated or they may be related to natural or anthropogenic background levels. Natural background refers to the concentrations of elements that occur naturally in the earth, without any human interference. Background concentrations of naturally-occurring elements in both soils and groundwater vary greatly depending on soil types, geologic strata, and depositional environment. Some soils in West Virginia have naturally high concentrations of arsenic, chromium, and some PAHs. Natural background levels of many elements in soil are described in published literature. This information can be used for comparing natural background levels with corrective action standard. A West Virginia subset of “Geochemical and Mineralogical Data for Soils of the Conterminous United States” is available on the U.S. Geological Survey site at <https://pubs.usgs.gov/ds/801/>.

Anthropogenic background refers to concentrations of elements that occur over a widespread area because of human activities. Extensive mining and oil and gas operations in West Virginia have led to higher values of some chemicals such as PAHs and arsenic in soils. Also, elevated arsenic levels have been linked to herbicide usage. If there is sufficient reason to suspect natural or anthropogenic sources are the cause of elevated sample concentrations. The selection area for background samples is a site-specific decision and should be discussed with the TCAU PM. The samples should be collected in an unbiased fashion. It is anticipated that a statistical analysis will be performed on the data; therefore, sufficient background samples to perform this analysis will be needed. The TCAU PM will evaluate the request and provide guidance on how to proceed with the background sampling.

Making a successful claim that the groundwater impact at a site is related to background can be difficult. Natural background ground water contamination may be demonstrated through an evaluation of the distribution of contaminants. Contamination must be ubiquitous across the site with concentrations no greater at potential source areas than at locations up or side gradient of potential source areas. A sufficient number of ground water samples must be collected across the site and upgradient from the site to demonstrate natural background contamination. Background and on-site groundwater samples need to be collected simultaneously for all on-site contaminants believed to be originating from off-site sources. A sufficient number of background samples must be collected to identify seasonal water quality variations and long-term trends. Statistical methods that may be employed to establish background ground water quality are discussed in the March 2009 “Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities” (USEPA, 2009).

It is impractical to remediate a site to levels below background levels. When a site contaminant concentration is determined to be less than background by appropriate statistical tests, no site remediation will be necessary for that contaminant.

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9.8 Composite Samples

Composite sampling is not accepted as an appropriate sampling protocol to provide data with regard to site investigation. Composite sampling may prove beneficial in the determination of site-specific background and waste disposal options.

9.9 Other Sampling and Testing

Soil vapor surveying is not considered a stand-alone investigation of contaminant extent. Soil vapor surveying may be required when vapor migration has occurred into basements or utility vaults. If soil vapor surveys are conducted, the rationale for using them, their results and limitations shall be clearly described in the Site Investigation Report. The traditional corrective action path for ASTs and USTs does not have standards established for vapor intrusion. Remediation under the traditional corrective action would be required to meet the soil and groundwater standards.

Geophysical testing methods may be used to indirectly determine the extent and nature of both unconsolidated and consolidated materials. Thickness of specific units, depth to water, location of faults, etc., may all be determined by various methods. This data may then be correlated with well logs or test boring data to verify results.

Aquifer tests may be conducted to determine specific aquifer characteristics. This information may be very useful in determining groundwater flow conditions, fate and transport modeling, and in designing Corrective Action Plans.

9.10 Boring Logs/Monitoring Well Construction Diagrams

Boring logs and monitoring well construction diagrams must be completed in accordance with the requirements of 47CSR59 & 60 of the Monitoring Well Regulations. Any report must supply the following minimum information for boring logs/monitoring well construction diagrams:

- A heading at the top of the log with:
 - ❖ Site name and location
 - ❖ Drilling company, type of drilling rig, name of driller
 - ❖ Consulting firm, Geologist/Hydrologist logging the boring
 - ❖ Boring/well number
 - ❖ Date drilled, time to complete (days), weather conditions

- Soil descriptions, utilizing ASTM – USCS, SCS, or other nationally recognized method. Observations need to be included in writing and in a vertical graphic stratified column with depths of significant changes.

- Field logs using the Unified Soil Classification System (ASTM D 2487) must be interpreted in terms of the U.S. Department of Agriculture’s Soil Conservation Service (SCS) classifications as the action level for volatiles were determined using the Johnson and Ettinger model which utilizes the SCS soil classification.

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- Surface elevation, total depth of boring and reason for termination of each boring (i.e. refusal, encountered groundwater, contamination no longer encountered, etc.)
- Sampling method, depth of samples, blow counts (if Standard Penetration Test is utilized)
- Depth of water table and any unique subsurface features, if encountered
- Field screening data, odors encountered and any evidence of product staining
- As-built construction diagram of the monitoring well corresponding to the lithologic/stratified column and screening results
- Bore hole diameter, casing diameter, length, and material of construction
- Screen materials and design, slot size and length
- Filter pack material, height in annulus
- Sealant material, height in annulus
- Surface completion and top of casing elevation
- Well development method, date, volume of water removed
- Depth to water after well development and recharge

Separate logs may be prepared for soil borings and monitoring well construction diagrams; however, all the information above must be included. The logs for a specific boring/well must be included consecutively (i.e., SB-1, MW-1, SB-2, MW-2, etc.) for ease of reference. Soil borings/monitoring well construction diagrams must be submitted in the Site Investigation Report.

9.11 Drill Cutting and Boring/Well Abandonment

Drill cuttings shall be properly containerized and disposed in accordance with State and Federal Regulations. Under no conditions shall cuttings be placed in the annular space of a monitoring well or returned to a soil boring.

Incomplete borings, destroyed wells, or decommissioned monitoring wells must be permanently abandoned in accordance with 47CSR60 to prevent any future conduit for contaminants to reach an aquifer. Copies of the monitoring well abandonment forms must be included in the site investigation report and documentation of any plugging activities shall be included in the boring logs. Borings and monitoring wells must be properly abandoned in accordance with 47CSR60 prior to the issuance of a No Further Action (NFA) letter for a site.

9.12 Investigation Derived Waste

Corrective actions often result in the generation of solid wastes including, but not limited to the following:

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- Tanks and containers
- Contaminated soil
- Contaminated water
- Liquid hydrocarbons from tanks or free product recovery
- Sludges
- Cuttings from soil borings

These wastes may be considered hazardous or special wastes according to State and Federal regulations. Petroleum impacted soil is considered a special waste under §33CSR1-4.13. Refer to Appendix I for additional information on disposal of petroleum contaminated soil. Contaminated or potentially contaminated material generated during site investigative or remedial activities must be:

- Contained to prevent the migration of contaminants into subsurface soil, surface water, or groundwater until the material is removed from the site.
- Stored or treated in stockpiles, drums, tanks, etc. in a manner that is consistent with State and Federal regulations. Petroleum contaminated media and debris subject to Corrective Action requirements of 40 CFR 280 and fail the test for toxicity (waste codes D018 – D043 only) are exempt from hazardous waste regulations (40 CFR 261.4(b)(10)). All other media / debris must be containerized and properly profiled. Waste piles are prohibited. On-site treatment may potentially require a hazardous waste permit.
- Containers must be labeled appropriately.
- Treated to the appropriate and applicable corrective action standards if the derived waste is to be returned to the on-site subsurface.
- Properly characterized to determine if the material is a hazardous waste or not.
- Material being removed from the site must be transported and disposed of at an approved facility. Manifests or other documents showing waste transportation and disposal shall be submitted to the Agency.

9.13 Site Investigation Report Format

To streamline Site Investigation Report, review and to ensure easier reference and use of these reports, the Tanks Corrective Action Unit is specifying a required format (see Checklist in Appendix B). This format will be used for both the Site Investigation Report and the Supplemental Site Investigation Report, if one is necessary. The standardized report format is intended to ensure that:

- Reports are complete.
- Reports allow easier review and future reference.
- Corrective actions are more quickly undertaken, when required.

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- The regulated community understands what is expected.

The TCAU recognizes that very few conclusions or recommendations may be derived from a situation where contamination has gone off-site and further investigative work is needed. However, some conclusions may be reached concerning the extent of on-site contamination and a recommendation made for further work. It is understood that recommendations regarding Corrective Actions may not be provided at this point. However, interim measures are strongly recommended in this situation and need to be documented in the Site Investigation Report.

9.14 Data Validation

The LAST and LUST Programs utilize specific numerical standards for soil and groundwater cleanup levels. Since the cleanup levels are based upon numerical standards rather than risk-based standards, the level of validation for the program is not as stringent as that set forth in the risk-based programs. Data collected under the LAST and LUST Programs are used to delineate the extent of contamination and to formulate corrective action plans, which result in the subsequent closure of the sites once specific numerical clean-up standards for soil and groundwater have been reached.

Validation for these programs is to be performed in general accordance with Stage 2B and Stage 3 levels of EPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (January 2009) pursuant to the EPA approved QAPP. Tank owners/operators and/or their consultants are encouraged to be familiar with the requirements and guidance provided in WVDEP's EPA approved Quality Assurance Program Plan (QAPP). Data validation is important to ensure that the decisions being made about a site are protective of public health and the environment. The level of validation for the LAST and LUST program is minimal in comparison with risk-based programs and centers around ensuring that correct field sampling, preparation, and analytical methods are performed; the hold times for analysis are met; and the laboratories run appropriate standards, method blanks, surrogates, etc. A copy of this guidance can be downloaded from

<https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockkey=P1002WWF.TXT>. The guidance document referenced above describes the Stage 2B and Stage 3 Levels as follows:

State 2B: A verification and validation on completeness and compliance checks of sample receipt conditions and both sample related and instrument related QC results.

