Bureau of Underground Storage Tank Regulations

Technical Guidance Manual

For Closure, Corrective Action, and Petroleum Contaminated Soil Rules

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Table of Contents

Tables

Figures

Flow Charts

Appendix

Acronyms

AL(s)	action level(s)
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
BDL	below detection limit
BQL	below quantitation limit
BTEX	benzene, toluene, ethylbenzene, xylene
BUSTR	Bureau of Underground Storage Tank Regulations
CA	corrective action
COC(s)	chemical(s) of concern
CUSTI	Certified Underground Storage Tank Inspector
DWSPA	Drinking Water Source Protection Area
EFR	enhanced fluid recovery
FID	flame ionization detector
FPR	free product recovery
GPS	global positioning system
GUPUS	Generic Unrestricted Potable-Use Standards
HEAST	Health Effects Assessment Summary Tables
HSA	hollow stem auger
IRA	Interim Response Action
IRIS	Integrated Risk Information System
LTTD	low-temperature thermal desorption
MCL	maximum contaminant level
MSDS	material safety data sheet
MTBE	methyl tertiary butyl ether
MW	monitoring well
ND	not detectable
NFA	no further action
NIOSH	National Institute for Occupational Safety and Health
OAC	Ohio Administrative Code
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
Ohio EPA	Ohio Environmental Protection Agency
O/O	owner/operator
ORC	Ohio Revised Code
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
PCS	petroleum contaminated soil
PID	photo ionization detector
PNA	polynuclear aromatic hydrocarbon
POD	point of demonstration
POE	point of exposure
PPM	parts per million
PUSTRCB	Petroleum Underground Storage Tank Release Compensation Board
QA/QC	quality assurance/quality control
RAP	Remedial Action Plan
SB	soil boring
SCEM	site conceptual exposure model
SIR	statistical inventory reconciliation

SSTL	site-specific target level
TGM	technical guidance manual
TPH	total petroleum hydrocarbon
TT	tightness test (tank, system)
UCL	upper confidence limit
USCA	United States Code Annotated
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	underground storage tank
USEPA	United States Environmental Protection Agency
VAP	Voluntary Action Program
VOC	volatile organic compound
WHP	Wellhead Protection Program

1.0 Introduction

The Technical Guidance Manual (TGM) is designed to help owners and operators (O/Os) understand the underground storage tank (UST) closure, corrective action (CA), and petroleum contaminated soil (PCS) processes and provide a discussion of the required activities for complying with the Bureau of Underground Storage Tank Regulations (BUSTR) rules, as stated in Ohio Administrative Code (OAC) 1301:7-9-12, OAC 1301:7-9-13, OAC 1301:7-9-16, and OAC 1301:7-9-17, effective date March 1, 2005. OAC 1301:7-9-02 includes definitions that may be applicable for the previously mentioned BUSTR rules.

OAC 1301:7-9-12 includes rules that address out-of-service, closure-in-place, permanent removal, and change-in-service for USTs. Collectively, these activities are known as closure. Section 2.0, below, identifies the UST systems that BUSTR regulates, describes the process for obtaining a permit for an UST system, and describes the requirements for preparing a Closure Assessment Report.

OAC 1301:7-9-13 includes rules that address the investigation of releases and suspected petroleum releases from UST systems and the required corrective actions for clean-up of a release to appropriate levels. Section 3.0 , below, describes the process of investigating a petroleum release, evaluating source area concentrations in comparison to generic action level (AL) concentrations, determining site-specific target level (SSTL) concentrations, and implementing the appropriate monitoring or remediation activities at an UST site. To protect human health and the environment for the citizens of Ohio, BUSTR uses a risk-based corrective action process to ensure an appropriate investigation and clean-up of releases from UST systems. The information in this TGM is intended to clarify the regulations, to provide examples of how BUSTR interprets certain parts of the regulations, and to assist the O/O in complying with those regulations.

OAC 1301:7-9-16 and 17 include rules that address sampling and management of petroleum contaminated soil (PCS). Section 4.0, below, describes those requirements.

1.1 Owner and/or Operator Applicability

UST regulations OAC 1301:7-9-01 through 1301:7-9-17 (with the exclusion of 1301:7-9-14) are applicable, by statute, to the O/O of UST systems. In addition, OAC 1301:7-9-12 describes the permitting and inspection requirements for any person conducting work on an UST system.

1.1.1 Owner

UST Systems in Service on or After November 8, 1984

For any UST system in use on November 8, 1984 or brought into use after that date, the person who owns the UST system is considered the owner.

UST Systems Taken Out-of-Service Prior to November 8, 1984

In the instance of an UST system in use before November 8, 1984, but no longer in use on that date, the person who owned the UST system immediately before the discontinuation of its use is considered the owner.

If the UST was last used prior to November 8, 1984, the owner is any person who held a legal, equitable, or possessory interest of any kind in the UST system or in the property on which the UST system is located on the date the UST system was last in operation. The definition of owner may include a trust, vendor, vendee, lessor, or lessee.

The term, owner, does not include any person who, without participating in the management of an UST system and without otherwise being engaged in petroleum production, refining, or marketing, holds indicia of ownership in the UST system primarily to protect the person's security interest in it.

If the UST system was in use on or after November 8, 1984, but is no longer located on the property, the owner of the UST system is the person who owned the UST system when it was removed from the ground.

1.1.2 Operator

The person in daily control of, or having responsibility for, the daily operation of the UST system is considered the operator.

1.2 Definition of an UST

An UST is defined as one or a combination of tanks, including the underground piping that is used to contain an accumulation of regulated substances, the volume of which, including the volume of the underground piping, is 10% or more below ground.

As specified in OAC 1301:7-9-02 the following do not meet the definition of an UST and therefore are exempt from closure and corrective action requirements:

- Farm or residential tanks of 1,100 gal. or less capacity used for storing motor fuel for noncommercial purposes;
- Tanks used for storing heating fuel for consumptive use on the premises where stored;
- Pipeline facilities, including gathering lines, regulated under the Natural Gas Pipeline Safety Act of 1968, 82 Stat. 720, 49 USCA 2001 (United States Code Annotated), as amended;
- Surface impoundments, pits, ponds, or lagoons;
- Storm or waste water collection systems (i.e., oil/water separators);
- Flow-through process tanks;
- Storage tanks located in underground areas, including without limitation, basements, cellars, mine workings, drifts, shafts, or tunnels, when the tanks are located on or above the surface of the floor and are visible for inspection on all sides;
- Septic tanks; and
- Liquid traps or associated gathering lines directly related to oil or gas production and gathering operations.

2.0 UST Closure Requirements Under OAC 1301:7-9-12

2.1 Introduction

OAC 1301:7-9-12, often referred to as the Closure Rule, establishes the requirements for USTs that contain regulated substances and that:

- Are out-of-service;
- Have been closed-in-place;
- Have been permanently removed; or
- Have undergone a change-in-service.

The Closure Rule also addresses closure assessments and permitting.

2.1.1 Removal Requirements

The Ohio Fire Code OAC 1301:7-7-28 requires that any underground tank that contains a flammable or combustible liquid and has not been used for a period of one year or longer, be removed from the property.

In some instances, if the appropriate fire official or safety inspector determines that the removal is not necessary, that official can allow the tank to be closed-in-place. (See Section 2.3.4, Closure-in-Place.) **The O/O must comply with the entire Closure Rule. Any person not defined as the O/O, who holds a legal, possessory, or equitable interest in a parcel of real property on which an UST system is located, must comply with the Closure Rule, except for the closure assessment and reporting requirements. Any person or contractor performing work on the UST system must obtain a permit for the work and have a Certified Installer and an UST Inspector present when work is being performed.**

For example, a property owner or the person performing the removal must obtain a permit and remove the UST(s), even if that person was not the O/O. However, the property owner would not be required to prepare and submit a Closure Assessment Report.

2.2 Regulated UST Systems and Exemptions

A regulated UST is defined as a tank and the underground piping connected to the tank, which has at least 10% of its volume below ground and contains a hazardous substance (as listed in OAC Rule 1301:7-9-03) or petroleum (as defined in OAC Rule 1301:7-9-02).

All the following regulated UST systems are exempt from the 2005 Closure Rule:

- Any UST system holding hazardous wastes listed or identified under OAC Chapter 3745-51 or a mixture of such hazardous wastes and other regulated substances;
- Any waste water treatment tank system that is part of a waste water treatment facility regulated under Section 402 or 307(B) of the Federal Water Pollution Control Act (33 USCA 1251 and following);
- Equipment or machinery that contains regulated substances for certain operational purposes such as hydraulic lift tanks and electrical equipment tanks;

- Any UST system whose capacity is 110 gal. or less;
- Any UST system that contains a *de minimis* concentration of regulated substances;
- Any emergency-spill or overflow-containment UST system that is emptied expeditiously after use;
- Waste water treatment systems;*
- Any UST system containing radioactive material that are regulated under the Atomic Energy Act of 1954 (42 USCA 2014 and following);*
- Any UST system that is part of an emergency generator system at nuclear power generation facilities regulated by the United States Nuclear Regulatory Commission;*
- Airport hydrant fuel distribution systems; and*
- Any UST systems with field-constructed tanks.*

*Indicates these regulated UST systems are exempt from the Closure Rule but releases from these systems are regulated under the Corrective Action Rule, OAC 1301:7-9-13.

2.3 Closure Options

2.3.1 Out-of-Service for 90 Days or Less

When an operating system is taken out-of-service for 90 days or less, it is considered "temporarily out-of-service". The fill line, gauge opening, and dispensing unit must be secured against tampering. Vent lines must remain open and functioning. BUSTR regulations continue to apply, including the release detection requirements during the temporarily out-of-service period. BUSTR prefers that the system be empty. If the system is empty, then the release detection requirements do not apply. The system is considered empty when regulated substances have been removed so that no more than one inch of residue or 0.3% by volume of the system's capacity remains in the tank. **Neither a closure assessment nor a permit is required** for taking an UST system temporarily out-of-service for 90 days or less.

2.3.2 Out-of-Service for More Than 90 Days

If the UST system is out-of-service for more than 90 days, the UST system must be maintained by performing *all* of the following:

- Empty all contents;
- Leave all vent lines open and functioning;
- Cap and secure all lines, pumps, man-ways, and ancillary equipment; and
- Obtain a permit from the fire marshal or a certified fire safety inspector with delegated authority.

UST systems that are part of a scheduled "seasonal discontinuation" of use are not required to obtain the out-of-service permit if *all* of the following conditions are met:

- The UST system is located at a marina, golf course, amusement park, or other seasonal facility as approved by the fire marshal or the certified fire safety inspector with delegated authority;
- Written approval is obtained from the fire marshal or the certified fire safety inspector with delegated authority;

- The UST system has been maintained in accordance with the requirements for UST systems out-of-service for more than 90 days; and
- The UST system has not been out-of-service for a period exceeding 12 months.

2.3.3 Out-of-Service for More Than 12 Months

If the UST system has been out-of-service for more than 12 months, *one* of the following activities must be conducted:

- The UST system must be permanently removed, changed-in-service, or closed-in-place;
- An extension must be obtained; or
- The system must be placed back into service provided *all* of the following requirements are met:
  - The UST system complies with cathodic protection requirements, as listed in OAC 1301:7-9-06 and 1301:7-9-08;
  - The UST system passes a tightness test, as described in OAC 1301:7-9-07;
  - The UST system is compliant with all registration and financial responsibility requirements, as listed in OAC 1301:7-9-04 and 1301:7-9-05; and
  - The fire marshal has not issued an order prohibiting the UST system from being placed back into service.

A closure assessment and Closure Assessment Report must be submitted to BUSTR as described in Section 2.5, Closure Assessment, below. (See Figure 2.2 for an example of boring/ monitoring well (MW) placement.)

2.3.4 Closure-in-Place

Only the fire marshal or a delegated authority may grant permission for all or part of an UST system to be closed-in-place. The Certified Underground Storage Tank Inspector (CUSTI) **does not** have the authority to approve closure-in-place. If approved, the UST system must be closed-in-place in accordance with American Petroleum Institute (API) Standard 1604-01: *Closure of Underground Petroleum Storage Tanks*. The system must also be cleaned and filled with a solid inert material with a density that is greater than the density of water (e.g., concrete slurry mix).

A closure assessment and Closure Assessment Report must be submitted to BUSTR as described in Section 2.5, Closure Assessment, below. (See Figure 2.2 for an example of boring/ MW placement.)

2.3.5 Permanent Removal and Replacement

When an UST system or any part of an UST system is removed from the ground, *all* the following must be completed:

- Obtain a permit prior to removal;
- Remove all portions of the UST system from the ground unless prior approval for closure-in-place has been granted from the fire marshal or a certified fire safety inspector with delegated authority;
- Clean and remove the UST system according to *all* of the following applicable standards:
  - API Recommended Practice 1604-01: *Closure of Underground Petroleum Storage Tanks;*

  - API Publication 2015-2001: *Safe Entry and Cleaning Petroleum Storage Tanks; and*
  - National Institute for Occupational Safety and Health (NIOSH): *Criteria for a Recommended Standard for Working in Confined Space.*
- Once empty and clean, monitor the UST to ensure that explosive vapors do not accumulate above a level that creates a hazardous or unsafe condition;
- Ensure that the UST system is free of residue and liquid, is rendered unusable, and is free of explosive vapors before the UST leaves the site; **no UST may be reused for any purpose unless written approval is obtained from the fire marshal prior to the removal activity;**
- Remove all backfill from the tank cavity excavation, piping trenches, and dispensing unit areas; handle according to PCS rules (OAC 1301:7-9-16 and 17); (See Section 4.0 for PCS re-use action levels); and
- Remove no more than 1 ft. of native soil from the sidewalls, bottom of the tank cavity excavation, piping trenches, and dispensing unit areas.

A closure assessment and Closure Assessment Report must be submitted to BUSTR after removing all or part of the UST system. The UST system may be replaced prior to completion of the closure report, but not before the closure assessment has been completed. Replacing the old system with a new system does not relieve the O/O from complying with closure and CA regulations.

2.3.6 Change-in-Service

A *change-in-service* means that the substance stored in the UST system has been changed from a regulated to a non-regulated substance (e.g., gasoline to water). The UST must be completely emptied and cleaned. All piping and ancillary equipment that is not part of the change-in-service must be closed-in-place or removed in accordance with the Closure Rule. Additionally, a minimum of three soil boring/MWs must be installed in the areas most likely to contain concentrations of chemicals of concern (COCs) and a Closure Assessment Report must be submitted. (See Appendix A, Data Collection.)

A closure assessment and Closure Assessment Report must be submitted to BUSTR as described in Section 2.5, Closure Assessment, below. (See Figure 2.2 for an example of boring/ MW placement.)

2.4 Permitting

2.4.1 Permit Requirements

A permit must be obtained by any person performing the following activities for UST systems:

- Out-of-service for more than 90 days;
- Closure-in-place;
- Permanent removal and/or replacement;
- Change-in-service;
- A *major repair* on a portion of the UST system that has caused a release; or
- A *modification* of an UST system or component that has not caused a release.

A *major repair* includes the restoration, modification, or upgrading of a tank or an UST system, but does not include routine maintenance or normal operational upkeep to prevent an UST system from releasing a product. Major repairs are always associated with a reportable release. A *modification* includes work performed on UST system components that have not leaked, such as adding, altering, or retrofitting. This includes, but is not limited to, dispenser sumps, vent lines, flexible connectors, leak detection, or UST lining components. The full definition of these terms can be found in OAC 1301:7-9-02.

All permit requirements are included in OAC 1301:7-9-10 and the Closure Rule.
Permits are issued by:

- BUSTR; and
- The local fire department that has delegated authority status.

2.4.2 Notification

Before any of the closure activities listed above takes place, the O/O must notify BUSTR in writing of the intent to perform an UST closure. Filing a permit application with BUSTR satisfies the notification requirement. **If a permit application is filed with a delegated authority, a copy of the permit should be sent to BUSTR and the Bureau of Testing and Registration.** In emergencies, UST removal permits can be issued with fewer than 30 days notice at the discretion of BUSTR or the delegated authority.

2.4.3 Permit Application Process

BUSTR Closure Permits

After receiving a completed permit application, BUSTR will determine and verify that the UST system complies with all applicable BUSTR registration requirements. If the system is not registered, BUSTR may require that the O/O pay previously unpaid registration fees before a permit is issued.

Delegated Authority Closure Permits

If the local fire department has delegated authority in the jurisdiction where the closure will take place, that fire department will issue permits, determine fees, and schedule inspections. However, local fire departments are not required to determine if the UST system complies with BUSTR requirements (e.g., compliance, registration, financial responsibility.) All UST system O/Os should verify compliance before closure work is initiated. Compliance with both BUSTR and the Petroleum Underground Storage Tank Release Compensation Board (PUSTRCB) requirements is crucial in establishing eligibility for reimbursement, if corrective action is required.

Other Permits

In addition to BUSTR requirements, other local, regional, or state regulations may affect the closure process. For example, the Ohio Environmental Protection Agency (Ohio EPA) may require permits for air emissions and water discharges. In addition, local governments may require special permits.

2.4.4 Required On-Site Personnel

A Certified UST Installer and an UST Inspector must be on-site for each of the following activities:

- Out-of-service for more than 90 days;
- Closure-in-place;
- Permanent removal and/or replacement; and
- Change-in-service.

The Certified UST Installer directs all removal activities and directly controls the personnel performing the work on the UST system. The Certified UST Installer does not have the authority to authorize a closure-in-place. Additionally, a Certified UST Installer does not determine the environmental status of the site.

The UST Inspector may be a BUSTR Inspector, an inspector from a delegated authority, or a private CUSTI. The UST Inspector is on-site to document that all potential fire and explosion hazards are properly handled by the Certified UST Installer. **UST Inspectors do not determine the environmental status of the site nor are they in control of on-site personnel**. UST removal activities may only take place if the UST Inspector is on-site.

2.5 Closure Assessment

The O/O must perform a closure assessment if any portion of the UST system is permanently removed (including removals resulting from modifications and major repairs), closed-in-place, changed-in-service, or has been out-of-service for more than 12 months. Sampling required by the Closure Rule determines if a release has occurred, but sampling is not intended to determine the extent of a release.

Modifications do not always require that a closure assessment be conducted. For instance, a closure assessment is not required if cathodic protection is added to the UST system. If any portion of the system is repaired or replaced during a modification, then a closure assessment must be conducted and a Closure Assessment Report submitted to BUSTR.

A closure assessment is not required if the portion of the UST system being closed is already being assessed under the CA rule (OAC 1301:7-9-13(H) through 1301:7-9-13(O)). Contact BUSTR prior to making this determination.

2.5.1 UST Site Characterization

Site History

The site history section of the closure report should describe:

- Historical and current land-use of the site and surrounding properties;
- Previous closures, releases, and suspected releases;
- Date the UST system was last used and by whom, if known;
- Locations of current and former UST systems; and

- Any out-of-service UST systems still existing on the site and the substance(s) stored during their use.

Visual Site Evaluation

A visual site evaluation should identify, but is not limited to, the following:

- Evidence of past or current operational problems, (e.g., surface soil staining, concrete or asphalt staining, or concrete patchwork); and
- Evidence of other sources of site contamination, such areas as where piping and pump islands appear to have existed.

2.5.2 Closure Assessment Sampling Requirements for Field Screening

The following section identifies all locations where field screening samples must be collected during closure activities. Field screening determines which samples must be submitted to the laboratory. (See Appendix A, Data Collection, for sampling and field screening procedures.)

Sample Location for Removal

Soil samples for field screening purposes must be taken at the following locations within 24 hrs. of completing the excavation (see Appendix A, Data Collection, for sampling procedures):

- At both ends of each UST. If the UST is longer than 35 ft., collect an additional sample under the middle of each UST;
- From each side wall of the UST cavity excavation using a ratio of one sample per 100 ft^2. These samples must be biased towards areas with the highest contamination. For instance, if the excavation is 24 ft. wide by 36 ft. long and 13 ft. deep, the total sidewall area of the excavation is 1,560 ft^2. This would require 15.6 samples for field screening (round up to 16). The cavity is then divided into 16 equal sections and sampled. (NOTE: Side wall samples must be collected even if ground water recharges within the excavation, however, the number of soil samples required must be recalculated based on the surface area of soil above the water table);
- Every 10 ft. along piping runs that routinely contain regulated substances unless the sample location is within 2 linear ft. of another sample required in accordance with this section;
- Under every joint, pipe elbow, and flex connector. If multiple joints, pipe elbows, or flex connectors are in a common trench and are located within 2 linear ft. of each other, then only one sample is required;
- Below each dispenser, unless the dispenser is located directly above the tank; and
- Below any remote fill pipe area greater than 10 ft. from the UST cavity.

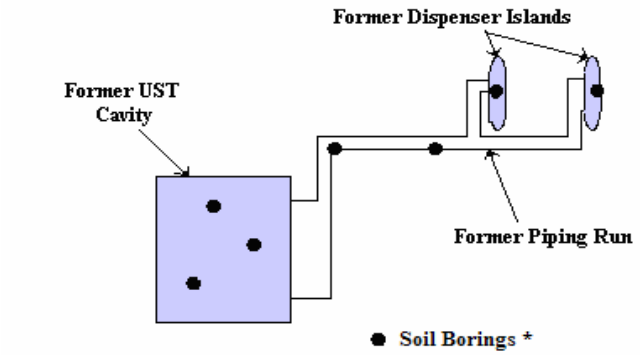
An alternative sampling plan must be submitted by the O/O for BUSTR approval if site conditions (e.g., bedrock) interfere with collecting samples. Such limitations may require the installation and sampling of one or more MWs.

Any water encountered in the excavation must be evacuated. If within 24 hrs. of pumping water out of the excavation, the water recharges, then a ground water sample must be collected. Collect ground water samples from any dispenser and piping trenches or tank cavity areas that contain ground water. If no water recharges within 24 hrs., then only soil sampling is required. (See Appendix A, Data Collection, for sampling procedures.)

Sampling Protocol for Other Closure Activities

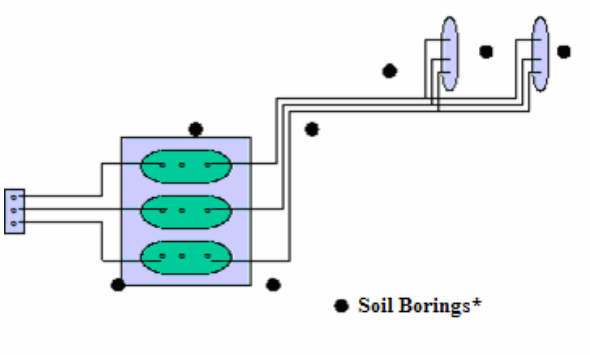
If an UST is closed-in-place or changed-in-service, is out-of-service for more than 12 months, or was previously removed and if a closure assessment was not conducted, then soil and water samples must be collected by installing a sufficient number of soil borings (SBs) to ensure the evaluation of the UST system. Sufficient sampling points must be selected to ensure the evaluation of the areas most likely to contain COCs above ALs. A minimum of three SBs must be converted into MWs. Of the three MWs, at least one must be installed in the former tank cavity and one into the area of the dispensers. (See Appendix A, Data Collection, for SB/MW installation and sampling procedures.) Examples of SB/ MW locations are illustrated below in Figures 2.1 and 2.2.

Figure 2.1 - Closure of a Previously Removed System



* NOTE: a minimum of three SBs must be converted into MWs.

Figure 2.2- Closure-in-Place, Change-in-Service, Systems Out-of-Service for More than 12 Months



*NOTE: a minimum of three SBs must be converted into MWs.

2.5.3 Samples Required for Laboratory Analysis

The following samples must be sent to the laboratory for analysis:

- One sample from each piping trench (including joints, piping elbows, and flex connectors) that has the highest field screening reading; if more than one piping trench is present, additional samples must be submitted;
- One sample from each dispenser island that has the highest field screening reading; if more than three dispensing units are present at the island, an additional sample must be submitted for each multiple or fraction of three dispensing units;
- One sample from each remote fill area that is greater than 10 ft. away from the UST system;
- Two samples from the UST cavity (including side wall samples) that have the highest field screening reading per set of three USTs or fraction thereof in that cavity; for example, if the cavity contained one, two, or three USTs, submit only two samples; if the cavity contained four, five, or six USTs, submit three samples;
- All water samples collected (see Appendix A, Data Collection); and
- Soil stockpile samples according to the volume of the stockpile. (See Table 2.2- Stockpile Sampling.)

If field screening was not conducted, then all samples collected must be submitted for laboratory analysis.

BUSTR requires that the laboratory methods listed in Section 3.7.1, Source Investigation, below, be used for analyzing samples collected during closure assessment activities.

2.5.4 Action Levels for UST Closure

During a closure assessment, COCs are to be selected and analyzed as discussed in Section 3.7.1, Source Investigation, below. Table 2.1- Summary of Closure and Site Check Action Levels provides the ALs applicable to the UST closure. Assume the soil type to be Class 1 soil or submit geotechnical documentation of the soil type that best represents the soil under the UST site. Bedrock is included in the category of Class 1 soil.

For closure assessments, assume that ground water underlying the UST site is a drinking water source and the depth to ground water is less than 15 ft. If the product stored in the UST being closed is in Analytical Group 3, 4, and/or 5, then additional COCs may need to be evaluated. (See Section 3.7.1, Source Investigation.) Action levels for COCs that are not listed in Table 2.1- Summary of Closure and Site Check Action Levels can be derived from the BUSTR Spreadsheets. For chemicals not listed in Table 2.1 or the BUSTR Spreadsheets, ALs must be developed based on the Ohio EPA Division of Emergency Remedial Response (DERR) Voluntary Action Program (VAP) standards listed in OAC 3745-300-08.

Table 2.1- Summary of Closure and Site Check Action Levels

Drinking Water Action Levels*	Chemical of Concern (COC)	Soil Action Levels*		
		Class 1	Class 2**	Class 3**
0.005	Benzene	0.149	0.252	0.937
1.0	Toluene	49.1	70.8	86.0
0.7	Ethylbenzene	45.5	83.0	282.0
10.0	Total Xylenes	15.7	18.0	21.7
0.04	MTBE	0.470	0.788	3.440
0.00026	Benzo(a)anthracene	11.0	11.0	11.0
0.0002	Benzo(a)pyrene	1.1	1.1	1.1
0.00017	Benzo(b)fluoranthene	11.0	11.0	11.0
0.0017	Benzo(k)fluoranthene	110.0	110.0	110.0
0.047	Chrysene	1,100.0	1,100.0	1,100.0
0.0002	Dibenz(a,h)anthracene	1.1	1.1	1.1
0.00022	Indeno(1,2,3-c,d)pyrene	11.0	11.0	11.0
0.14	Naphthalene	39.8	54.0	54.0
-	TPH C_6-C_{12}	1,000.0	5,000.0	8,000.0
-	TPH C_{10}-C_{20}	2,000.0	10,000.0	20,000.0
-	TPH C_{20}-C_{34}	5,000.0	20,000.0	40,000.0

* COC concentrations are expressed in parts per million (ppm).
** The use of soil class two or three during the closure assessment requires geotechnical analysis to confirm the classification.
NOTE: Action levels for additional COCs can be derived from the BUSTR Spreadsheets.