Stage 3: A verification and validation based on completeness and compliance checks of sample receipt conditions, both sample related and instrument related QC results with recalculation checks.

If a responsible party anticipates the likelihood of bringing a LAST or LUST site into one of the risk-based programs, they may want to obtain a full CLP-like data package from the laboratory as the data validation requirements for these programs are more stringent.

SECTION 10: TANK CLOSURE GUIDANCE

The closure, repair, and/or upgrades of tank systems or tank system components (i.e. piping, spill buckets, sumps, under dispenser containment, etc.) is not considered a corrective action, but it frequently leads to confirmation of a release that results in corrective action. It is possible to perform an AST or UST closure which requires sampling to close the tank but does not result in any remediation of a site. Also, it is possible to perform a closure and the closure sampling confirms a release. If all of the necessary documentation is provided in the closure report, the closure can be deemed complete, but the site will then move from closure activities to corrective action if a release is confirmed.

Despite the difference in closure and corrective action, it is worth mentioning closure activities in this guidance document. Pursuant to 40CFR280.61 and 47CSR63.7.2, owners and operators must be prepared to take immediate action to remediate contamination as soon as it is found. Over excavation at the time of tank system closures and upgrades can significantly reduce time and cost of remediation at a site. FastTrack is an option in these cases to move quickly from finding contamination, removing the contamination, and collecting confirmation samples to move the site quickly from discovery of a release to receipt of a No Further Action letter. Over excavation can always be halted if it is determined that the extent of contamination is greater than anticipated and/or a physical barrier or groundwater is encountered. **After tank closure, it is highly recommended that the excavation be backfilled with soil** instead of gravel or sand to take advantage of the Tier 2 and Tier 3 soil action levels. See the flowchart and associated instructions in Appendix A for additional information.

Any **accumulated water with a sheen observed within the excavation zone** at the time of permanent closure **shall be removed and containerized** to protect groundwater. The excavation must be observed to determine whether groundwater recharge occurs during the remainder of the permanent closure process. Any water removed shall be properly containerized, treated in accordance with applicable regulatory requirements and properly disposed of. The tank owner/operator has the option of on-site treatment after obtaining a NPDES permit for the treatment and discharge of the contaminated water. Alternatively, the owner/operator may have the contaminated water transported to an approved permitted facility for treatment/disposal.

SOIL DISPOSAL

When petroleum contaminated soil is removed from an excavation it becomes Solid Waste and it may not be placed back into a pit because you would be improperly disposing of a waste.

Impacted soil that is excavated or disturbed (i.e. laying loosely in the excavation) must be properly **DISPOSED** of at an appropriate facility or placed in a biopile (if approved by the Agency).

10.1 UST Closures

UST closure sampling shall be performed in accordance with the UST/LUST Closure Guidance Memo (refer to Appendix D). Sampling must be performed to measure for the presence of a release where contamination is most likely to be present. If there is obvious contamination from a release (e.g. stained soils) a sample must be collected from this area. All samples shall be collected from native soil, sampling of non-soil like backfill material is not acceptable. **Sample depths to the nearest foot must be documented** and included in the closure report.

Refer to the UST/LUST Closure Guidance Memo for information on soil sampling locations. Groundwater sampling is not required at closure; however, if the UST excavation fills with water, a water sample shall be collected in lieu of a floor soil sample. Prior to collecting the water sample, the excavation pit water shall be removed first, and the water allowed to recharge into the pit. If the water does not recharge, then floor samples of the soil shall be collected. Further analysis may be required if a release is confirmed.

A site sketch of the facility showing the locations of the sample collection points is to be submitted with the closure documentation. Soil sampling protocol for volatile organics (such as BTEX, MTBE, and TBA) must follow the requirements of SW846 Method 5035 utilizing vials with preservatives for collection of VOCs.

Samples must be analyzed for BTEX, MTBE, and TBA (method SW 846 8260) if the release is related to gasoline. Samples must be analyzed for lead if the gasoline is a leaded gasoline such as commonly found in some aviation and racing fuels.

Samples must be analyzed for BTEX (method SW846 8260) and PAHs (method SW846 8270) for releases of diesel, kerosene, fuel oils, lubricating oils, and waste oils. Additionally, the RCRA eight (8) metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver) are required to be sampled in cases of waste oil tanks. If required, metals analysis should be for “total metals” unless otherwise specified by the Agency. Ethylene glycol and/or chlorinated solvent analysis may be requested for waste oils if warranted.

UST SOIL SAMPLING

While the minimum soil sampling requirements must be performed for UST closure, in order to take full advantage of the flexibility offered by the new guidance additional sampling may be prudent. For example, since different action levels exist based upon the vertical depth of contamination, there can be value in having samples from both the 0-8 feet depth and the greater than 8 feet depth in the same location.

Closure samples must be reflective of the contamination remaining in the excavation pit.

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Unless significant over excavation is performed, it is likely that most samples (piping, dispenser, tank sidewall) associated with UST closure will fall into the 0-8' vertical depth range while the tank bottom samples will likely be at the greater than 8' depth. It will be very important for the Class B Certified Worker who is performing the closure to document all sampling depths and provide a description of the soil type to utilize the flexibility offered by having action levels for different depth ranges.

10.2 AST Closures

AST closure sampling shall be performed in accordance with a WVDEP approved closure plan. Sampling must be performed to measure for the presence of a release where contamination is most likely to be present. If there is obvious contamination from a release (e.g. stained soils, dead vegetation) a sample must also be collected from this area. All samples shall be collected from 1-foot below ground surface in native soil, unless directed to do otherwise by the Agency. Sampling of non-soil like backfill material is not acceptable. **Sample depths to the nearest foot must be documented** and included in the closure report. Refer to the AST/LAST Closure Guidance Memo (Appendix D) for information on approved soil sampling locations.

Unless significant over excavation is performed, it is likely that most samples associated with the AST closure will fall into the 0-8' vertical depth range; however, sampling depths must be well documented.

10.3 Tank Closure Notifications

Refer to Appendix D for a copy of the memo of UST closures and handling contaminated soils at closure sites and a copy of the template for AST closure plans and reports. An intent to close an AST must be made, at a minimum of thirty (30) days prior to the intended closure date by submitting a closure plan for review and approval electronically to dep.ast@wv.gov. The WVDEP closure plan template shall be used for submittal of closure plans.

AST SOIL SAMPLING

While the minimum soil sampling requirements must be performed for AST closure, in order to take full advantage of the flexibility offered by the new guidance additional sampling may be prudent. For example, since different action levels exist based upon the vertical depth of contamination, there can be value in having samples from both the 0-8 feet depth and the greater than 8 feet depth.

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An intent to close an UST must be made thirty (30) days prior to the intended closure date by submitting a request to dep.ast@wv.gov and the Tanks Inspector. Use the WVDEP Intent to Close form when request a closure number. A closure plan is not required for UST closure. AST and UST closure reports are due within sixty (60) days of the closure and can be submitted electronically to dep.ast@wv.gov.

AST or UST closure sampling shall be performed as soon as possible after the tank closure activities have begun. Sampling must be commenced within 48 hours of starting closure activities. Closure reports are due within sixty (60) days of the closure sampling.

BACKFILL OF EXCAVATIONS

It is highly recommended that any excavation area is backfilled with soil that is a **SILT LOAM** or a soil type similar to silt loam or one with less soil saturated hydraulic conductivity.

There must be a minimum of 5-foot of vertical separation using soil between contamination and a receptor (i.e. person, house, etc.) to utilize the Tier 2 or Tier 3 standard for certain volatiles.

See the flowchart and instructions in Appendix A for additional information.

SECTION 11: CORRECTIVE ACTION PLANS

The Tank owner/operator must prepare and submit a corrective action plan (CAP) when requested by WVDEP. In some cases, the contamination at a site may be minor and would not require the submittal of a CAP and in other cases the tank owner/operator may choose to use a presumptive remedy instead of submitting a CAP. Regardless, of the path taken, sites must be remediated to target cleanup levels provided in Section 12 to obtain a No Further Action (NFA) letter from the Agency.

UST: CAP due within one hundred twenty (120) days of a confirmed release.

AST: CAP due within ninety (90) days of the SIR approval for a confirmed release.

11.1 Traditional CAP

The objectives of the CAP are to summarize and document all the activities and decisions made to date to identify and evaluate contamination at a site, compare contaminant levels to target clean-up levels, and to describe in detail the corrective action(s) chosen to bring the site into compliance. Furthermore, the CAP includes the rationale for the selected remediation, milestones for the clean-up, and a proposed schedule for monitoring activities to obtain compliance.

The required CAP elements are site specific and depend on the remediation technology that is selected. Source removal is a preferred mechanism for remediation; however, the TCAU will review proposals for both conventional and alternative cleanup technologies. Sufficient information must be provided in the CAP to support the effectiveness of the proposed remedial action(s). CAPs must contain a discussion of the rationale for technology selection, an engineering design plan, monitoring plan, waste management strategy, and schedule. It is very important that the remedial design considers the site conditions and chemicals being remediated to ensure that the remedial technology selected is appropriate for the site.

11.1.1 Rational for Technology Selection

In selecting a remediation technology or technologies, it is important that the technology be compatible with site conditions and contaminants. The technology selected must be designed to fully facilitate environmental cleanup. Documentation of the effectiveness of the selected corrective action and its applicability to the site must be provided.

11.1.2 Site Investigation Requirements

Prior to submitting a CAP, the site shall be characterized to fully delineate the extent of contamination. The only time that a full site investigation may not be required prior to implementing a CAP is when a site is utilizing FastTrack at a low impact site which is anticipated to have limited extent of contamination due to the nature of the release and type of contaminants present.

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The following site characteristics, at a minimum, and their effect upon the proposed remediation method must be discussed in the CAP. Other characteristics that would affect the chosen remediation method's effectiveness shall also be discussed.

- Full extent of contamination and presence/absence of free product
- Concentrations of contaminants
- Intrinsic permeability of soil and soil stratification
- Depth to groundwater
- Chemical characteristics of contaminants (such as Henry's law constant, vapor pressure, boiling point, solubility, etc.)
- For chemical oxidant or biological treatment, describe the calculate mass of contaminants requiring biodegradation and the mass of dissolved oxygen or biological nutrients necessary to biodegrade the contaminants.
- Description of radius of influence for wells and/or injection points.

11.1.3 Engineering Design Plan

A CAP must include an engineering design plan which provides a detailed description and proposed design of the remediation technology system(s). The design plan must include:

- Complete design criteria such as expected contaminant concentrations; total contaminant volumes; soil permeability, characteristics of the chemicals being remediated (i.e. vapor pressure, boiling point, etc.), projected flow rates and volumes; temperatures, pressures, etc., under varying conditions (seasonal and project phases); methods for all onsite collection, treatment, storage, and disposal of product and/or wastes;
- Alarm and safety features to respond to malfunctions, potential overflows, etc., including the name and phone number of a site contact;
- Type and location of utility services (submit utility location figure);
- General layout and process flow diagrams depicting the location of all collection, treatment, storage, and disposal activities (schematics or plans are acceptable);
- Measures to protect the system(s) from damage resulting from tampering and inclement weather (cold, floods, etc.).

Any modifications made to the engineering design plan upon system installation must be submitted to the appropriate TCAU PM within 30 days of system start-up.

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11.1.4 Monitoring Plan

A CAP must include a monitoring plan. The remediation-monitoring plan needs to consist of four main sections described below:

- Section 1 needs to describe monitoring of the treatment system (the monitoring plan to document the system's performance and any modification to optimize that performance).
- Section 2 needs to describe influent and effluent monitoring conducted to meet conditions of permits or establish treatment effectiveness.
- Section 3 needs to describe monitoring of soils, groundwater, and vapors that identify progress toward cleaning up the environment to the target soil levels and groundwater standards noted above.
- Section 4 needs to describe the monitoring report format (for the submittals that will be made to the WVDEP during system operation). Refer to Section 11.4 of this document for additional information on the CAP reporting requirements.

11.1.5 Waste Management Strategy

Corrective actions often result in the generation of wastes that must be properly handled and disposed. The CAP shall discuss the types of waste that will be generated, how the wastes generated are managed, including description of any on-site and off-site storage, treatment and disposal arrangements.

11.2 Presumptive Remedies

A “presumptive remedy” refers to a technology or technique where experience has shown the remedy to be a proven solution for specific types of sites and/or contaminant classes. EPA established presumptive remedies many years ago to accelerate site-specific analysis of remedies at CERCLA sites. While initially utilized for CERCLA sites, the use of presumptive remedies for LAST/LUST sites is a valuable tool to assist owners/operators in remediating their sites. A site must be fully characterized, and the plume delineated prior to use of a presumptive remedy. The only time that a full site investigation may not be required prior to implementing a presumptive remedy is when a site is utilizing the excavation remedy as part of the FastTrack process. Sites eligible for FastTrack are low impact sites which are anticipated to have limited extent of contamination due to the nature of the release and type of contaminants present.

By providing presumptive remedy technologies, this guidance attempts to streamline selection of these technologies and shift the time and resources employed in remedy selection to other, more fundamental aspects of remediation. The Agency encourages the use of presumptive remedies. To streamline the corrective action process. It improves consistency and increases the speed at which sites are remediated. The presumptive remedy is simply an expedited approval process.

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Circumstances where a presumptive remedy may not be used include unusual site soil characteristics, mixtures of contaminants not treated by the remedy, demonstration of significant advantages of alternate (or innovative) technologies over the presumptive remedies, or extraordinary community and state concerns. The use of a presumptive remedy is not applicable when the contamination has migrated beyond the facility boundary unless it can be demonstrated that the presumptive remedy will address the contamination beyond the facility boundary. All presumptive remedy use is subject to approval by WVDEP.

For sites containing a mixture of contaminants, the presumptive remedies shall be considered only if they can also be effective in removing all the contaminants or combined with other presumptive remedies or non-presumptive remedies in a treatment train that could effectively treat all contaminants. If utilizing multiple remedies to remediate the site, this information must be clearly articulated to the Agency in the CAP. Caution needs to be utilized in using multiple presumptive remedies at a site to ensure the remedy to address one set of contaminants does not exacerbate the problems with the other contaminants at the site. Note that sites containing mixtures of VOCs and non-VOCs are varied, and for this reason, remedy selection may be more complicated than the framework presented in this guidance. Therefore, the presumptive remedy analysis may need to be supplemented or modified on a site-specific basis.

Currently, the Agency has developed checklists for several approved “presumptive remedies”. A tank owner/operator wanting to utilize this streamlined approach to corrective action would need to complete the appropriate checklist(s) and submit to the TCAU PM for approval. Nothing precludes the use of multiple presumptive remedies at a site. For example, limited soil excavation may be performed followed by or in conjunction with another remedy such as chemical injections. When utilizing multiple presumptive remedies, it is important to clearly articulate what is being done in a particular area, in what order things are being done, what areas of the site are being affected, etc. Refer to Appendix C for checklists and additional instructions for the following presumptive remedies. These remedies are briefly discussed in the following sections.

- Soil Excavation
- Soil Vapor Extraction (SVE)
- Low Temperature Thermal Desorption (LTTD)
- Air Sparging (AS)
- Dual Phase Extraction (DPE)
- *In situ* Chemical Oxidation (ISOC)
- Aggressive Fluid Vapor Recovery (AFVR)

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11.2.1 Soil Excavation

Excavation of contaminated soil from a site involves digging it up for “ex situ” (above-ground) treatment or for disposal in a landfill. Removing the potential sources of contamination by excavation prohibits people from contacting the contaminated soil, helps prevent migration of contaminants to groundwater, and expedites the cleanup of contaminated groundwater that may be present.

Contaminated soil is excavated using standard construction equipment, such as backhoes and excavator track hoes. The equipment chosen depends on how large and deep the contaminated area is, and whether access is limited by the presence of buildings or other structures that cannot be moved. Long-reach excavators can excavate as deep as 100 feet below ground, but excavations are generally limited to much shallower depths due to safety concerns and difficulty keeping the hole open. Sometimes soil is excavated below the water table, which requires walling off the contaminated area and pumping out the water to keep dry during excavation.

To use excavation as a presumptive remedy, the tank owner/operator must properly characterize and dispose of contaminated soil at an approved facility. Short term on-site stockpiling of soils confirmed to be non-hazardous may be allowed with approval from the Agency. Refer to Soil Excavation checklist in Appendix C to evaluate the applicability of this remedy to your site.

11.2.2 Soil Vapor Extraction (SVE)

Soil Vapor Extraction (SVE), is also known as soil venting or vacuum extraction. This technology has been proven effective in reducing concentrations of volatile organic compounds (VOCs) and certain semi-volatile organic compounds (SVOCs).

It is an *in-situ* process which physically removes contaminants from vadose zone soils by inducing air flow through the soil matrix. The flowing air strips VOCs from the solids and carries them to extraction wells. The recovered vapors may require further treatment. Concentration reductions greater than 90% are difficult to achieve.

In designing an SVE system, contaminant properties, hydrogeology, and contaminant distribution must be considered. Soil properties affecting SVE performance include temperature, organic carbon content, and air permeability of the contaminated media. Air permeability is affected by the heterogeneity, porosity, stratigraphy, and moisture content of the soil. Intrinsic permeability is a measure of the ability of soils to transmit fluids and is the single most important factor in determining the effectiveness of SVE. If geologic

CHEMICALS TREATED

Applicable to a wide range of contaminant groups with no particular target group

CHEMICALS TREATED

Petroleum Hydrocarbons

Volatile Organic Compounds
(like BTEX)

Ketones/Furans

Chlorinated Solvents

Other VOCs and some SVOCs having physical and chemical characteristics similar to the compounds listed here may also be treated by SVE.

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conditions are amenable to SVE, the effectiveness of SVE becomes highly dependent on the chemical properties of the contaminant. The three most influential physiochemical properties are Henry's constant, vapor pressure, and water solubility (Johnson and Ettinger, 1997; Watts, 1998a).

SVE is a proven and well-understood technology for remediating sites impacted by gasoline releases. SVE is generally more successful for compounds with lower solubilities; therefore, the effectiveness of this method for MTBE remediation is highly dependent upon the release and site conditions. MTBE has a relatively low Henry's law constant indicating that it may not be very amendable to removal by SVE. Diesel fuel, heating oils, kerosene, and lubricating oil which are less volatile than gasoline, are not readily treated by SVE. Refer to SVE checklist in Appendix C to evaluate the applicability of remedy to your site.

11.2.3 Low Temperature Thermal Desorption

Low-Temperature Thermal Desorption (LTTD), also known as low-temperature thermal volatilization, thermal stripping, and soil roasting, is an *ex situ* remedial technology that uses heat to physically separate chemicals from excavated soils. Thermal desorbers are designed to heat soils to temperatures sufficient to cause constituents to volatilize and desorb from the soil. The vaporized hydrocarbons are generally treated in a secondary treatment unit or collected for subsequent treatment or disposal. A hazardous waste permit will be required if the soils being treated are a hazardous waste.