2.5.5 Stockpile Soil Samples

All excavated soil and backfill materials are assumed to be PCS. Handle this soil and backfill material according to OAC 1301:7-9-16 and 17, unless analytical data demonstrates concentrations are less than re-use ALs. (See Section 4.0, Petroleum Contaminated Soil.) Table 2.2- Stockpile Sampling, below, indicates the number of samples that must be field screened and submitted for laboratory analysis. If samples are not field screened, all grab samples must be submitted for laboratory analysis.

Table 2.2- Stockpile Sampling

	Cubic Yards of Soil and Backfill Material Generated				
	<25*	26-100	101-250	251-450	>450
1. Minimum number of grab samples to collect and field screen	3	6	12	18	18 plus 1 sample per each additional 50 yd^3 (or fraction thereof)
2. Minimum number of grab samples to submit to the laboratory	2	3	6	8	8 plus 1 sample per each additional 100 yd^3 (or fraction thereof)

* For excavated soil in containers having a capacity of 55 gal. (0.27 yd^3) or less, one grab sample must be collected from the center at mid-depth of the soil in the container and submitted to the laboratory for analysis.

2.5.6 Closure Assessment Report

Upon completing the closure assessment and within 90 days after collecting the samples, a Closure Assessment Report must be submitted describing the results to BUSTR. A BUSTR Closure Form must be submitted with each closure report. The BUSTR Closure Form, found in Appendix E, Forms, lists all information required to prepare a complete Closure Assessment Report. Although the typical UST O/O hires an environmental consultant to prepare the report, BUSTR holds the O/O (not the consultant) responsible for the report's accuracy and completeness. Therefore, the UST O/O must sign, date, and submit the closure form. Before signing, the O/O should carefully review the report and ask the consultant to explain any unclear issues.

If concentrations of COCs at any location on the UST site are above the ALs, the O/O must conduct corrective actions described in Section 3.0, Corrective Actions, below. If COC concentrations are below ALs and the Closure Assessment Report is technically accurate and complete, then no further action (NFA) is necessary.

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3.0 Corrective Action Requirements Under OAC 1301:7-9-13

3.1 Purpose and Scope

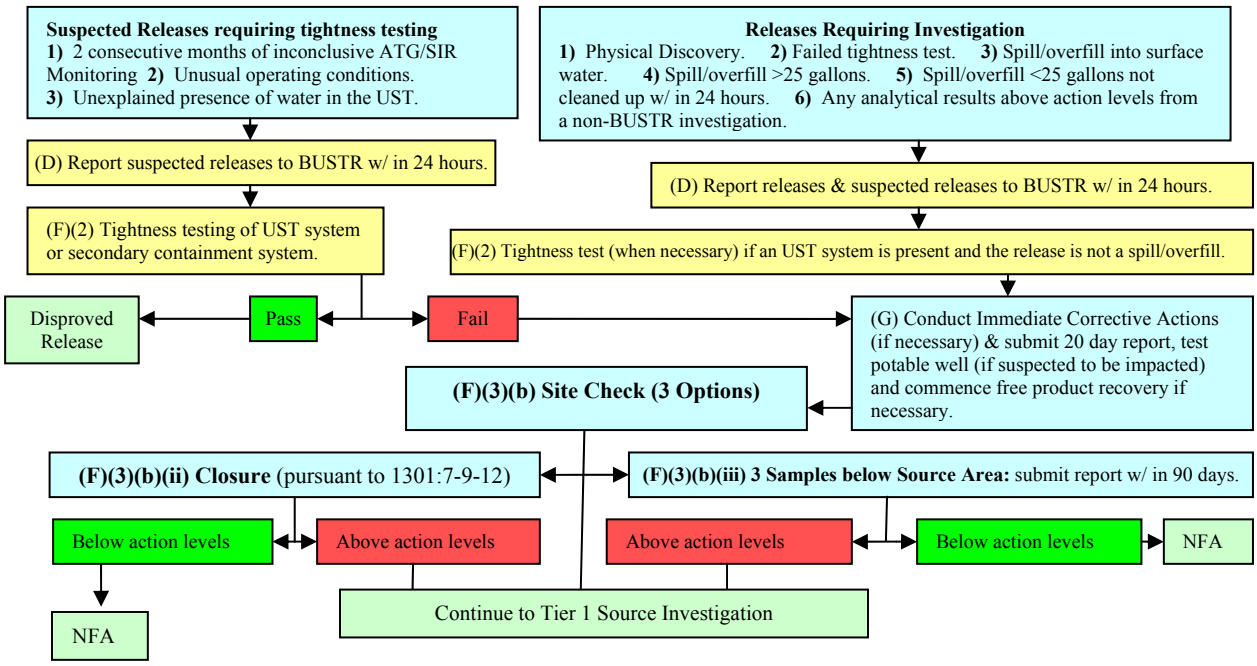
OAC 1301:7-9-13 describes the BUSTR required process for investigating a petroleum release, evaluating source area concentrations in comparison to generic AL concentrations, determining site-specific target level concentrations, and implementing appropriate monitoring or remediation activities at an UST site.

The BUSTR corrective action process described here includes, but is not limited to, the following:

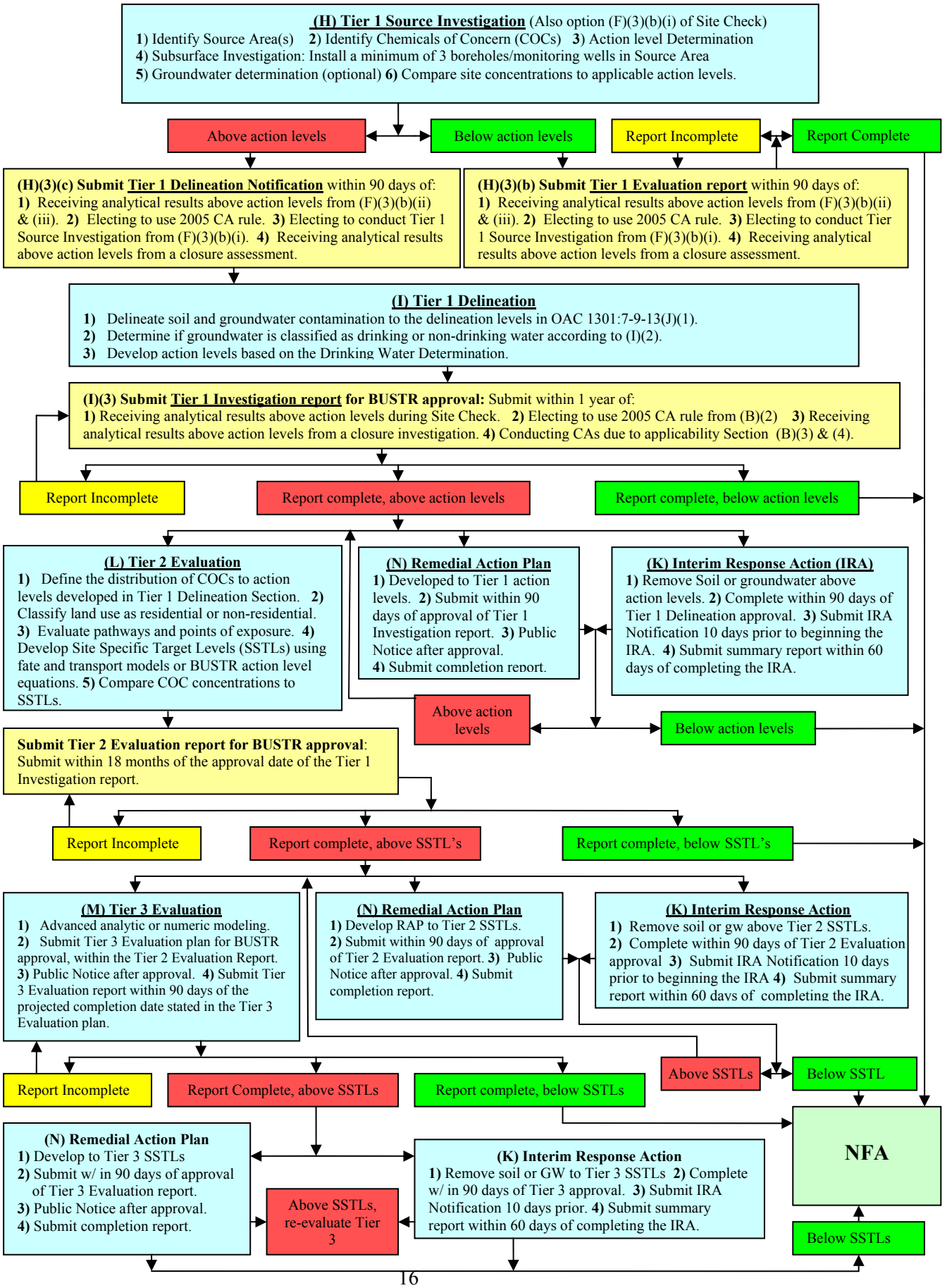
- Reporting releases and suspected release of petroleum products from USTs;
- Cleaning up spills and overfills of petroleum products, and performing immediate corrective actions at UST sites;
- Investigating releases and suspected releases;
- Determining the extent of contamination, and evaluating the risks posed by the petroleum chemicals released using the risk-based, tier evaluation process; and
- Performing remedial actions and monitoring at BUSTR-regulated sites to ensure that the chemicals released do not pose an unacceptable risk to human health or the environment.

To better understand the BUSTR corrective action process, see Flowchart 3.1 below:

Flowchart 3.1- Corrective Action Process



Flowchart 3.1 continued on the following page.


(H) Tier 1 Source Investigation (Also option (F)(3)(b)(i) of Site Check)
1) Identify Source Area(s) 2) Identify Chemicals of Concern (COCs) 3) Action level Determination
4) Subsurface Investigation: Install a minimum of 3 boreholes/monitoring wells in Source Area
5) Groundwater determination (optional) 6) Compare site concentrations to applicable action levels.
Above action levels
Below action levels
Report Incomplete
Report Complete
(H)(3)(c) Submit Tier 1 Delineation Notification within 90 days of: 1) Receiving analytical results above action levels from (F)(3)(b)(ii) & (iii). 2) Electing to use 2005 CA rule. 3) Electing to conduct Tier 1 Source Investigation from (F)(3)(b)(i). 4) Receiving analytical results above action levels from a closure assessment.
(H)(3)(b) Submit Tier 1 Evaluation report within 90 days of: 1) Receiving analytical results above action levels from (F)(3)(b)(ii) & (iii). 2) Electing to use 2005 CA rule. 3) Electing to conduct Tier 1 Source Investigation from (F)(3)(b)(i). 4) Receiving analytical results above action levels from a closure assessment.
(I) Tier 1 Delineation
1) Delineate soil and groundwater contamination to the delineation levels in OAC 1301:7-9-13(J)(1).
2) Determine if groundwater is classified as drinking or non-drinking water according to (I)(2).
3) Develop action levels based on the Drinking Water Determination.
(I)(3) Submit Tier 1 Investigation report for BUSTR approval: Submit within 1 year of: 1) Receiving analytical results above action levels during Site Check. 2) Electing to use 2005 CA rule from (B)(2) 3) Receiving analytical results above action levels from a closure investigation. 4) Conducting CAs due to applicability Section (B)(3) & (4).
Report Incomplete
Report complete, above action levels
Report complete, below action levels
(L) Tier 2 Evaluation
1) Define the distribution of COCs to action levels developed in Tier 1 Delineation Section. 2) Classify land use as residential or non-residential. 3) Evaluate pathways and points of exposure. 4) Develop Site Specific Target Levels (SSTLs) using fate and transport models or BUSTR action level equations. 5) Compare COC concentrations to SSTLs.
(N) Remedial Action Plan
1) Developed to Tier 1 action levels. 2) Submit within 90 days of approval of Tier 1 Investigation report. 3) Public Notice after approval.
4) Submit completion report.
(K) Interim Response Action (IRA)
1) Remove Soil or groundwater above action levels. 2) Complete within 90 days of Tier 1 Delineation approval. 3) Submit IRA Notification 10 days prior to beginning the IRA. 4) Submit summary report within 60 days of completing the IRA.
Above action levels
Below action levels
Submit Tier 2 Evaluation report for BUSTR approval: Submit within 18 months of the approval date of the Tier 1 Investigation report.
Report Incomplete
Report complete, above SSTL's
Report complete, below SSTL's
(M) Tier 3 Evaluation
1) Advanced analytic or numeric modeling. 2) Submit Tier 3 Evaluation plan for BUSTR approval, within the Tier 2 Evaluation Report. 3) Public Notice after approval. 4) Submit Tier 3 Evaluation report within 90 days of the projected completion date stated in the Tier 3 Evaluation plan.
(N) Remedial Action Plan
1) Develop RAP to Tier 2 SSTLs. 2) Submit within 90 days of approval of Tier 2 Evaluation report. 3) Public Notice after approval. 4) Submit completion report.
(K) Interim Response Action
1) Remove soil or gw above Tier 2 SSTLs. 2) Complete within 90 days of Tier 2 Evaluation approval 3) Submit IRA Notification 10 days prior to beginning the IRA 4) Submit summary report within 60 days of completing the IRA.
Report Incomplete
Report Complete, above SSTLs
Report complete, below SSTLs
Above SSTLs
Below SSTL
(N) Remedial Action Plan
1) Develop to Tier 3 SSTLs
2) Submit w/ in 90 days of approval of Tier 3 Evaluation report.
3) Public Notice after approval.
4) Submit completion report.
Above SSTLs, re-evaluate Tier 3
(K) Interim Response Action
1) Remove soil or GW to Tier 3 SSTLs 2) Complete w/ in 90 days of Tier 3 approval. 3) Submit IRA Notification 10 days prior. 4) Submit summary report within 60 days of completing the IRA.
NFA
Below SSTLs

3.2 Applicability

OAC 1301:7-9-13, effective March 1, 2005, (i.e., the 2005 Corrective Action [CA] Rule) applies to all O/Os performing corrective actions at petroleum UST sites, as follows:

- For releases reported on or after March 1, 2005, the O/O must conduct corrective actions in accordance with the current CA Rule;
- For releases reported prior to March 1, 2005, the O/O may elect to conduct corrective actions in accordance with this rule by submitting a letter to BUSTR stating an election to conduct corrective actions in accordance with the current CA Rule. Only the O/O can make this election (i.e., consultants/contractors cannot sign a letter for an O/O). This correspondence should identify the site's BUSTR facility/release number and the name and address of both the site and the O/O. The correspondence should contain a statement similar to the following:

  > We (O/O) hereby inform BUSTR of our election to apply the 2005 CA Rule (effective March 1, 2005) to the release site referenced in this correspondence. We also acknowledge that once this election is made, it cannot be reversed. This notification is provided in accordance with current BUSTR policy.

- O/Os conducting corrective actions in accordance with OAC 1301:7-9-13 (effective date September 1, 1992), may continue to conduct corrective actions in accordance with that version until September 1, 2005. Thereafter, all O/Os must conduct corrective actions in accordance with the current CA Rule;
- O/Os conducting corrective actions in accordance with OAC 1301:7-9-13 (effective date March 31, 1999), may continue to conduct corrective actions in accordance with that version until March 1, 2006. Thereafter, all O/Os shall conduct corrective actions in accordance with the current CA Rule; and
- O/Os may request an extension of time in accordance with OAC 1301:7-9-13(Q) to continue corrective actions under a previous version of the CA Rule where good cause exists as determined by BUSTR. BUSTR may grant, modify, or deny any extension request at its sole discretion. (See Section 3.15, Requests for Extensions, for guidance.)

The following regulated UST systems are **exempt** from the 2005 CA Rule*:*

- Any UST system holding hazardous wastes listed or identified under OAC Chapter 3745-51 or a mixture of such hazardous wastes and other regulated substances;
- Any waste water treatment tank system that is part of a waste water treatment facility regulated under Section 402 or 307(b) of the Federal Water Pollution Control Act (33 U.S.C.A. 1251 and following);
- Equipment or machinery that contains regulated substances for operational purposes such as hydraulic lift tanks and electrical equipment tanks;
- Any UST system whose capacity is 110 gal. or less;
- Any emergency spill or overflow containment UST system that is expeditiously emptied after use;
- Any UST system that contains a *de minimis* concentration of regulated substances; and
- Any UST system that contains hazardous substances listed under OAC Rule 1301:7-9-03.

The following UST systems are exempt from the Closure Rule but releases from these systems are regulated under the 2005 CA Rule:

- Waste water treatment systems;
- Any UST system containing radioactive material that are regulated under the Atomic Energy Act of 1954 (42 USCA 2014 and following);
- Any UST system that is part of an emergency generator system at nuclear power generation facilities regulated by the United States Nuclear Regulatory Commission;
- Airport hydrant fuel distribution systems; and
- Any UST systems with field-constructed tanks.

3.3 Reporting of Releases and Suspected Releases

An O/O must report a release or suspected release to BUSTR and the local fire department within 24 hrs. of discovery. All spills and overfills that occur while transferring or attempting to transfer petroleum into an UST system must be reported within 24 hrs. However, if a spill/overfill is 25 gal. or less, does not reach a surface water body, and is cleaned up within 24 hrs. to pre-spill/overfill conditions, a release does not need be reported.

Suspected Release

A release is suspected when *any* one of these events occurs:

- Monitoring results from a release detection method, such as inventory control and automatic tank gauging, indicates a release may have occurred (unless the monitoring device is found to be defective or a second month of inventory control does not confirm the initial result);
- Unusual operating conditions are observed (unless the system equipment is found to be defective, but not leaking, and is immediately repaired or replaced); such unusual operating conditions shall include, but are not limited to, the erratic behavior of petroleum dispensing equipment, the sudden loss of petroleum from the UST system, or an unexplained presence of water in the UST; or
- Physical discovery of a petroleum product is detected. The definition of "physical discovery" includes *one or more* of the following six scenarios:
    - Free product is discovered during removal of any portion of an UST system in an excavation on an UST site, or on a property nearby an UST site;
    - Petroleum vapors are discovered within or along building foundations or other subsurface manmade structures on or off-site (i.e., building foundations, basements) or in a drinking water well located on or off-site;
    - Free product is discovered in a monitoring or observation well located on or off-site;
    - The presence of petroleum products are discovered on a surface water body and are suspected to have originated from the UST system;
    - Analytical results are received and are above ALs (using the assumptions that ground water is drinking water and land-use is residential) for any non-corrective action activities (i.e., divestment assessment, phase II assessment); or
    - Free product is discovered on-site in an UST secondary containment system other than a spill bucket.

Release

A release is defined as *any* of the following:

- Any spilling, leaking, emitting, discharging, escaping, leaching, or disposing of a petroleum product from an UST system into the ground water, a surface water body, subsurface soil, or otherwise into the environment;
- Any spilling, leaking, emitting, discharging, escaping, or disposal of a petroleum product into ground water, a surface water body, subsurface soil or otherwise into the environment while transferring or attempting to transfer petroleum products into an UST system; or
- COCs in subsurface soil or ground water on the UST site found in concentrations above the ALs, while conducting activities pursuant to the Closure or CA Rules. (See Section 3.9, Action and Delineation Levels.)

3.4 Clean-up of Spills and Overfills

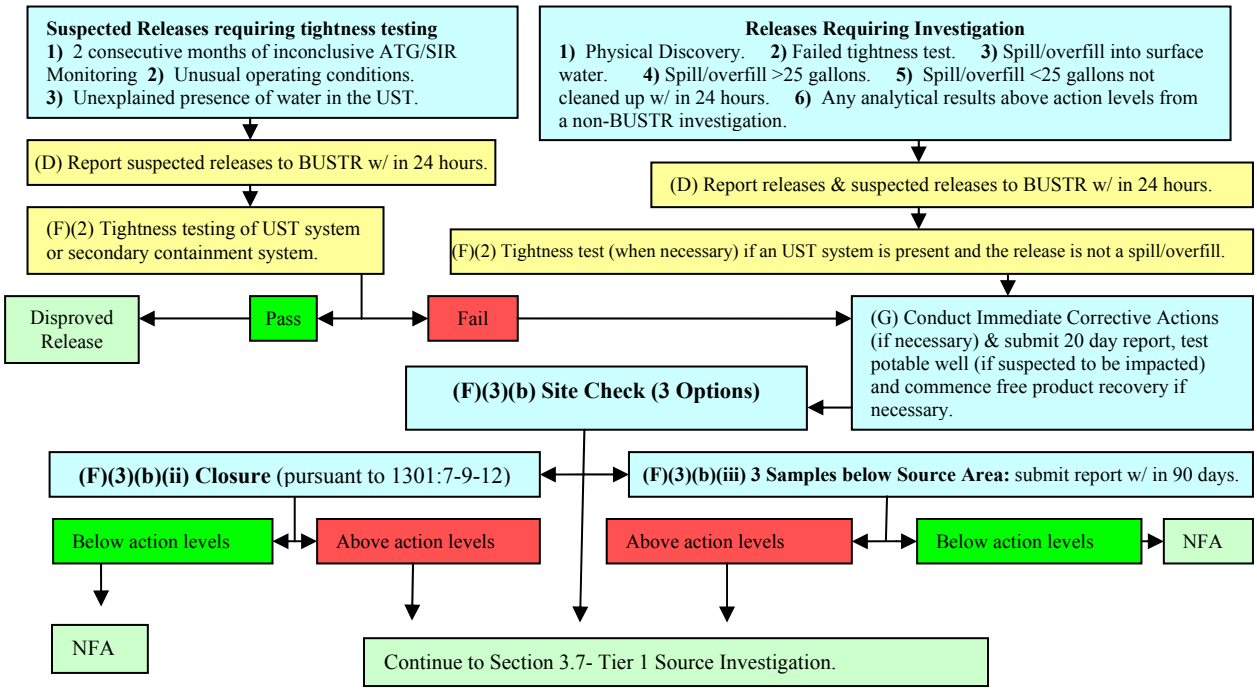
If a spill or overfill occurs while transferring or attempting to transfer petroleum product into an UST system, the O/O must immediately contain and clean up the spill or overfill to pre-spill/overfill conditions. In addition, a Site Check (see Section 3.5.3, Site Check) and immediate corrective actions (Section 3.6, Immediate Corrective Actions) are required if *one* of the following occurs:

- If a spill or overfill of petroleum products results in a release into a nearby surface water body;
- If a spill or overfill consists of a release to the environment of more than 25 gal. of petroleum product; or
- If a spill or overfill is not cleaned up to pre-spill/overfill conditions within 24 hrs., regardless of the amount of product spilled/overfilled.

3.5 Investigating Releases and Suspected Releases

The purpose of the Investigating Releases and Suspected Releases section is to determine if an UST system is leaking or has leaked, to identify the source or sources of a release and to determine if a release, above ALs, has occurred. The definitions of a release or suspected release are located in Section 3.3, Reporting of Releases and Suspected Releases. Flowchart 3.2 below may be used to better understand the investigation of releases and suspected releases.

Flowchart 3.2- Investigating Releases and Suspected Releases



3.5.1 UST System Evaluation

If a release is determined to have occurred, inspect for above-ground releases or exposed below-ground releases. This evaluation may include an inspection of product dispensers, product piping (i.e., flex connectors, joints, etc.), release detection equipment, spill and overfill buckets, and containment sumps.

If testing or other evidence confirms that a release has or continues to occur from the UST system, immediate corrective actions must be conducted to stop all further releases. (See Section 3.6, Immediate Corrective Actions.)

3.5.2 Tightness Test

If a suspected release occurs, the O/O must complete *all* of the following:

- Conduct a tightness test (TT) on all existing suspected UST systems using a BUSTR approved method in OAC 1301:7-9-07 within seven days of reporting the suspected release;
- Notify BUSTR of the TT results by telephone, e-mail, or facsimile within 24 hrs. of receiving the results; and
- Submit copies of the TT results to BUSTR within seven days of receipt by the O/O.

If a release is suspected because of the presence of free product in a secondary containment system (i.e. double wall piping, containment sump), the O/O must complete *all* the following:

- Conduct a TT using a BUSTR approved method in OAC 1301:7-9-07 demonstrating that the secondary containment system is tight and has not released petroleum into the environment with seven days of reporting the suspected release;

- Notify BUSTR of the TT results by telephone, e-mail, or facsimile within 24 hrs. of receiving the results;
- Submit copies of the TT results to BUSTR within seven days of receipt by the O/O.

NOTE: The O/O may elect to conduct a Site Check option listed below and forgo the TT requirements listed above for a release or suspected release from a secondary containment system.

3.5.3 Site Check

A site check must be completed and submitted in a report to BUSTR within 90 days of a failed tightness test, determining that the secondary containment system is not tight, physical discovery (excluding free product discovered in a secondary containment system), or the occurrence of a spill/overfill requiring a Site Check. Additionally, if a repair is conducted on a portion of the system from which a release has or may have occurred, then the release must be reported and a Site Check option must be conducted. The O/O must notify BUSTR if a Site Check is discontinued for any reason.

The three options for a Site Check are:

1. Conduct a Tier 1 Source Investigation;
2. Close all or a portion of the UST system and conduct a closure assessment (BUSTR approval may be required); or
3. Collect a minimum of three soil samples from the native soil immediately below the source of the suspected release.

The appropriate option for a particular UST site will depend upon the site-specific circumstances.

Option 1: Conduct Tier 1 Source Investigation According to 1301:7-9-13(H)

The O/O may elect to install SBs/MWs for investigating a release or suspected release by placing a **minimum** of three SBs/MWs in or as close to the **source area(s)** as possible (i.e., locations where the highest COC concentrations would most likely be present). The O/O should consider information known about the UST site, the source of the suspected release, and the likely distribution of COCs when determining the placement of SBs and MWs. (See Figures 3.1 through 3.5 below for examples of SB placement among several different release scenarios.) The specific circumstances of the release or suspected release and UST site characteristics may warrant alternative placement and/or additional borings. (See Appendix A, Data Collection, for installation of SBs/MWs.)

If this option is selected, a Tier 1 Evaluation Report or Tier 1 Delineation Notification Report must be submitted to BUSTR within 90 days from the date the release or suspected release was reported.