Some pre- and postprocessing of soil is necessary when using LTTD. Excavated soils must be screened to remove large diameter objects prior to treatment. After treatment, soils must be cooled and re-moistened to control dust. Treated soil may be redeposited onsite, used as cover in landfills, or incorporated into asphalt unless the soil was contaminated with a listed hazardous waste. Soil contaminated with a listed hazardous waste must be disposed of at a hazardous waste facility.

In designing an LTTD system, contaminant properties and soil characteristics must be considered. All soil types are amenable for treatment by LTTD systems. However, different soils may require varying degrees and types of pretreatment. Soil properties affecting LTTD include, but are not limited to, soil plasticity, particle size distribution, moisture content, heat capacity, and bulk density. Contaminant properties affecting LTTD include, but are not limited to, contaminant concentrations, boiling point range, vapor pressure, thermal stability, and dioxin formation.

CHEMICALS TREATED

LTTD has proven very effective in reducing concentrations of petroleum products including gasoline, jet fuels, kerosene, diesel fuel, heating oils, and lubricating oils. Other VOCs and SVOCs may be treated using LTTD. Depending upon the system used, LTTD can achieve temperatures of up to 1200°F.

Not to be used for treatment of chlorinated compounds or heavy metals.

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LTTD is a proven and well-understood technology for remediating sites impacted with various VOCs and SVOCs. LTTD has proven very effective in reducing concentrations of petroleum products including gasoline, MTBE, jet fuels, kerosene, diesel fuel, heating oils, and lubricating oils. LTTD may not be used for treatment of chlorinated compounds or heavy metals. Refer to LTTD checklist in Appendix C to evaluate the applicability of this remedy to your site.

11.2.4 Air Sparging

Air sparging (AS) is an *in situ* remedial technology that reduces concentrations of volatile constituents that are adsorbed to soils and dissolved in groundwater. This technology, which is also known as “*in situ* air stripping” and “*in situ* volatilization,” involves the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor phase. The air is then vented through the unsaturated zone. Air sparging is most often used together with soil vapor extraction (SVE), but it can also be used with other remedial technologies. Air sparging has been used to address a broad range of VOCs and SVOCs in groundwater and soil including gasoline and other fuels and chlorinated solvents. Air sparging is applicable for the treatment of less volatile and/or tightly sorbed chemicals that could not be remediated using vapor extraction alone.

Soil properties affecting air sparging performance include the intrinsic permeability of the soil and the soil structure and stratification. Assuming the soil properties are amenable to air sparging, the effectiveness of air sparging becomes highly dependent on the chemical properties of the contaminant such as boiling point, vapor pressure, solubility, Henry’s law constant, and contaminant concentration. Refer to Air Sparging checklist in Appendix C to evaluate the applicability of this remedy to your site.

CHEMICALS TREATED

Air Sparging has proven very effective in reducing concentrations of various fuels (such as gasoline, diesel, jet fuel, kerosene, heating oils, etc.); oils and greases; and chlorinated solvents. Other VOCs and SVOCs may be treated using air sparging.

11.2.5 Dual Phase Extraction

Dual-phase extraction, also known as multi-phase extraction, vacuum-enhanced extraction, or bioslurping, is an in-situ technology that uses pumps to remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface. Extracted liquids and vapor are treated and collected for disposal, or re-injected to the subsurface (where permissible). Dual-phase extraction systems can be effective in removing separate-phase product from the subsurface, thereby reducing concentrations of chemicals in both the saturated and unsaturated zones of the subsurface.

Significant variations in the DPE technology exist. DPE systems often apply relatively high vacuums to the subsurface. Thus, the adjective "high-vacuum" is sometimes used to describe DPE technologies, even though all DPE systems are not high-vacuum systems. Single-pump systems rely on high-velocity airflow to lift suspended liquid droplets upwards by frictional drag through an extraction tube to the land surface. Single-pump vacuum extraction systems can be used to extract groundwater or combinations of separate-phase product and groundwater. The more conventional dual-pump systems use one pump to extract liquids from the well and a surface blower (the second pump) to extract soil vapor. A third DPE configuration uses a total of three pumps, including the surface blower together with one pump to extract floating product and one to extract groundwater.

DPE is often selected because it enhances groundwater and/or product recovery rates, especially in layered, fine-grained soils. The application of DPE also maximizes the effectiveness of SVE by lowering the water table and therefore increasing air-phase permeabilities in the vadose zone. Finally, DPE can enhance biodegradation by increasing the supply of oxygen to the vadose zone. The key site parameters that need to be evaluated in deciding whether DPE will be a viable remedy for a site is permeability of the soil and volatility of chemicals being treated.

Refer to Dual Phase Extraction checklist in Appendix C to evaluate the applicability of this remedy to your site.

11.2.6 *IN SITU* Chemical Oxidation (ISCO)

ISCO involves the introduction of a chemical oxidant into the subsurface to react with contaminants of concern to convert them into less harmful products. Chemical oxidation is an approach for the in-situ reduction of contaminants in both the soil and groundwater. A chemical oxidation reaction involves the breaking of chemical bonds and the removal of electrons. The electrons are then transferred from the contaminant to the oxidant. Chemical oxidation is a sequential process that takes the parent contaminant through a series of partially oxidized intermediate daughter products on the path to complete mineralization. Chemical oxidation usually requires multiple applications.

CHEMICALS TREATED

Petroleum Hydrocarbons

Volatile Organic Compounds (like BTEX)

Chlorinated Solvents

Other VOCs and some SVOCs having physical and chemical characteristics similar to the compounds listed here may also be treated by DPE.

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Chemical oxidation technologies are used to address contaminants in the source area saturated zone and capillary fringe. Cost concerns can preclude the use of chemical oxidation technologies to address large and dilute petroleum contaminant plumes. More frequently, chemical oxidation technologies are employed to treat smaller source areas where the petroleum mass is more concentrated. The total costs of ISCO applications are often dependent on the amount of injected oxidant. Three key parameters for selecting oxidant dose are: The contaminants' oxidant demand, the natural oxidant demand (NOD), and the oxidant persistency in the subsurface.

Overcoming natural oxidant demand is one of the major challenges for ISCO. Although NOD has been extensively studied, it has been impossible to create generalized values for NOD due to NOD dependence on individual site conditions. NOD is primarily an issue for stable oxidants such as permanganate and non-activated persulfate.

11.2.6.1 Oxidant Delivery

Oxidant delivery is critical for the success and cost efficiency of ISCO, as it controls oxidant-contaminant contact. The type of delivery system selected depends upon the depth of the contaminants, the physical state of the oxidant (gas, liquid, solid), and its decomposition rate. Site permeability, level of site investigation, depth of contamination and budget considerations are things to consider when selecting a delivery method. The most common methods and their applicability are:

- Direct push technology can be very effective when the contaminated zone is well characterized as it allows for targeted injections. This technology is however unsuitable for sites where rocks/cobbles and boulders are present, as these can prevent the tool from advancing into the subsurface.
- Injection into wells allow for directing transport of the chemical oxidant into the subsurface; therefore, it is suitable for low permeability layers. However, high permeability zones within the treated low permeable layer may result in preferential flow pathways that bypass the contaminant.
- Solid mixing where oxidant solutions or particles are mixed into the soil with an auger or backhoe. This method can be used to treat contaminants in low permeability media, but its suitability depends largely on the depth of the contaminated zone.

11.2.6.2 Site Conditions

Site hydrogeologic conditions are extremely important when considering chemical oxidation as a remediation method. Site hydrogeologic conditions determine the extent to which the chemical oxidants come into contact with the contaminants. If the oxidant doesn't contact the contaminant, then remediation will not occur. Also, different chemical oxidation technologies are most appropriate for particular hydrogeologic conditions. For example, Fenton's Reagent will not work well in groundwater with high concentrations of carbonate. The carbonate ion preferentially scavenges the hydroxyl radicals created by Fenton's Reagent reactions before they have a chance to

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react with the contaminants. Conversely, the presence of carbonate minerals increases the effectiveness of permanganate.

Soil reactivity with chemical oxidants are extremely important when considering chemical oxidation as a remediation method. Soil reactivity is important because if the chemical oxidant is reacting with organics or metals naturally occurring in the soil, it limits the amount available to react with the contaminants.

To manage the risks associated with chemical oxidation it is important to:

- Locate pockets of high levels of petroleum contamination in the treatment area.
- Identify and evaluate preferential flow paths.
- Clear the area of subsurface utilities, basements or other enclosed spaces that could accumulate and transmit vapors.
- Ensure that no petroleum storage tanks or lines are in the treatment area.

11.2.6.3 Chemical Oxidants

The selection of an oxidant for site cleanup involves the following key concepts (EPA 2006- *In Situ Chemical Oxidation*):

- Is the oxidant capable of degrading the contaminant of concern? Is a catalyst or other additive required to increase effectiveness?
- What is the natural soil oxidant demand? High natural soil oxidant demand will increase the cost of cleanup, as more oxidant will be required.
- What is the naturally occurring pH of the soil/groundwater system? Some oxidants require an acidic environment to work. If the soil is basic, an acid needs to be applied in addition to the oxidant.
- How will the decomposition rate of the oxidant affect application strategies? Some unreacted oxidants may remain in the subsurface for weeks to months, while others naturally decompose within hours of injection.