Figure 3.1 - Suspected Release from an Existing UST

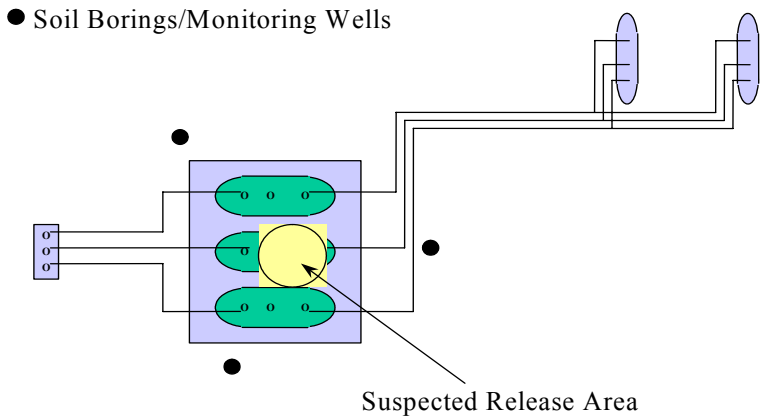


Figure 3.2- Suspected Release from Existing Piping in Dispenser Area

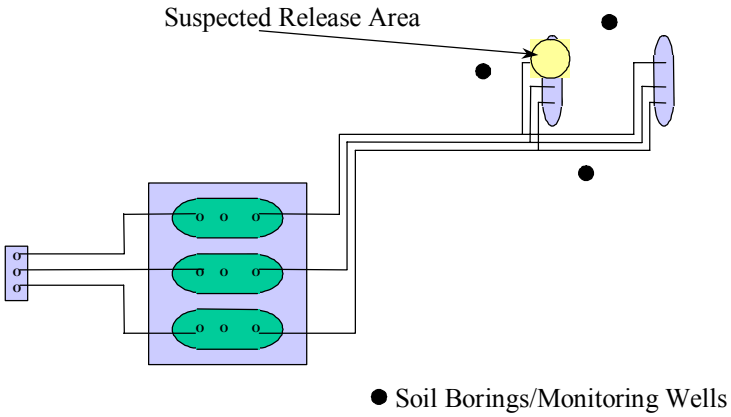


Figure 3.3 - Suspected Release from Existing Piping

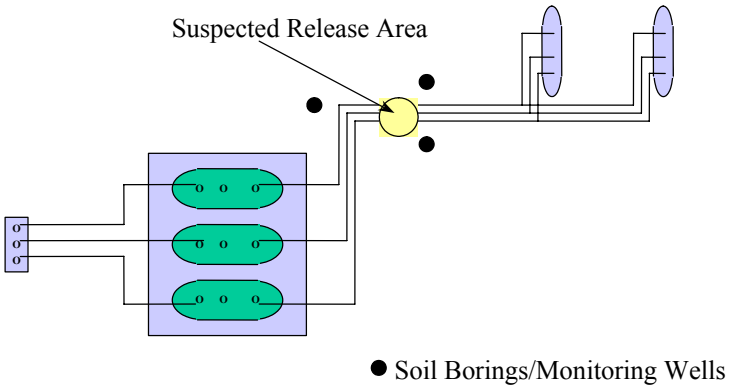
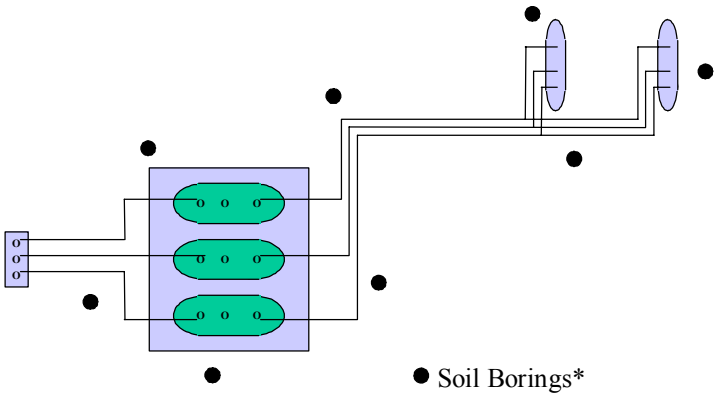
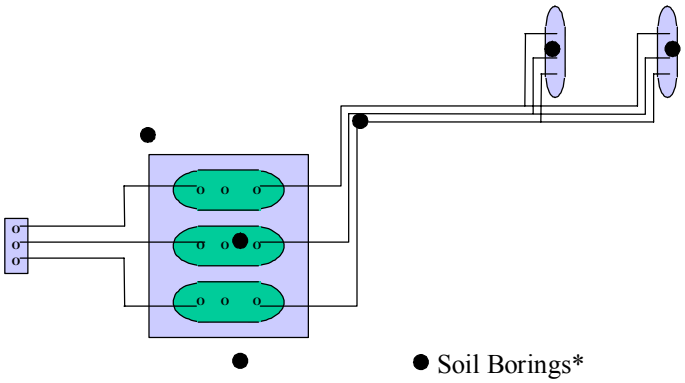


Figure 3.4 - Suspected Release from Unknown Source Area



*NOTE: a minimum of three SBs must be converted into MWs.

Figure 3.5- Suspected Release from a Previously Removed System



*NOTE: a minimum of three SBs must be converted into MWs.

Option 2: Closure of All or a Portion of the UST System According to 1301:7-9-12

The O/O may elect to remove all or a portion of the UST system that is the potential source of the release or suspected release, and conduct a closure assessment.

The O/O must obtain prior approval from BUSTR for the closure of the UST system, if *any* of the following conditions exist:

- Ground water is known or suspected to contain COC concentrations;
- Free product is present;
- A receptor or surface water body is known to be impacted by the release;
- The UST site is in a Sensitive Area defined in OAC 1301:7-9-09;
- The UST site is in a Drinking Water Source Protection Area (DWSPA); or
- A potable well is located on the UST site.

This approval may have conditions that require additional work, most likely involving additional soil and ground water sampling.

Where an UST closure is to be used to meet site check requirements, **at least one of the required samples must be taken from the suspected area** of highest COC concentration (i.e., sample any obvious areas of contamination).

For example, if a piping release is identified, submit a sample from that location and from the 10 ft. intervals required in the Closure Rule. For purposes of site check, BUSTR recommends that at least one sample be obtained from piping runs less than 10 ft. long.

If this option is selected, a Closure Assessment Report must be submitted to BUSTR within 90 days from the date the release or suspected release was reported.

Option 3: Collect Three Samples Below the Source of the Suspected Release

This option allows the O/O to take samples in the native soil below the source of the spill/overfill or suspected release to demonstrate that COC concentrations in the native soil are below the ALs. This option may be utilized for. but is not limited to, suspected releases discovered under dispenser areas, in product piping runs less than 10 ft., a failed tightness test (TT) of a secondary containment system, or in product piping connections (i.e., joints, elbows, flex connectors.)

All of the following guidelines must be followed:

- Samples shall be biased towards the areas suspected to have the highest COC concentrations resulting from the suspected release;
- Samples from each SB or excavation shall be field screened and the sample with the highest field screening result from each location shall be submitted for laboratory analysis. SBs must be continuously sampled for field screening and extended to a minimum depth of 1 ft. into the native soil (see Appendix A, Data Collection);
- If ground water is encountered, collect a sample for analysis (see Appendix A, Data Collection); and
- Submit all soil and ground water samples for analysis for the appropriate COCs. (See Section 3.7.1, Source Investigation, for a list of the appropriate COCs.)

The O/O must obtain approval from BUSTR prior to selecting this option if *any* of the following conditions exist:

- The ground water is known or suspected to contain COC concentrations;
- Free product is present;
- A receptor or surface water is known to be impacted by the release;
- The UST site is in a Sensitive Area defined in OAC 1301:7-9-09;
- The UST site is in a DWSPA; or
- A potable well is located on the UST site.

If this option is selected, the O/O must prepare and submit a Site Check Report to BUSTR within 90 days of a failed TT, a determination that the secondary containment system is not tight, physical discovery, or the occurrence of a spill or overfill requiring a site check be conducted. The Site Check Report shall contain, at a minimum, *all* of the following:

- Name, address, and contact information for the facility and UST owner;
- Associated site maps and drawings;
- Description of the nature and location of the suspected release;

- Type and location of samples collected;
- Sampling methodologies and preservation techniques;
- Soil boring logs;
- Chain of custody(s) forms; and
- Laboratory analytical results.

3.5.4 Release Determination

After completing a site check option as listed in Section 3.5.3, Site Check, the O/O must determine if a release has occurred by comparing site COC concentrations to the appropriate ALs for the UST site. For all UST sites where Site Check investigations are conducted, the O/O must assume ground water underlying the site is a drinking water source, Class 1 soil type, and residential land-use. (Section 3.9, Delineation and Action Levels, for a list of ALs.)

The O/O must provide geotechnical data (i.e., sieve analysis, particle size analysis) to support a modification different from Class 1 soil types. The drinking water and land-use classification may not be modified during the Site Check process.

If site COC concentrations are above applicable ALs under Options 2 or 3, the O/O must conduct a Tier 1 Source Investigation (See Section 3.7, Tier 1 Source Investigation.) If Option 1 of Site Check was conducted and COC concentrations are above applicable ALs, submit a Tier 1 Delineation Notification Report and proceed to Tier 1 Delineation. (See Section 3.8, Tier 1 Delineation, for additional guidance.)

If site COC concentrations are at or below applicable ALs under Option 1, 2, or 3, and the applicable report is technically accurate and complete, then a NFA or a disproved status will be issued by BUSTR, as appropriate.

3.6 Immediate Corrective Actions

3.6.1 Mitigating Releases from UST Systems

Once a release has occurred, the O/O must initiate *all* of the following immediate corrective actions within 24 hrs.:

- Take immediate action to prevent any further release of petroleum from an UST system into the environment, including removal of petroleum from an UST system as necessary to prevent further release into the environment;
- Immediately identify and mitigate fire, explosion, vapor, and safety hazards associated with such releases and notify BUSTR by telephone, e-mail, or facsimile within 24 hrs. after starting such activities;
- Inspect for releases and take steps to prevent further migration of releases into surrounding soil and ground water through use of absorbent pads, absorbent booms, dikes, siphon dams, or similar items;
- Continue to monitor and mitigate any additional fire and safety hazards posed by vapors or free product that have migrated to subsurface structures, such as basements, sewers, or similar locations;
- Manage contaminated materials that are generated in a manner that complies with applicable federal, state, and local requirements; and

- If a release is suspected to impact a drinking water well, an O/O must have the drinking water well tested for the appropriate COCs within three days of discovery. The O/O must also notify BUSTR within 24 hrs. of receipt of test results and submit the written results to BUSTR within seven days of receiving the analytical results. If a drinking water well shows any impact, it should be reported to the local health department.

3.6.2 Immediate Corrective Action Report

BUSTR must receive an Immediate Corrective Action Report documenting the proper clean-up of a release within 20 days of starting any immediate corrective action. (See Appendix E, Forms, for the Immediate Corrective Action Form.) At a minimum, the Immediate Corrective Action Report must contain *all* the following information:

- Date and time the release was discovered;
- Addresses and locations of buildings, sewers, surface water bodies, and any building or space affected by the release;
- An overview of activities leading to the discovery of free product;
- Type and amount of product released;
- A description of the UST system and operational status;
- A description of all completed and planned immediate corrective actions;
- Amount and disposition of any materials generated (e.g., soil and liquids), including any supporting documentation (e.g., copies of disposal receipts); and
- Copies of site maps, plans, and photographs and other information that may assist in evaluating and/or investigating the release.

3.6.3 Free Product Removal and Reporting

Free product means a separate liquid hydrocarbon phase that has a measurable thickness of greater than 0.01 ft. (0.12 in.) An O/O must report free product to BUSTR within 24 hrs. of discovery. The presence of free product must be evaluated during closure assessment, site check, and tier evaluations.

Where free product is present, the O/O must immediately implement a free product recovery (FPR) program that removes free product to the maximum extent practicable while continuing other required corrective action activities. The O/O must remove free product in a manner that minimizes the spread of COCs into previously unimpacted zones. Free product recovery includes activities such as manual bailing, skimming, pumping, or other removal technologies that effectively remove free product.

Free product recovery is an immediate corrective action and pre-approval from BUSTR is not required. However, the O/O must secure any permits required by Federal, state, or local regulatory agencies and handle any flammable products in a safe and competent manner to prevent fires and explosions.

Free Product Recovery Report

An O/O must prepare a FPR Report on a form prescribed by BUSTR and submit a completed form on a monthly basis until free product has been removed to the maximum extent practicable. (See Appendix E, Forms for the Free Product Recovery Report Form.) At a minimum, the FPR reports must contain *all* the following:

- Name, address, and facility identification number of the UST site;
- Details of the FPR system (i.e., drawings, discharge locations, operations)*;
- A site map that shows the location of buildings, structures, utilities, and past and present UST systems*;
- Copies of installation, operation, treatment, and discharge permits granted*;
- A discussion of any FPR system malfunctions;
- Product thickness in wells, bore holes, and excavations;
- Gallons and type of free product recovered each month and to date;
- Gallons of water recovered each month and to date;
- Disposition of recovered free product and water; and
- A description of any changes or modifications to the FPR system.

(NOTE: * denotes items only required for the initial monthly FPR report)

The O/O must immediately report to BUSTR and the local fire department (i.e., by telephone, e-mail) if a FPR system cannot be repaired within 24 hrs. of discovering its malfunction. The O/O must correct the malfunction and place the system back into service as promptly as is technically feasible.

If free product is present one year after initiating FPR activities, BUSTR may require a written re-evaluation of recovery technique(s). The re-evaluation must include a discussion of the reliability, effectiveness, cost, and time needed for completing FPR. Free product removal activities may be terminated once free product is no longer present on and off-site for three consecutive months. BUSTR must be notified within 30 days of termination of FPR activities.

3.7 Tier 1 Source Investigation

The purpose of the Tier 1 Source Investigation is to determine the concentrations of the COCs in the source area(s) for a release or to investigate a suspected release. The Tier 1 Source Investigation consists of the source investigation, action level determination, and Tier 1 Source Investigation reporting.

3.7.1 Source Investigation

Identification of Potential Source(s) of a Release or Suspected Release

All potential source(s) of the release or suspected release must be identified. These potential sources may include existing, closed-in-place, or removed underground storage tanks, piping systems, or dispensers. Any areas of known or suspected surface spills or overfills must also be identified.

If the source of the release or suspected release is unknown, all potential source(s) related to the release or suspected release on the UST site must be investigated. This investigation should include a review of current and historical uses of the site. Information sources may include site plans, personal interviews, fire department records, Sanborn maps, deeds, etc.

Identification of Potential Source Areas

The potential source areas of the release or suspected release must also be identified. These areas may be identified based on the location of the known release (e.g., USTs or piping systems that have failed tightness testing) or areas that have the highest COC concentrations identified through field screening methods or laboratory analysis. Areas that contain free product must also be identified as source areas.

Determination of Chemicals of Concern

Chemicals of concern must be identified based on the contents of the UST system. The different substances regulated during corrective actions have been divided into five analytical groups.

- Analytical Group 1: light distillates, including unleaded gasoline, leaded gasoline, naptha, and aviation gasoline;
- Analytical Group 2: middle distillates, including diesel, light fuel oils, Stoddard solvents, mineral spirits, kerosene, and jet fuels;
- Analytical Group 3: heavy petroleum distillates, including, but not limited to, lubricating and hydraulic oils;
- Analytical Group 4: used oil;
- Analytical Group 5: unknown petroleum products or petroleum products other than those listed in analytical groups above; if the contents of the UST system falls into Analytical Group 5, BUSTR must be consulted to determine the appropriate COCs and the associated analytical methods; these chemicals may be selected based on the properties of the stored chemical(s) and information provided on the Material Safety Data Sheets (MSDS) for the chemical.

COCs and their associated analytical methods must be selected based on the above analytical groups and Table 3.1- Selected Chemical(s) of Concern.

Table 3.1- Selected Chemical(s) of Concern

	Analytical Group Number	1	2	3	4	5	Analytical Methods	
		Light Distillates	Middle Distillates	Heavy Distillates	Used Oil	Unknowns & Others	**Soil**	**Ground Water**
	Chemical							
Aromatics	Benzene	X	X		X		8021 or 8260	8021 or 8260
	Toluene	X	X		X			
	Ethylbenzene	X	X		X			
	o, m and p-Xylenes	X	X		X			
Additives	Methyl tertiary-butyl ether (MTBE)	X			X		8021 or 8260	8021 or 8260
Polynuclear Aromatics (PAH)	Benzo(a)anthracene		X	X	X		8270, 8310	8270, 8310
	Benzo(a)pyrene		X	X	X			
	Benzo(b)fluoranthene		X	X	X			
	Benzo(k)fluoranthene		X	X	X			
	Chrysene		X	X	X			
	Dibenz(a,h)anthracene		X	X	X			
	Indeno(1,2,3-c,d)pyrene		X	X	X			
	Naphthalene		X	X	X			
Chlorinated Hydrocarbons	Volatile Organic Hydrocarbons				X		8260	8260
Total Petroleum Hydrocarbons *	TPH (C6 – C12)	X			X		8015	N/A
	TPH (C10 – C20)		X		X			
	TPH (C20 – C34)			X	X			
Additional COCs	Varies based on UST contents **			X	X	***	Consult BUSTR for lab method	

* TPH analysis is not required for ground water samples.

** Additional COCs should be based on Material Safety and Data Sheets (MSDS) and analyzed with an appropriate laboratory test method capable of meeting established target levels.

*** Refer to Section 3.7.1, Source Investigation, *Determination of Chemicals of Concern*.

Subsurface Investigation

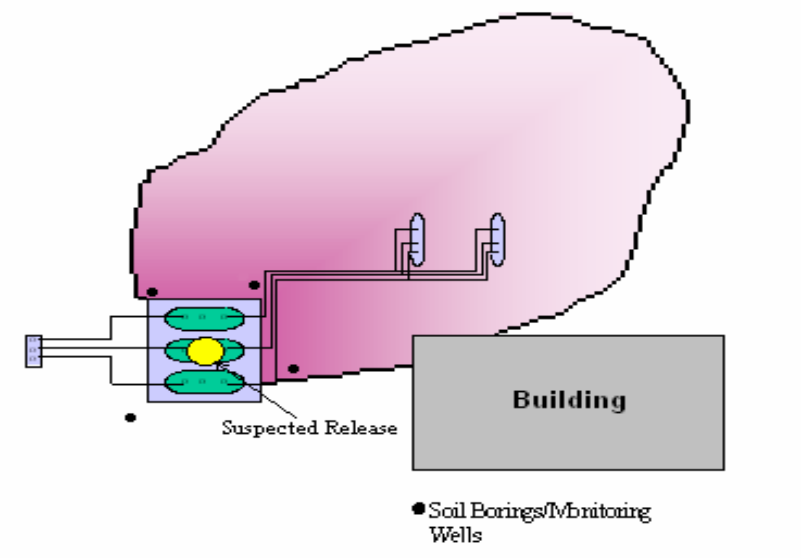
During the subsurface investigation, major geologic, hydrogeologic, and physical characteristics of the UST site and surrounding area that may influence the migration of COCs must be identified. In the immediate vicinity of the release or suspected release, the O/O must investigate the following:

- Direction and gradient of ground water flow (if ground water is encountered);
- Known faults, fissures, fractures, or geologic transport routes (based on published data from ODNR or USGS);
- Identified soil type(s) based on field observations and/or laboratory analysis (soil survey maps are not appropriate);
- Known depth to ground water; and
- Location of any man-made structures such as sewer lines, water lines, electrical conduits, or drainage tiles.

The physical investigation of the source area should include the installation of a minimum of three SBs/MWs within, or as close as possible to, the source area to determine the highest concentration for each COC. The locations selected should consider the location of potential sources, potential source areas, and the likely distribution and temporal variations in COC concentrations in soil and ground water. If a portion of the source area is not accessible, at least one SB/ MW must be installed in an area immediately down gradient of the source area. **In many instances, more than three SBs/ MWs will be necessary to characterize the source area.** (See Appendix A, Data Collection, for guidance on SB/ MW installation and sampling.)

An example of soil boring/monitoring well placement is shown in Figure 3.6, below.

Figure 3.6 - Typical Well Placement for Tier 1 Source Investigation



Ground Water Determination

The O/O must determine if the saturated zone meets the definition of ground water. The O/O may either assume the encountered saturated zone is ground water or evaluate the site's ground water yield and *in situ* hydraulic conductivity. If the saturated zone is capable of yielding at least 1.5 gal./8 hrs. and has an *in situ* hydraulic conductivity greater than 5.0×10^{-6} cm/sec., then the saturated zone is ground water. However, if the initial field study for one of the criteria fails to meet the definition of ground water, then additional evaluation is not required. (See Appendix A, Data Collection, for more information on yield determination and yield adjustments.)

3.7.2 Action Level Determination

Upon completion of the Tier 1 Source Investigation, O/Os must complete a site feature determination to determine the appropriate ALs for each environmental medium and exposure pathway. The site feature determination consists of *all* the following:

- Identify the COCs based on the petroleum product released (see Table 3.1, Selected Chemicals of Concern, in Section 3.7.1, Source Investigation);
- Assume residential land-use exposures;
- Determine if the saturated zone is ground water in accordance with Section 3.7.1, Source Investigation, *Ground Water Determination*. The saturated zone is assumed to be ground water unless a determination has been made;
- Select a soil type that best represents the soil under the UST site and is most appropriate to the specific exposure pathway. For purposes of the Tier 1 Source Investigation, classify the bedrock as a Class 1 soil type (see Table 3.2, BUSTR Soil Classification Form); and
- Determine the depth to ground water using site-specific data. If ground water depth is unknown, the O/O must use a depth of less than 15 ft.

Determine ALs by applying the ground water determination, depth to ground water, and soil class information to the action level tables. (See Sections 3.9.2, Action Levels, and 3.9.3, Action Level Tables, to determine the applicable pathways and ALs.)

Point(s) of Exposure

A point of exposure (POE) is the point at which an individual or population may be exposed to COCs originating from an UST site. In the Tier 1 Source Investigation, the POE is assumed to be within the source area(s). In Tier 1 Source Investigation, it is assumed that any identified current or potential future drinking water source in the surrounding area is within the source area(s). In Tier 2 Evaluation, the fate and transport of COCs in the dissolved phase in ground water is evaluated.

Table 3.2- BUSTR Soil Classification Form

Major Divisions			Letter Symbol	Typical Description	Soil Class
Coarse Grained Soils (More than 50% of material is retained on #200 sieve)	**Gravel and Gravelly Soils** (More than 50% of coarse fraction retained on #4 sieve)	**Clean Gravels** (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	**Class 1**
			GP	poorly-graded gravels, gravel-sand mixtures, little or no fines	
		Gravels With Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures	
			GC	Clayey gravels, gravel-sand-clay mixtures	
	Sand and Sandy Soils (More than 50% of coarse fraction passes through #4 sieve)	**Clean Sand** (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	
			SP	Poorly-graded sands, gravelly sands, little or no fines	
		Sands with Fines (Appreciable amount of fines)	SM	Silty-sands, sand-silt mixtures	
			SC	Clayey sands, sand-clay mixtures	**Class 2**
Fine Grained Soils (More than 50% of material passes through #200 sieve)	**Silts and Clays** Liquid limit <50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	
			CL	Inorganic clays of low-to-medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and Clays Liquid limit >50		MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils	
			CH	Inorganic clays of high plasticity, fat clays	**Class 3**
			OH	Organic clays of medium-to-high plasticity, organic silts	
Highly Organic Soils			PT	Peat, humus, swamp soils with high organic contents	

Pathway	Symbol	Pathway	Symbol
Soil to drinking water (DW) leaching		**Ground water (GW) to indoor air**	
Soil to indoor air		**Soil to non-DW leaching**	

3.7.3 Tier 1 Source Investigation Reporting

The O/O must prepare and submit to BUSTR either a Tier 1 Evaluation Report or a Tier 1 Delineation Notification within 90 days of *any* of the following:

- Receiving analytical results which exceed ALs during Options 2 and 3 of a site check;
- Electing to conduct corrective action under the 2005 corrective action rule for releases reported prior to March 1, 2005;
- Electing to conduct a Tier 1 Source Investigation as part of a site check;
- Receiving analytical results, which exceed ALs, from a closure assessment as part of the closure rule; or
- Conducting corrective action activities in accordance with the 2005 CA Rule following the expiration date of the 1992 (September 1, 2005) or the 1999 (March 1, 2006) corrective action rules.

The O/O must submit a **Tier 1 Evaluation Report** on a form prescribed by BUSTR if COC concentrations are **at or below** applicable ALs upon completion of a Tier 1 Source Investigation.

The O/O must submit a **Tier 1 Delineation Notification** on a form prescribed by BUSTR if the COC concentrations are **above** ALs upon completion of a Tier 1 Source Investigation.

3.8 Tier 1 Delineation

The purpose of the Tier 1 Delineation is to ensure adequate investigation of the source area(s), regardless of the land and ground water use determination. The Tier 1 Delineation requires the O/O to complete *all* of the following:

- Define the vertical and horizontal extent of COCs in soil and ground water to the delineation levels. (See Section 3.9.1, Delineation Levels.)
- Determine the potential drinking water use at the site and surrounding area. (See Section 3.8.2, Drinking Water Use.)
- Determine appropriate ALs based on the potential drinking water use for the UST site. (See Section 3.9.2, Action Levels, and 3.9.3, Action Level Tables.)

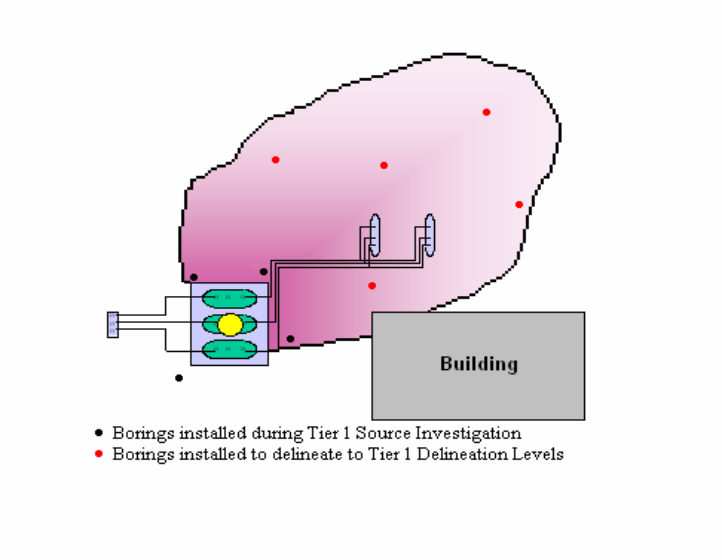
3.8.1 Assessment and Delineation of Chemicals of Concern

Additional investigation must be conducted to determine the distribution of COCs by conducting the following:

- Determine the horizontal and vertical distribution of COCs to the delineation levels listed in Table 3.3 of Section 3.9.1, Delineation Levels. In areas of high ground water recharge, where pumping wells exist, or other indicators of elevated vertical gradients are present, additional wells may be required to evaluate vertical distribution of COCs. Analysis of COCs required in the Tier 1 Source Investigation cannot be eliminated, regardless of their exclusion from the delineation level table. BUSTR reserves the right to request delineation of any additional COCs not listed in Table 3.3, Delineation Levels (e.g., TPH, compounds required for analytical groups 3, 4, and 5) See Figure 3.7, Typical Well Placement for Delineation of Chemicals of Concern below for an example of SB/ MW locations;

- Install SBs and ground water MWs in accordance with BUSTR procedures (See Appendix A, Data Collection);
- Determine the geologic, hydrogeologic, and physical characteristics of the UST site and the surrounding area that may influence the migration and transport of COCs; and
- Obtain off-site access if the distribution of COCs is determined to have migrated to off-site areas. Off-site access agreements must be obtained from the affected property owner. Off-site access denial documentation must be submitted to BUSTR within 45 days of receipt.