There are many compounds that can be used for chemical oxidation; however, this presumptive remedy will discuss only a few such compounds. If a tank owner/operator wants to use different compounds than discussed here, they must choose to submit a standard CAP. This presumptive remedy will consider the following compounds for chemical oxidation: hydrogen peroxide, Fenton's reagent, permanganate, ozone, persulfate, and percarbonate.

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Chemicals Treated

Chemical Oxidant	Chemicals Generally Treated with Chemical Oxidant
Hydrogen peroxide	TPH, Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), PAHs, pesticides
Fenton's Reagent	TPH, BTEX, MTBE, PAHs
Permanganate ¹	Chlorinated solvents, TPH, PAHs
Ozone ²	TPH, BTEX, PAHs, MTBE (limited effectiveness), phenols, PCBs, pesticides
Persulfate	Chlorinated solvents, TPH, BTEX, PAHs, MTBE
Percarbonate	TPH, BTEX, MTBE, chlorinated solvents

¹ Permanganate is generally not used to treat petroleum products, if benzene or MTBE is present, because it doesn't readily degrade benzene or MTBE.

² Ozone has only limited effectiveness in degrading MTBE

Hydrogen Peroxide

While catalysts can be added to increase oxidation potential, hydrogen peroxide also can be used alone to oxidize contaminants. Hydrogen peroxide is a strong oxidant that can be injected into a contaminated zone to destroy contaminants. When injected to groundwater, hydrogen peroxide is unstable, and reacts with organic contaminants and subsurface materials. It decomposes to oxygen and water within hours of its introduction into groundwater generating heat in the process. In fact, peroxide oxidation is an exothermic reaction that can generate sufficient heat to boil water. The generation of heat can assist in making contaminants more available for degradation, as well as allowing them to escape to the surface.

With its high reaction and decomposition rates, hydrogen peroxide is not likely to address contaminants found in low permeability soil. Solid peroxides (e.g., calcium peroxide) in slurry form moderate the rate of dissolution and peroxide generation, thereby allowing a more uniform distribution.

Peroxide is typically shipped to a remediation site in liquid form at dose concentrations ranging from five percent to 50 percent by weight. The reactivity of hydrogen peroxide can limit the extent to which it may be distributed in the subsurface before it decomposes.

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Fenton's Reagent

Fenton's reagent or modified Fenton's reagent uses hydrogen peroxide in the presence of ferrous sulfate and acidic conditions to generate hydroxyl radicals that are powerful oxidants. Ferrous iron may be naturally present at the site, but most often it is added as a catalyst solution together with the hydrogen peroxide. The reaction is fast, releases oxygen and heat, and can be difficult to control when high strength peroxide is used. Caution must be utilized when using Fenton's Reagent to remediate a site as the reaction of hydrogen peroxide with ferrous iron is a very aggressive chemical reaction. Because of the low pH requirement, Fenton's Reagent treatment is not effective at sites with limestone geology.

Permanganate

Permanganate is a chemical oxidant that can be used to destroy organic compounds in soil and groundwater and has successfully been used to treat MTBE and chlorinated solvents. Permanganate is generally not used for remediation of petroleum sites because of its inability to oxidize benzene.

It can be used over a wide range of pH values and does not require a catalyst. Permanganate tends to remain in the subsurface for a long time, allowing for more contaminant contact and the potential of reducing rebound. As permanganate oxidizes organic materials, manganese oxide forms as a dark brown to black precipitate. It does not normally produce heat, steam, vapors or associated health and safety concerns. If bioremediation is planned as a polishing step, permanganate will have an adverse effect on microbial activity and may cause a change in microbe distribution. Overcoming natural oxidant demand can be a major challenge for permanganate which in part explains why it works well at some sites and not as well at other sites.

Ozone

One of the stronger oxidants, ozone can be applied as a gas or dissolved in water. It has an oxidation potential about 1.2 times greater than hydrogen peroxide. As a gas, ozone can degrade several chemicals directly in both the dissolved and pure forms, and it provides an oxygen-rich environment for contaminants that degrade under aerobic conditions. It is capable of oxidizing BTEX constituents, PAHs, and MTBE (with limited effectiveness). Ozone may require longer injection times than other oxidants, and vapor control equipment may be needed at the surface. Because of its fast reactivity, ozone is not appropriate for slow diffusion into low-permeability soil as it will be spent before it can diffuse.

Ozone, a gas, is typically generated on-site using a membrane filtration system and typically delivered to the subsurface through sparge wells. Delivery concentrations and rates vary, however, because of the high reactivity of ozone and associated free radicals. Ozone needs to be generated near the treatment area, and sparge wells need to be spaced closely in the target remedial zone.

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Persulfate

Persulfate is a strong oxidant with a higher oxidation potential than hydrogen peroxide. Persulfate reaction is slow unless placed in the presence of a catalyst, such as ferrous iron, or heated to produce sulfate free radicals that are highly reactive and capable of degrading many organic compounds. At temperatures above 40 °C, persulfate becomes especially reactive and can degrade most organics. Persulfate can be activated in the presence of base conditions (pH 12). The aquifer can be made basic by the addition of a strong alkali hydroxide such as potassium or sodium hydroxide. Persulfate activation decreases as the pH falls (from 12) but does not stop even at a pH of 8. Overcoming natural oxidant demand can be a major challenge for non-activated persulfate which in part explains why it works well at some sites and not as well at other sites.

Percarbonate

Sodium percarbonate is a chemical oxidant that can be used to destroy petroleum and other organic compounds in soil and groundwater and has successfully been used to treat petroleum hydrocarbons and chlorinated solvents. Sodium percarbonate, when mixed with water, is highly soluble and rapidly releases hydrogen peroxide as a by-product. In the presence of a suitable catalyst (such as dissolved iron), the hydrogen peroxide can react to produce a modified Fenton's chemical reaction. The Fenton's chemical reaction is a highly effective method to degrade synthetic organic compounds, such as petroleum hydrocarbons and organic solvents, into carbon dioxide and water. Delivering hydrogen peroxide to the subsurface by way of dissolving sodium percarbonate in water is highly stable and safe when compared to the issues involved with handling the higher concentration liquid forms of hydrogen peroxide. Sodium percarbonate has approximately the same oxidizing capacity as permanganate.

11.2.6.4 Evaluation

Sampling of dissolved oxygen, redox potential, and pH must be performed on at least a monthly basis to evaluate the effectiveness of chemical oxidant while treatment is on-going. The performance of the chemical oxidation system needs to be determined by the chemistry of soil and groundwater located between, around, and downgradient of oxidant delivery locations rather than in the immediate vicinity of the oxidant delivery points. Conditions inside or in the immediate vicinity of oxidant injection locations have been preferentially altered by chemical oxidation to destroy the petroleum contaminants (i.e. injection of an oxidant and subsequent sampling of that well provides false positives). Therefore, data from these locations are not representative of the subsurface conditions that exist beneath most of the site. To understand the effect the chemical oxidation system is having on the subsurface conditions as a measure of its performance, samples of soil and groundwater shall be collected from alternate locations, if possible. If not practical, then compliance samples shall not be collected until, at a minimum, one (1) month after an oxidant has been injected in the well. Additional sampling may be required to ensure that rebound does not occur at the site when wells used for chemical oxidant injection are also used for compliance sampling. Refer to Chemical Oxidation checklists in Appendix C to evaluate the applicability of this remedy to your site.

11.2.7 Aggressive Fluid Vapor Recovery

Aggressive fluid vapor recovery (AFVR) is sometimes referred to as high vacuum extraction (HVE) or enhanced fluid recovery. Regardless of what you call these systems, they are in effect a mobile version of a Dual Phase Extraction (DPE) system. Generally, they use a vacuum truck or a trailer with mobile equipment. Like DPE, these systems can also include air sparging and soil vapor

extraction (SVE) as part of the mobile system. AFVR can be utilized to remove contaminated groundwater (dissolved phase hydrocarbons), free-phase hydrocarbons (free product), and volatile organic compounds (vapor phase) from the subsurface. A well or series of wells can be used for the removal of groundwater and VOCs from the subsurface.

There are numerous classes of systems ranging from utilizing a high vacuum single-pump system to utilizing traditional groundwater submersible pumps and moderate and high vacuum for extraction of contaminants. The single-pump systems rely on a surface blower to produce a high vacuum/velocity to extract total fluids (water and product) and induce a vacuum on the unsaturated zone simultaneously removing vapor phase hydrocarbons. The more conventional dual-pump system uses a submersible pump to extract soil vapors.

Air injection wells can be utilized where an increase in air flow rates from the extraction wells is required. As the area is de-watered and the water table is lowered, the system induces a vacuum to the subsurface for recovery of volatile organic compounds (VOCs) that are trapped in the vadose zone. The vapor recovery technology is a mobile soil vapor extraction (SVE) system.

Like DPE, this system is often selected because it enhances groundwater and/or product recovery rates, especially in layered, fine-grained soils. The application of AFVR also maximizes the effectiveness of SVE by lowering the water table and therefore increasing air-phase permeabilities in the vadose zone. Like DPE its effectiveness is highly dependent upon permeability of the subsurface soils and the volatility of the contaminants. Refer to Aggressive Fluid Vapor Recovery checklist in Appx C to evaluate the applicability of this remedy to your site.

CHEMICALS TREATED

Petroleum Hydrocarbons

Volatile Organic Compounds (like BTEX)

Chlorinated Solvents

Other VOCs and some SVOCs having physical and chemical characteristics similar to the compounds listed here may also be treated by AFVR.