Figure 3.7- Typical Well Placement for Delineation of Chemicals of Concern



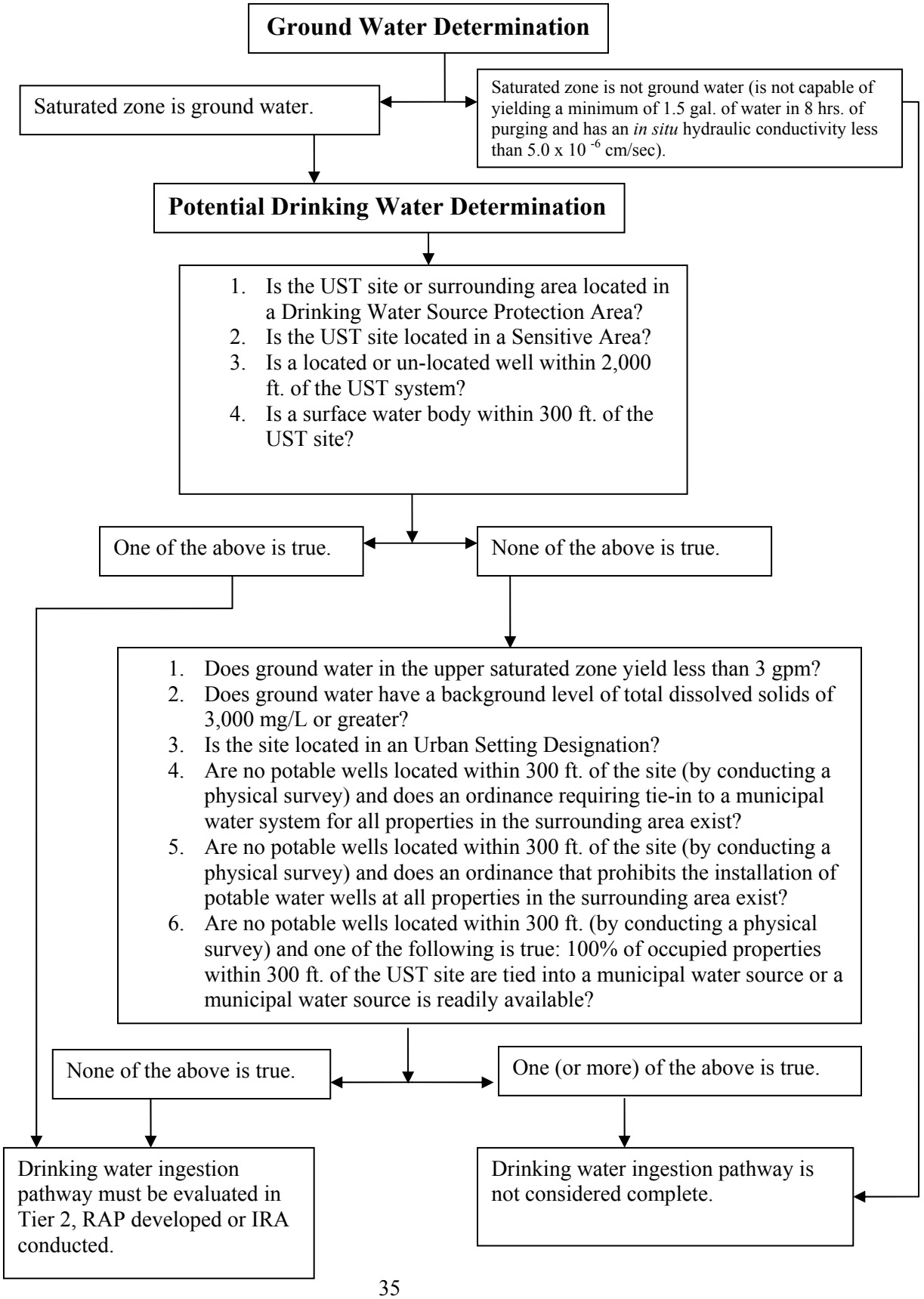
3.8.2 Potential Drinking Water Use

For purposes of the Tier 1 evaluation, evaluate the current and potential future use of ground water underlying the UST site and surrounding area (within 2,000 ft. of the UST system) to determine whether ground water is or is not a drinking water source. During this evaluation, assume that:

- Ground water use being evaluated is the upper-most saturated zone underlying the UST site. If any evidence suggests that COCs are present in lower saturated zones, they must also be evaluated; and
- Any identified current or potential future drinking water source in the surrounding area is assumed to be within the source area(s).

In the Tier 1 Delineation, a drinking water or non-drinking water determination must be made. The O/O can assume that ground water underlying the UST site is drinking water and avoid the costs associated with this determination. If the drinking water determination has been assumed, the determination may **not** be reversed during further tier evaluations. Flowchart 3.3- Drinking Water Pathway Evaluation in Tier 1 below may be used to better understand the drinking water use determination.

Flowchart 3.3- Drinking Water Pathway Evaluation in Tier 1



Drinking Water Evaluation – Current and Potential Future Usage

During Tier 1 Delineation, ground water underlying the UST site will always be considered a drinking water source if *any* of the following applies:

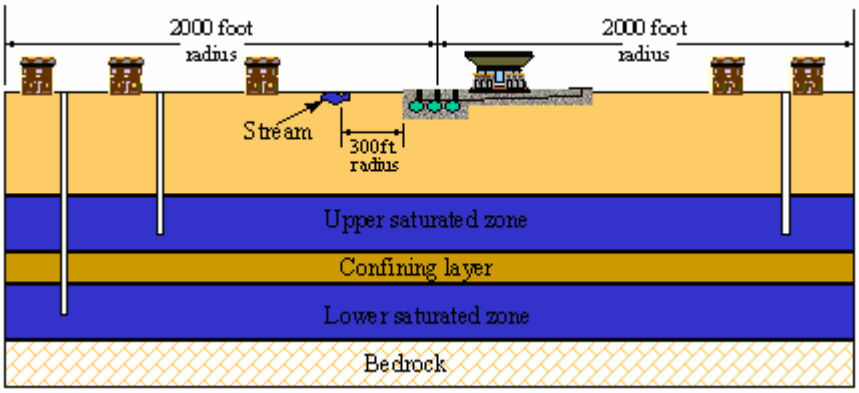
- The UST site or surrounding area is located in a Drinking Water Source Protection Area;
- The UST site is in a Sensitive Area;
- A drinking water source in the ground water is identified within the surrounding area; or
- A surface water body is located within 300 ft. of the UST site.

If the UST site does not meet the drinking water requirements as listed above, then ground water underlying the UST may be considered non-drinking water if *any* of the following apply:

- Ground water in the upper saturated zone yields less than 3 gal./min., as adjusted (see Appendix A, Data Collection);
- Ground water in the upper saturated zone has a background level of total dissolved solids of 3,000 mg/L or greater, as determined by laboratory results;
- The UST site is located in an Urban Setting Designation. Refer to Ohio EPA, DERR VAP, to determine if the UST site is located within an Urban Setting Designation;
- No potable wells are located within 300 ft. of the UST site based on a physical survey *and* a local ordinance *requires* a mandatory tie-in to a municipal water system for all properties in the surrounding area;
- No potable wells are located within 300 ft. of the UST site based on a physical survey *and* a local ordinance *prohibits* the installation of potable water wells at all properties within the surrounding area; or
- No potable wells are located within 300 ft. of the UST site based on a physical survey *and* 100 % of the properties within 300 ft. of the UST site area are connected to a municipal water source or a municipal source is readily available.

If ground water is not considered a drinking water source and ground water cannot be classified as a non-drinking water source using the above criteria, then ground water must be considered drinking water. Action levels must be determined by applying the ground water determination, depth to ground water, and soil class information. (See Section 3.9.3, Action Level Tables.) An action level must be identified for each environmental medium and exposure pathway. (See Figure 3.8, below, for an example of a drinking water use scenario.)

Figure 3.8- Example of Drinking Water Use Scenario



Drinking Water Source Protection Area

Drinking Water Source Protection Area (DSWPA) means the surface and subsurface area surrounding a public water supply well(s) supplying a community or non-transient, non-community public water system which will provide water from an aquifer to the well(s) within five years as delineated or endorsed by Ohio EPA under Ohio's Wellhead Protection and Source Water Assessment and Protection Programs.

DWSPA information is available by contacting the Ohio EPA's Division of Drinking and Ground Water (DDAGW) by e-mail, fax, and mail. Each request must include the following:

- Name of person and company or organization making the request;
- A mailing address and contact information (phone number and e-mail address);
- Purpose of request (i.e., BUSTR Tier 1 Delineation); and
- Topographic map identifying the UST site and surrounding area with the name and address of the UST site.

Please specify a preference for paper or electronic response. Maps provided via e-mail will be prepared in a PDF or JPG format.

Submit fax requests to the attention of "SWAP Program Staff" (614) 644-2909.

Submit e-mail requests to WHP@epa.state.oh.us

Submit mail requests to:

SWAP Program
Ohio EPA/DDAGW
PO Box 1049
Columbus, OH 43016-1049

Sensitive Areas

BUSTR rules define certain parts of Ohio as *Sensitive Areas* and establish technical standards for USTs in those areas. Proximity to drinking water sources is the main criterion for designating areas as sensitive. OAC 1301:7-9-09 defines certain Sensitive Areas associated with sole source aquifers and areas associated with, but not limited to, lakes, reservoirs, developed springs, and water supply wells. (See Appendix D, Sensitive Areas, for more detailed information.)

Surface Water

Surface water body is defined as a body of water greater than one acre in size or a river, creek, or stream. To determine if a body of water within 300 ft. of the UST site is considered a river, creek, or stream by BUSTR definition, perform the following:

- Reference the OAC 3745-1-01 through 54;
- Search 7.5 minute United States Geological Survey (USGS) quadrangle maps; and
- Conduct a physical survey.

If a body of water is identified in any of the above, it will be considered a river, creek, or stream by BUSTR. The site conceptual exposure model assumes that ground water is discharging into a surface water body if the surface water body is within 300 ft. of the UST site.

Well Log Search

The O/O must identify the source or sources of potable water for the UST site and the surrounding area, including documentation of all public and private drinking water wells and public water supply sources within the surrounding area. This evaluation may be conducted by contacting the Ohio EPA, the Ohio Department of Natural Resources (ODNR), health departments, and public water supply organizations.

The well log search in Tier 1 Delineation is not to identify a point of exposure but is used to determine if groundwater is or has the potential to become drinking water.

The following section clarifies the requirements for locating potential drinking water sources (i.e., water wells, dug wells, industrial process water, irrigation, or other non-potable wells) within the 2,000 ft. area surrounding the UST system.

Consider these points before attempting to locate water wells:

- When attempting to eliminate the drinking water pathway, the O/O must perform a thorough search (as discussed below) for drinking water sources within the surrounding area;
- If a well log (excluding logs for MWs) is identified to be within the surrounding area of the site, classify the ground water as drinking water;
- Any identified current or potential future drinking water source in the surrounding area is assumed to be within the source area;
- Assume that wells completed in lower saturated zones are drawing water from the upper saturated zone;
- If the location of a potable well cannot be conclusively determined to be beyond the surrounding area, ground water is classified as drinking water.

Standard Search

Most searches for drinking water sources (i.e., water well logs) begin at the ODNR, Division of Water. The search for well logs at ODNR is usually conducted one of two ways, either by visiting ODNR and physically reviewing their files or by submitting a request (via fax or mail) that the ODNR staff perform (and report) the search. Each well log search request (fax or mail) must include the following:

- Name of person and company or organization making the request;
- A mailing address and contact information (phone number and e-mail address);
- Purpose of request (i.e., BUSTR Tier 1 Delineation); and
- Topographic map identifying the UST site and surrounding area with the name and address of the UST site.

Submit fax requests to the attention of "Groundwater Resources Section" (614) 265-6767

Submit mail requests to:

Ohio Department of Natural Resources
Division of Water
Groundwater Resource Section
2045 Morse Rd, Building B-2
Columbus, OH 43229-6605

The well log search must include both the *located* and *unlocated* well logs. According to ODNR, approximately 30% of the potable wells are listed as located wells. The remaining 70% have not been physically located by ODNR because either the agency did not have enough resources to document the exact location of each well, or the well log did not contain enough information (i.e. street address, nearest intersection, map) to determine the specific location. The well log search comprises three steps. The steps are as follows:

1. Identify all located wells in the surrounding area and any unlocated wells on the UST site;
2. Identify all unlocated wells with a physical street address in the surrounding area; and
3. Identify all unlocated wells without a physical street address in the surrounding area.

Step 1

The located well logs have been identified by ODNR on a topographic map. A copy of the topographic map with the well locations identified and a copy of each well log within the surrounding area is required to be submitted to BUSTR. If no located wells are present in the surrounding area, a copy of the ODNR located wells map or a letter from ODNR indicating that there are no potable wells in the surrounding area should be submitted to BUSTR. If a letter from ODNR is submitted, a map indicating the search area must also be included.

Step 2

If no potable wells are identified in Step 1, the unlocated well logs that have a physical street address must be reviewed. Each of these unlocated wells, which have a physical street address, must be identified on a topographic map. A topographic map with the location of each of these wells and a copy of each well log must be provided to BUSTR.

Step 3

If no potable wells are identified in Steps 1 and 2, the unlocated well logs that do not have a physical street address must be reviewed. This step typically involves interviews, review of city directories, a door-to-door survey, correspondence with the local/municipal water provider, etc. Each of the unlocated wells must be identified on a topographic map. The topographic map with the location of each of these wells and a copy of each well log must be provided to BUSTR. If the location of an unlocated well cannot be determined, the well is assumed to be within the surrounding area and therefore, ground water is considered drinking water.