11.3 Permits and Other Regulatory Requirements

Regardless of the remediation technology selected, the remediation must be performed in accordance with all State and Federal requirements including obtaining permits and authorization where appropriate. For example, the injection of materials (such as oxygen release compounds, petroleum degrading bacteria, nutrients, electron donors, etc.) underground will require approval by the WVDEP Groundwater Program pursuant to the requirements of 47CSR13. The Groundwater Program issues Rule Authorization letters for injection of fluids into the subsurface for several activities. Petroleum contaminated soils are considered a special waste and require WVDEP approval for proper disposal at a landfill. Also, excavations, soil treatment, and other activities related to remediation may require permits from Air Quality, Hazardous Waste, National Pollutant Discharge Elimination System (NPDES), Solid Waste or other sections of the WVDEP in addition to local planning, building, health, or fire departments. The time to process permits can vary from days to months depending on the type of permit, state and local government procedures, and complexity of the site. Any necessary permits must be obtained prior to beginning site remediation. In emergencies, contact the permitting agency for guidance on how to proceed.

11.4 CAP Monitoring Report

Regardless of whether an owner/operator chooses the traditional CAP path or chooses to use a presumptive remedy, it is necessary for them to submit a monitoring report to update the Agency on the status of the remediation activities. At a minimum, the report shall:

- Be complete and concise. It is only expected to consist of approximately four to six pages, including tables and figures, which document analytical results, monitoring well gauging, free product thickness, etc.
- Be submitted quarterly, unless a different time frame is requested by the Agency.
- Describe all work performed for the reporting time frame. It is preferred that this information be provided either in tabular or bulleted form.
- Briefly describe the remediation system operation, if applicable, such as hours of operation, hours of down time, problems encountered, etc. Tabular form is preferred for this information.
- Present tables and figures of both current and cumulative data, with current data highlighted.
- Provide graphs showing cumulative contaminant removal over time shall also be included.
- Propose future activities.

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11.5 CAP Modifications

If CAP monitoring reports indicate that the chosen corrective action is not effective in remediating a site in a timely manner, the Agency may require the owner/operator to modify the CAP. If required, the Agency will provide notice to the tank owner/operator in writing and give the tank owner/operator a minimum of thirty (30) days to propose a CAP modification.

11.6 Public Participation

If the Agency requires a tank owner/operator to submit a CAP or if a presumed remedy is utilized for a site, notice must be provided to the public by a means designed to reach those members of the public directly affected by the release and the planned corrective action. A CAP addendum may also trigger the need for public notice pursuant to 40CFR280.67 for USTs if the addendum proposes a remediation method not previously addressed in the original CAP. Public notice may also be required pursuant to 47CSR10. The methods of public notice may include, but are not limited to, publication in a newspaper of general circulation, posting at the facility, mailing a notice to owners of property affected or potentially affected by contamination from the release and corrective actions. Refer to Appendix G for an example public notice utilized for publication in a newspaper.

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SECTION 12: CORRECTIVE ACTION LEVELS

The soils standard for LAST and LUST sites incorporates a three-tiered approach which has the potential to return sites more quickly to productive use while still being protective of public health and the environment. It must be understood that the soil action levels are applicable to soil contamination only. The presence of free product will require investigation and mitigation. The presence of contaminated soils in close proximity to groundwater and/or groundwater contamination will require investigation and mitigation.

The Tier 1 level is the most conservative of the three tiers. The default action level for a site will always be the more conservative Tier 1 action level. Tiers 2 and 3 consider the depth of the contamination at a site and potential limiting conditions such as preferential pathways. There are two depth ranges (0 to 8' and greater than 8') for Tiers 2 and 3. Tier 2 provides action levels at the multiple depth ranges for residential land usage. Residential land usage as defined in the VRP rule (60CSR3-2) means "any real property or portion thereof which is used for housing human beings. This term includes property used for schools, day care centers, nursing homes, or other residential style facilities or recreation areas." Tier 3 may be utilized for determining compliance with the soil action levels when a site meets requirements described in Section 12.4.3 and the property owner has agreed to place a deed restriction on the property appropriately restricting its use to non-residential. The deed restriction must remain on the property until the site is remediated or otherwise meets the residential soil action levels. The use of a deed restriction does not provide relief from the requirement to fully delineate both the soil and groundwater contamination at the site. Furthermore, a deed restriction offers no relief for contaminated groundwater. Under the LUST/LAST programs, groundwater must be remediated to the groundwater standard as mandated by 47 CSR 12 prior to issuance of a No Further Action letter by WVDEP.

For the regulated community's convenience due to the prevalence of petroleum USTs and ASTs in WV, the analytical parameters required for various petroleum products are listed in Tables 1-3. Be advised these are typical analytical parameters; however, the WVDEP may require additional analytical parameters based upon specific site situations as is necessary to properly protect public health and the environment. Please contact a TCAU PM if you have questions about analysis of specific contaminants at a specific site.

Table 1. Gasoline¹ Analytical Parameters

Chemical ²	Analytical Method ³
Benzene	SW 846 8260
Toluene	SW 846 8260
Ethylbenzene	SW 846 8260
Xylenes (total)	SW 846 8260
Tertiary butyl alcohol (TBA)	SW 846 8260
Methyl tertiary butyl ether (MTBE)	SW 846 8260
Lead ⁴	SW846 6010

¹Includes leaded gasoline, unleaded gasoline, aviation gasoline, jet fuel, racing fuel, etc.

² Soil sampling protocol for BTEX, MTBE, & TBA must follow the requirements of SW846 Method 5035.

³Use the most recently promulgated version of the SW 846 method

⁴Lead must be analyzed in addition to the other parameters listed in the table for leaded gasoline.

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Table 2. Diesel, Kerosene, and Refined Oils¹ Analytical Parameters

Chemical²	Analytical Method³
Benzene	SW 846 8260
Toluene	SW 846 8260
Ethylbenzene	SW 846 8260
Xylenes (total)	SW 846 8260
PAHs	SW 846 8270
Lead ⁴	SW846 6010
Arsenic ⁴	SW846 6010
Barium ⁴	SW846 6010
Cadmium ⁴	SW846 6010
Chromium ⁴	SW846 6010
Mercury ⁴	SW846 7474
Selenium ⁴	SW846 6010
Silver ⁴	SW846 6010

¹Includes diesel, kerosene, fuel/heating oil, lubricating oils, and used oils

²Soil sampling protocol for BTEX must follow the requirements of SW846 Method 5035.

³Use the most recently promulgated version of the SW 846 method

⁴For used oil, metals must be analyzed in addition to the other parameters listed in the table. Additional request for ethylene glycol or a chlorinated solvent scan may be made on a site-by-site basis.

Table 3. Crude Oil, Brine, Produced Fluids¹ Analytical Parameters

Chemical²	Analytical Method³
Benzene	SW 846 8260
Toluene	SW 846 8260
Ethylbenzene	SW 846 8260
Xylenes (total)	SW 846 8260
PAHs	SW 846 8270
Chloride	SW846 9056

¹Includes crude oil, brine, produced fluids, condensates, etc.

²Soil sampling protocol for BTEX must follow the requirements of SW846 Method 5035.

³Use the most recently promulgated version of the SW 846 method

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Two methods are available for determining compliance with the soil action levels and groundwater standards: direct comparison and statistical evaluation. The direct comparison is the preferred method. However, the Agency recognizes the usefulness in using statistical evaluations in certain conditions, such as when most samples are well within action levels.

12.1 Direct Comparison

When using direct comparison as the method for determining compliance with the soil action level or groundwater standard, the test results for each sample is compared to the soil action level or the groundwater standard. If even one (1) sample exceeds the soil action level or the groundwater standard, the site does not meet the requirements for a No Further Action (NFA) determination by WVDEP. Direct comparison can only be used at sites where there is documented, reliable information that the compliance monitoring samples have been taken from locations where the contamination is most likely to be present.

12.2 Statistical Evaluation

The ninety-five percent upper confidence level (UCL) of the arithmetic mean (95% UCL) is an option to demonstrate compliance. The 95% UCL is a value that when repeatedly calculated for randomly drawn subsets of the sample size from a population, equals or exceeds the population arithmetic mean 95% of the time. The arithmetic mean is calculated by adding up all the numbers in the data set and dividing the result by the total number of data points.

Under ideal conditions, a minimum of ten (10) samples are recommended to perform a 95% UCL calculation. The strength of the data set is an important concept when determining the 95% UCL; therefore, the data set size needs to be as large as practical to properly represent the distribution of concentration levels to ensure the reliability of the data. WVDEP may require additional samples to increase the strength of the data set.

Several calculation methods could be utilized in determining the 95% UCL; however, the WVDEP recommends the use of ProUCL for calculating the 95% UCL. ProUCL is free software available from EPA at:

<http://www.epa.gov/land-research/proucl-software>

If utilizing a method other than ProUCL, it will be necessary to submit documentation regarding the calculation method and how it is applicable for use with the given data set.

STATISTICAL EVALUATION

**MUST USE the
ARITHMETIC MEAN**
in calculating the 95% UCL

Arithmetic Mean vs Geometric
Mean

The arithmetic mean is used when the individual data points are independent of each other and the geometric mean is use when the individual data points are dependent on the previous data points.

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12.2.1 Handling Data with Non-Detects

Proper delineation of a release will result in some non-detect analytical results. These results may be utilized in calculating a 95% UCL if the following apply:

- The data is from within the release area.
- The data is from an area immediately down-gradient of the release area.
- No data from up-gradient areas or other areas outside of the release area and associated plume area may be utilized in calculating a 95% UCL.

If the data set contained non-detect results, typically one-half (1/2) of the lab reporting limit was used in place of the non-detect. The current best practice is to use statistical methods like employed in ProUCL to handle the non-detect results. If ProUCL is not used, a similar statistical method to address non-detect is recommended to be utilized. Alternatively, the lab reporting limit, not the minimum detection limit, must be utilized for the data if not using ProUCL.

12.2.2 Handling Data Outliers

Outliers are important to consider when evaluating the distribution of chemical concentrations in the environment and an analysis for statistical outliers can be performed as part of the evaluation of a 95% UCL data set. It is important to remember that statistical outliers identified represents site conditions. If the statistical outlier is removed from 95% UCL data set, the area with the elevated concentrations will need to be addressed through remediation.

12.2.3 Statistical Evaluation Considerations for Soil

There are multiple considerations when demonstrating compliance with a soil action level through a statistical evaluation of soil samples:

- The upper 95th percentile confidence limit on the arithmetic mean concentration at the site must be less than the soil action level.
- No more than 20% of the samples can exceed the soil action level.
- No single soil sample in the zero to 8-foot depth range (0-8') can be greater than two (2) times the soil action level for soils.
- No single soil sample in the greater than 8-foot depth range can be greater than three (3) times the soil action level for soils.
- If there are duplicate or replicate samples, both sample results must not be included in the data set for 95% UCL as that would impart a bias due to double counting. In this case, the higher value for each analyte of the two samples shall be used.

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- Sample results being compared to soil action levels specific to a certain depth must be gathered from the specified depth. For example, a sample gathered at >8 ft. cannot be compared to the <8 ft. standard.

12.2.4 Statistical Evaluation Considerations for Groundwater

There are multiple considerations when demonstrating compliance with a groundwater standard through a statistical evaluation of groundwater samples:

- The upper 95th percentile confidence limit on the arithmetic mean concentration at the site must be less than the groundwater standard.
- No single groundwater sample can be greater than twenty percent (20%) of the groundwater standard.
- Can only be used on sites when there is a steady-state or diminishing groundwater plume.
- If there are duplicate or replicate samples, the complete sample results for both samples shall not be included in the data set for 95% UCL as that would impart a bias due to double counting. In this case, the higher value for each analyte out of the two samples must be used.
- When utilizing statistical evaluation for groundwater samples:
 - ❖ The last quarter of data in all wells must be below the groundwater standard; and,
 - ❖ As previously noted, a minimum of ten (10) samples are recommended to perform a 95% UCL calculation of which at least four (4) consecutive quarters of monitoring data from the specific well in question must be used in the evaluation. Additional quarters of data may be necessary if the data is highly inconsistent.
 - ❖ If a monitoring well is replaced during the compliance monitoring timeframe, there must be at least four (4) consecutive quarters of monitoring data from that well (i.e. you cannot use two (2) quarters of data from an existing well, replace the well and then use two (2) quarters of data from the replacement well).

DUPLICATE SAMPLES

The highest data value from the original sample or the duplicate shall be used in calculation the 95% UCL, but the complete data from both samples must not be used.

Example:

Original BTEX sample:

B 0.150 mg/kg
T 0.500 mg/kg
E 0.555 mg/kg
X 1.000 mg/kg

Duplicate sample:

B 0.185 mg/kg
T 0.450 mg/kg
E 0.750 mg/kg
X 1.190 mg/kg

USE for 95% UCL

B 0.185 mg/kg
T 0.500 mg/kg
E 0.750 mg/kg
X 1.190 mg/kg

This applies to both soil and groundwater samples.

12.3 Groundwater Standard

The primary objective of a groundwater investigation is to determine whether the concentrations of chemicals constituents exceed regulatory limits as specified under West Virginia’s Requirements Governing Groundwater Standards (Legislative Rule 47CSR12). The cleanup levels identified for groundwater will be specific to the source of contamination (i.e. only chemicals associated with the release will be evaluated for to determine compliance with the standards). Cleanup levels for chemical constituents beyond those specifically codified in 47CSR12 will be established as needed.

Post remediation sampling shall be performed and shall meet a minimum of four (4) quarters at or below applicable standards prior to the issuance of a “No Further Action” (NFA) status for the site.

Refer to Appendix H for a full listing of the chemicals of concern found in the WV Groundwater Standard (47CSR12), the Federal Drinking Water Standards, and the Voluntary Remediation *de minimis* Table (60-3B). For the regulated community’s convenience due to the prevalence of petroleum USTs and ASTs in WV, the groundwater standards/action levels most typically associated with petroleum are listed below.

STANDARDS / ACTION LEVELS

Groundwater Standards (GW) and Federal Drinking Water Standards are established in State and Federal law. To receive a “No Further Action” (NFA) for a release impacting GW, these **Standards must be met.**

Many chemicals do not have a GW or Drinking Water standard; however, they may still pose an environmental or health risk and will be evaluated as appropriate for a site/release.

Table 4. Groundwater Standard/Action Levels for Common Contaminants

Contaminant	Analytical Method ¹	Concentration (ug/l)
Benzene ²	SW846 8260	5
Toluene ²	SW846 8260	1000
Ethylbenzene ²	SW846 8260	700
Xylenes (total) ²	SW846 8260	10,000
Methyl tertiary butyl ether ³	SW846 8260	40
TBA ³	SW846 8260	360
Benzo (a) pyrene ²	SW 846 8270	0.2
Lead ²	SW846 6010	15

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Arsenic ²	SW846 6010	10
Barium ²	SW846 6010	2000
Cadmium ²	SW846 6010	5
Chromium ²	SW846 6010	100
Mercury ²	SW846 7474	2
Selenium ²	SW846 6010	50
Silver ²	SW846 6010	100
Chlorides ²	SW846 9056	250,000

¹Use the most recently promulgated version of the SW 846 method

²Federal Drinking Water Standard (Primary and Secondary standard) and/or WV Groundwater Standard

³ EPA Drinking Water Advisory (1997)

12.4 Soil Action Levels

12.4.1 Derivation of Soil Action Levels

Many LAST/LUST sites are petroleum sites; therefore, special emphasis was placed on development of soil action levels related to petroleum contamination. The TCAU PM shall be contacted for guidance when volatile chemicals, other than those shown in the Tier 1, 2, and 3 tables, are encountered. Additional soil action levels will be developed on a case by case basis. Please contact a TCAU PM if you have questions about a soil action level for a contaminate not listed in this section. The Tier 2 and Tier 3 action level for soils considers the depth of the contamination at a site in determining clean up criteria. There are two depth ranges, the first is zero to eight feet and the second is greater than eight feet.

While the action levels have their scientific basis in risk assessment calculations, the resulting action levels presented in Tables 5, 6, and 7 are numeric standards to be used in the LAST/LUST programs. It is important to recognize that the Tier 2 and Tier 3 action levels are based on a number of site assumptions that must be considered. If there are any on-property buildings or adjacent off-property buildings (current or proposed) that are within proximity distance (30 foot laterally or 5 feet vertically for petroleum contaminants) of the contaminated area, then potentially limiting factors must be considered for Tier 2 and Tier 3 levels. If contamination is not located within the above referenced proximity distances, then limiting factors are not an issue for the site. (Note: Consideration of limiting factors only applies to action levels that were derived based upon vapor intrusion as the more conservative exposure pathway. Limiting factors do not have to be considered for action levels where dermal contact and/or ingestion were determined to be the most conservative exposure pathway. For the common petroleum contaminants, the following action levels were based on vapor intrusion exposure pathways: benzene, toluene, ethylbenzene, naphthalene, and MTBE). There must be a minimum of 5-foot of vertical separation between contamination and a receptor (i.e. person, house, etc.) utilizing a soil similar to silt loam or one with less hydraulic conductivity than silt loam to utilize the Tier 2 or Tier 3 standard for certain volatiles. See the flowchart and associated instructions in Appendix A for additional information.

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Limiting factors, if present, at the site could preclude the use of the LUST/LAST Tier 2 or Tier 3 soil action level until remedial activities are taken at the site. Alternatively, site contamination may be addressed by entering the site into one of the WVDEP risk-based programs (UECA or VRP).

Limiting factors can include preferential pathways, significant foundation openings in buildings, and soil lithology.

- *Preferential Pathways* – A preferential pathway is a natural or man-made feature that enhances vapor migration from a potential vapor intrusion source to or into an inhabited building. Utility corridors are an example of a preferential pathway common to most sites. To exclude a subsurface feature as a preferential pathway, soil between the subsurface feature and the building foundation within the distances specified above must consist of acceptable soil or soil-like material with a hydraulic conductivity similar to or less than silt loam. If a subsurface feature cannot be excluded as a preferential pathway, remedial activities will need to be taken prior to requesting an NFA letter.
- *Significant Foundation Openings* – A significant foundation opening is a breach in a building foundation or basement wall that may amplify the entry of subsurface vapors. Examples of a significant foundation opening may be a dirt floor, a large opening in the basement wall or floor, or an unsealed sump. Typical cracks, gaps, and utility line penetrations on their own are generally not considered to be significant openings. In fact, all foundations, even new ones, will have these minor openings which will permit the ingress of some vapors if a source is close to a building foundation. If a preferential pathway does not exist, then significant foundation openings will not be a limiting factor. If significant foundation openings are sealed, then they will no longer be a limiting factor. If a significant foundation opening cannot be corrected, then remedial activities will need to be taken prior to requesting an NFA letter.
- *Soil-like Material and Soil Lithology* –The general soil lithology in the area of contamination for a Tier 2 or Tier 3 site must be at least a silt loam or a soil type like silt loam or one with less soil saturated hydraulic conductivity. The general soil lithology must NOT be gravel, sand, or similar materials having a soil saturated hydraulic conductivity greater than silt loam. Soil used for backfilling must be silt loam or one with a less soil saturated hydraulic conductivity and have a minimum depth of 5 (five) feet to utilize Tier 2/3 soil action levels.

A flowchart and instructions (refer to Appendix A) has been created to assist the tank owner/operator in submitting specific information. Related to the above referenced action levels. It contains information necessary for the Agency to determine if a “No Further Action” status is warranted when applying the Tier 2 or Tier 3 action levels.

12.4.2 Tier 1 Action Level

The Tier 1 level is the most protective and is the default action level for all sites regardless of depth of contamination. The calculations assumed a sandy loam soil type and contamination was within six (6) inches of a residence. The Tier 1 soil action levels most typically associated with petroleum releases are listed in Table 5.

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Table 5. Tier 1 Soil Action Levels for Common Contaminants of Concern

Contaminant	Analytical Method¹	Action Level (mg/kg)
Benzene	SW 846 8260 ²	0.130
Toluene	SW 846 8260 ²	44
Ethylbenzene	SW 846 8260 ²	2.0
Xylenes (total)	SW 846 8260 ²	5.2
Tertiary butyl alcohol (TBA)	SW 846 8260 ²	1400
Methyl tertiary butyl ether (MTBE)	SW 846 8260 ²	25
Acenaphthene	SW 846 8270	4100
Acenaphthylene	SW 846 8270	4200
Anthracene	SW 846 8270	23000
Benzo(a)anthracene	SW 846 8270	1
Benzo(a)pyrene	SW 846 8270	1
Benzo(b)fluoranthene	SW 846 8270	1
Benzo(g,h,i)perylene	SW 846 8270	1800
Benzo(k)fluoranthene	SW 846 8270	1
Chrysene	SW 846 8270	1
Dibenz(a,h)anthracene	SW 846 8270	1
Fluoranthene	SW 846 8270	2400
Fluorene	SW 846 8270	2900
Indeno(1,2,3-cd)pyrene	SW 846 8270	1
Naphthalene	SW 846 8270	4.1
Phenanthrene	SW 846 8270	23000
Pyrene	SW 846 8270	2300
Lead	SW846 6010	400
Arsenic ⁵	SW846 6010	18
Barium	SW846 6010	15000
Cadmium	SW846 6010	37
Chromium ³	SW846 6010	120000
Mercury ⁴	SW846 7474	3.1
Selenium	SW846 6010	390
Silver	SW846 6010	390
Chloride	SW846 9056	1000

¹Use the most recently promulgated version of the SW 846 method

² Sampling method must utilize SW846 5035

³ Assumes Chromium III

⁴ Assumes inorganic Mercury

⁵ Background level in WV

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12.4.3 Tier 2 Action Level

The Tier 2 level considers the depth of the contamination and is appropriate for residential sites if limiting factors do not exist or have been mitigated. If the depth of a sample is not known, it will be assumed that the depth is in the zero to eight-foot (0-8') range. Vapor intrusion rates for Tier 2 were calculated assuming silt loam soil. The Tier 2 action levels most typically associated with petroleum releases are listed in Table 6.

Table 6. Tier 2 Soil Action Levels for Common Contaminants of Concern

Contaminant	Analytical Method ¹	Action Level Depth (0-8 ft) (mg/kg)	Action Level Depth (>8 ft) (mg/kg)
Benzene	SW 846 8260 ²	0.75	5.0
Toluene	SW 846 8260 ²	44	44
Ethylbenzene	SW 846 8260 ²	6.2	46
Xylenes (total)	SW 846 8260 ²	260	260
Tertiary butyl alcohol (TBA)	SW 846 8260 ²	1400	42000
Methyl tertiary butyl ether (MTBE)	SW 846 8260 ²	40	50
Acenaphthene	SW 846 8270	4100	70000
Acenaphthylene	SW 846 8270	4200	80000
Anthracene	SW 846 8270	23000	700000
Benzo(a)anthracene	SW 846 8270	1	88
Benzo(a)pyrene	SW 846 8270	1	4.3
Benzo(b)fluoranthene	SW 846 8270	1	43
Benzo(g,h,i)perylene	SW 846 8270	1800	33000
Benzo(k)fluoranthene	SW 846 8270	1	430
Chrysene	SW 846 8270	1	4300
Dibenz(a,h)anthracene	SW 846 8270	1	4.3
Fluoranthene	SW 846 8270	2400	44000
Fluorene	SW 846 8270	2900	62000
Indeno(1,2,3-cd)pyrene	SW 846 8270	1	43
Naphthalene	SW 846 8270	4.1	25
Phenanthrene	SW 846 8270	23000	700000
Pyrene	SW 846 8270	2300	66000
Lead	SW846 6010	400	1000
Arsenic ⁵	SW846 6010	18	35
Barium	SW846 6010	15000	400000
Cadmium	SW846 6010	37	980
Chromium ³	SW846 6010	120000	1000000
Mercury ⁴	SW846 7474	3.1	3.1
Selenium	SW846 6010	390	12000
Silver	SW846 6010	390	12000
Chloride	SW846 9056	1000	1000

¹Use the most recently promulgated version of the SW 846 method

² Sampling method must utilize SW846 5035

³ Assumes Chromium III

⁴ Assumes inorganic Mercury

⁵ Background level in WV

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12.4.4 Tier 3 Action Level

Because of the nature of the LAST/LUST programs use of numeric standards versus risk-based standards, the flexibility offered using the Tier 3 action level is limited but can have applicability to some sites. Vapor intrusion calculations for Tier 3 were calculated assuming silt loam as the soil type and the site is non-residential. The risk-based programs (VRP and UECA) will offer far more flexibility for nonresidential properties and may be considered by an owner/operator.

Within the LAST/LUST program, a Tier 3 action level for soils may be utilized for certain sites if they meet the following criteria:

- Contamination is limited to soil contamination only (i.e. no groundwater contamination) and the contaminated soil is not in close proximity (within 10 feet) of the groundwater table.
- The soil contamination does not extend offsite.
- The soil contamination is not located within thirty (30) feet of the current property borders.
- The site is currently zoned in a manner that prohibits any residential usage of the property. Documentation of zoning will have to be provided along with draft language submitted for the deed restriction.
- The property owner is willing to place a deed restriction on the property that includes the following:
 - Restricts the property from residential usage until the contamination on the property subject to the restriction is remediated to the Tier 1 or Tier 2 action levels.
 - Prevents the property from being divided up in such a manner that would allow the soil contamination subject to the restriction to be within thirty (30) feet of the property border.

If utilizing the Tier 3 soil action level, a copy of the zoning for the site and draft language for the deed restriction must be provided to Agency. The language in the deed restriction must be reviewed and approved by the Agency to utilize the restriction. Failure to provide an acceptable deed restriction will prevent usage of the Tier 3 soil action level.

If the depth of a sample is not known, it will be assumed that the depth is in the zero to eight-foot (0-8') range. The Tier 3 soil action levels most typically associated with petroleum releases are listed in Table 7.

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Table 7. Tier 3 Soil Action Levels for Common Contaminants of Concern

Contaminant	Analytical Method¹	Action Level Depth (0-8 ft) (mg/kg)	Action Level Depth (>8 ft) (mg/kg)
Benzene	SW 846 8260 ²	5.0	57
Toluene	SW 846 8260 ²	44	820
Ethylbenzene	SW 846 8260 ²	46	280
Xylenes (total)	SW 846 8260 ²	260	260
Tertiary butyl alcohol (TBA)	SW 846 8260 ²	42000	42000
Methyl tertiary butyl ether (MTBE)	SW 846 8260 ²	50	2300
Acenaphthene	SW 846 8270	70000	70000
Acenaphthylene	SW 846 8270	80000	80000
Anthracene	SW 846 8270	700000	700000
Benzo(a)anthracene	SW 846 8270	88	88
Benzo(a)pyrene	SW 846 8270	4.3	4.3
Benzo(b)fluoranthene	SW 846 8270	43	43
Benzo(g,h,i)perylene	SW 846 8270	33000	33000
Benzo(k)fluoranthene	SW 846 8270	430	430
Chrysene	SW 846 8270	4300	4300
Dibenz(a,h)anthracene	SW 846 8270	4.3	4.3
Fluoranthene	SW 846 8270	44000	44000
Fluorene	SW 846 8270	62000	62000
Indeno(1,2,3-cd)pyrene	SW 846 8270	43	43
Naphthalene	SW 846 8270	25	25
Phenanthrene	SW 846 8270	700000	700000
Pyrene	SW 846 8270	66000	66000
Lead	SW846 6010	1000	1000
Arsenic	SW846 6010	35	35
Barium	SW846 6010	400000	400000
Cadmium	SW846 6010	980	980
Chromium ³	SW846 6010	1000000	1000000
Mercury ⁴	SW846 7474	3.1	3.1
Selenium	SW846 6010	12000	12000
Silver	SW846 6010	12000	12000
Chloride	SW846 9056	1000	1000

¹Use the most recently promulgated version of the SW 846 method

² Sampling method must utilize SW846 5035

³ Assumes Chromium III

⁴ Assumes inorganic Mercury

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