Located and unlocated well logs are available on ODNR's website at www.dnr.state.oh.us. The map identifying all of the located wells and the sketch at the bottom of each individual well log is not available on the website. Therefore, review of only the online database will not be sufficient to make the determination that no potable wells are present in the surrounding area.

In addition to the search at ODNR, the local health departments must also be contacted to determine whether they have any well log records within the UST site and surrounding area. The Ohio Department of Health (ODH) website at www.odh.state.oh.us has contact information regarding local health departments.

Physical Survey

A physical survey of all properties within 300 ft. of the release site property boundaries may be necessary when trying to eliminate ground water as a drinking water source. The survey must include, but not be limited to, correspondence on a form prescribed by BUSTR to all property owners within 300 ft. of the UST site property boundaries. The information submitted to BUSTR should include a map of all properties within 300 ft. of the UST site and documentation of all correspondence from the physical survey. If such correspondence is inconclusive, and less than 75% of the surrounding properties respond to the survey, BUSTR may require that additional survey methods (i.e., phone call, door-to-door) be conducted. BUSTR will evaluate overall survey results for each site on a case-by-case basis. (See Appendix E, Forms, for correspondence language.)

Local Ordinances

Local ordinances requiring a mandatory tie-in to the municipal water supply system or prohibiting the installation of potable water wells must be promulgated by the municipality or by municipalities with jurisdiction over all properties within the surrounding area of the UST system.

Municipal Water Availability

The local municipality must be contacted to determine that the UST site and 100% of the properties within 300 ft. of the UST site are currently receiving municipal water. Undeveloped properties must have a water main within 50 ft. of the property boundary to be considered a readily available water source.

3.8.3 Tier 1 Source Investigation and Delineation Reporting (Tier 1 Investigation Report)

The purpose of the Tier 1 Investigation Report is to summarize the Tier 1 Source Investigation and Tier 1 Delineation activities.

The O/O must prepare a Tier 1 Investigation Report on a form prescribed by BUSTR. The Tier 1 Investigation Form in Appendix E, Forms provides an outline to be followed when completing the Tier 1 Investigation Report. The O/O must submit the report within one year of the following:

- Receiving analytical results that exceed ALs during Options 1, 2, or 3 of a Site Check;
- Electing to conduct corrective actions under the 2005 CA Rule for releases reported prior to March 1, 2005;
- Receiving analytical results that exceed ALs from a closure assessment as part of the closure rule; or
- Conducting corrective action activities in accordance with the 2005 CA Rule following the expiration date of the 1992 (September 1, 2005) or the 1999 (March 1, 2006) corrective action rules.

3.8.4 Tier 1 Investigation Decision

Upon submission of the Tier 1 Investigation Report, BUSTR will evaluate the report for completeness and technical adequacy. If the concentrations of all COCs are at or below the ALs for all applicable pathways, then NFA is required. If the concentrations of a particular COC are at or below the ALs, then no further evaluation is necessary for that COC and its corresponding exposure pathway. However, that particular COC must continue to be analyzed during subsequent investigations.

If the concentration of one or more COC is above the applicable AL and upon approval of the completeness and technical adequacy of the Tier 1 Investigation Report, the O/O must conduct *one or a combination* of the following:

- Conduct an Interim Response Action (IRA) in accordance with Section 3.10;
- Conduct a Tier 2 Evaluation in accordance with Section 3.11; or
- Submit a Remedial Action Plan (RAP) in accordance with Section 3.13.

3.9 Delineation and Action Levels

3.9.1 Delineation Levels

Soil delineation levels were chosen from the lowest action level from the following pathways: soil to indoor air, soil to non-drinking water, and direct contact. Ground water delineation levels were calculated by dividing the ground water to indoor air action level by a factor of 10. If the calculated delineation level is less than the ground water ingestion number (e.g., xylenes), the ground water ingestion number was used. The delineation levels are not risk-based and may not be revised. The delineation levels in soil and ground water for COCs are listed in Table 3.3, below:

Table 3.3- Delineation Levels

Chemicals of Concern	Ground Water (mg/L)	Soil (mg/kg)
Benzene	0.428	1.04
Toluene	15.5	61.3
Ethylbenzene	38.1	199
o, m and p-Xylenes	10	15.7
Methyl tertiary-butyl ether (MTBE)	1,240	1,240
Benzo(a)anthracene	66.7	11
Benzo(a)pyrene	12.7	1.1
Benzo(b)fluoranthene	6.72	11
Benzo(k)fluoranthene	2380	110
Chrysene	715	1,100
Dibenz(a,h)anthracene	35.3	1.1
Indeno(1,2,3 –c,d)pyrene	202	11
Naphthalene	2.22	54

NOTE: TPH must be delineated to the action levels in Table 3.8, TPH Action Levels.

3.9.2 Action Levels

Use the complete exposure pathways to determine the appropriate action level table(s). Use the data and information collected during the Tier 1 Investigation to determine the appropriate action level within each table. Refer to the tables listed in Section 3.9.3, Action Level Tables for the ALs specific to each applicable pathway listed below.

Drinking Water Scenario

If ground water is determined to be drinking water, then compare the highest concentration of each of the COCs in soil and ground water to the ALs for the following pathways:

- Direct Contact;
- Ground Water Ingestion;
- Ground Water to Outdoor Air;
- Ground Water to Indoor Air;
- Soil to Drinking Water Leaching;
- Soil to Indoor Air; and
- Soil to Outdoor Air.

In addition to the above-mentioned pathways, TPH concentrations must also be compared to the action levels in Table 3.8, TPH Action Levels.

Non-Drinking Water Scenario

If ground water is determined to be non-drinking water, then compare the highest concentration of each of the COCs in soil and ground water to the ALs for the following pathways:

- Ground Water to Indoor Air;
- Ground Water to Outdoor Air;
- Direct Contact;
- Soil to Indoor Air;
- Soil to Outdoor Air; and
- Soil to Non-Drinking Water Leaching.

In addition to the above-mentioned pathways, TPH concentrations must also be compared to the action levels in Table 3.8, TPH Action Levels.

No Ground Water Scenario

If no ground water has been encountered, then compare the highest concentration of each of the COCs in soil to the ALs in the following pathways:

- Direct Contact;
- Soil to Outdoor Air; and
- Soil to Indoor Air.

3.9.3 Action Level Tables

Table 3.4- Ground Water Ingestion Action Levels

Chemicals of Concern	Action Levels
Benzene	0.005
Toluene	1
Ethylbenzene	0.7
o, m and p-Xylenes	10
Methyl tertiary-butyl ether (MTBE)	0.04
Benzo(a)anthracene	0.00026
Benzo(a)pyrene	0.0002
Benzo(b)fluoranthene	0.00017
Benzo(k)fluoranthene	0.0017
Chrysene	.047
Dibenz(a,h)anthracene	0.0002
Indeno(1,2,3-c,d)pyrene	0.00022
Naphthalene	0.14

All chemical concentrations expressed in milligrams per liter (mg/L).

Tables 3.5- Ground Water to Indoor Air Action Levels

Soil Class 1

Chemicals of Concern	Ground Water to Indoor Air							
	<15 Feet		15-30 Feet		31-50 Feet		>50 Feet	
	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.
Benzene	4.28	26.80	4.28	26.80	4.34	27.20	4.42	27.70
Toluene	155.00	2,510.00	155.00	2,520.00	157.00	2,550.00	160.00	2,600.00
Ethylbenzene	381.00	6,180.00	381.00	6,180.00	387.00	6,270.00	393.00	6,380.00
o, m and p-Xylenes	41.30	670.00	41.30	671.00	41.90	681.00	42.70	692.00
MTBE*	12,400.00	200,000.00	12,400.00	201,000.00	12,600.00	204,000.00	12,800.00	208,000.00
Benzo(a)anthracene	667.00	4,170.00	668.00	4,180.00	683.00	4,270.00	701.00	4,390.00
Benzo(a)pyrene	127.00	794.00	127.00	796.00	132.00	825.00	137.00	860.00
Benzo(b)fluoranthene	67.20	421.00	67.30	421.00	68.40	428.00	69.60	436.00
Benzo(k)fluoranthene	23,800.00	149,000.00	23,900.00	149,000.00	25,000.00	156,000.00	26,300.00	164,000.00
Chrysene	7,150.00	44,700.00	7,160.00	44,800.00	7,270.00	45,500.00	7,410.00	46,400.00
Dibenz(a,h)anthracene	353.00	2,210.00	356.00	2,230.00	404.00	2,530.00	461.00	2,890.00
Indeno(1,2,3-c,d)pyrene	2,020.00	12,600.00	2,030.00	12,700.00	2,100.00	13,100.00	2,190.00	13,700.00
Naphthalene	22.20	359.00	22.20	360.00	22.50	365.00	22.90	372.00

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Soil Class 2

Chemicals of Concern	Ground Water to Indoor Air							
	<15 Feet		15-30 Feet		31-50 Feet		>50 Feet	
	Residential	Non-Resid.	Residential	Non-Resid	Residential	Non-Resid	Residential	Non-Resid
Benzene	4.29	26.80	4.29	26.90	4.38	27.40	4.49	28.10
Toluene	155.00	2,520.00	155.00	2,520.00	159.00	2,570.00	162.00	2,640.00
Ethylbenzene	382.00	6,190.00	382.00	6,200.00	390.00	6,330.00	399.00	6,480.00
o, m and p-Xylenes	41.40	672.00	41.40	672.00	42.30	686.00	43.30	703.00
MTBE*	12,400.00	201,000.00	12,400.00	201,000.00	12,700.00	206,000.00	13,000.00	211,000.00
Benzo(a)anthracene	669.00	4,180.00	670.00	4,190.00	689.00	4,310.00	712.00	4,450.00
Benzo(a)pyrene	127.00	795.00	127.00	797.00	132.00	828.00	138.00	865.00
Benzo(b)fluoranthene	67.40	422.00	67.50	422.00	69.00	432.00	70.80	443.00
Benzo(k)fluoranthene	23,800.00	149,000.00	23,800.00	149,000.00	24,900.00	156,000.00	26,200.00	164,000.00
Chrysene	7,170.00	44,900.00	7,180.00	44,900.00	7,340.00	45,900.00	7,530.00	47,100.00
Dibenz(a,h)anthracene	344.00	2,150.00	346.00	2,160.00	369.00	2,310.00	397.00	2,490.00
Indeno(1,2,3-c,d)pyrene	2,020.00	12,700.00	2,030.00	12,700.00	2,110.00	13,200.00	2,200.00	13,800.00
Naphthalene	22.20	360.00	22.20	361.00	22.70	369.00	23.30	378.00

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Soil Class 3

Chemicals of Concern	Ground Water to Indoor Air							
	<15 Feet		15-30 Feet		31-50 Feet		>50 Feet	
	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.
Benzene	4.39	27.50	4.42	27.60	4.80	30.10	5.26	32.90
Toluene	159.00	2,580.00	160.00	2,600.00	174.00	2,820.00	190.00	3,090.00
Ethylbenzene	391.00	6,350.00	393.00	6,380.00	427.00	6,930.00	468.00	7,590.00
o, m and p-Xylenes	42.40	688.00	42.70	692.00	46.40	752.00	50.80	824.00
MTBE**	12,700.00	206,000.00	12,800.00	207,000.00	13,900.00	226,000.00	15,300.00	249,000.00
Benzo(a)anthracene	669.00	4,190.00	670.00	4,190.00	690.00	4,320.00	714.00	4,470.00
Benzo(a)pyrene	126.00	789.00	126.00	790.00	129.00	804.00	131.00	822.00
Benzo(b)fluoranthene	68.90	431.00	69.30	433.00	74.90	469.00	81.70	511.00
Benzo(k)fluoranthene	23,500.00	147,000.00	23,600.00	147,000.00	23,900.00	150,000.00	24,400.00	153,000.00
Chrysene	7,330.00	45,800.00	7,360.00	46,100.00	7,960.00	49,800.00	8,660.00	54,200.00
Dibenz(a,h)anthracene	337.00	2,110.00	337.00	2,110.00	342.00	2,140.00	347.00	2,170.00
Indeno(1,2,3-c,d)pyrene	2,010.00	12,600.00	2,010.00	12,600.00	2,050.00	12,800.00	2,090.00	13,100.00
Naphthalene	22.80	370.00	22.90	372.00	25.00	406.00	27.50	446.00

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Tables 3.6- Ground Water to Outdoor Air Action Levels

Soil Class 1

Chemicals of Concern	Ground Water to Outdoor Air		
	Residential	Non-Residential	Excavation Worker
Benzene	818.00	515.00	5,520.00
Toluene	32,500.00	53,100.00	68,800.00
Ethylbenzene	82,700.00	135,000.00	175,000.00
o, m, and p-Xylenes	8,560.00	14,000.00	18,100.00
Methyl tertiary-butyl ether (MTBE)	758,000.00	>1E^+6	>1E^+6
Benzo(a)anthracene	24,800.00	15,600.00	507,000.00
Benzo(a)pyrene	7,680.00	4,840.00	157,000.00
Benzo(b)fluoranthene	2,020.00	1,270.00	41,200.00
Benzo(k)fluoranthene	>1E^+6	>1E^+6	>1E^+6
Chrysene	212,000.00	133,000.00	>1E^+6
Dibenz(a,h)anthracene	78,400.00	49,400.00	>1E^+6
Indeno(1,2,3-c,d)pyrene	123,000.00	77,200.00	>1E^+6
Naphthalene	1,200.00	1,970.00	2,550.00

All chemical concentrations expressed in milligrams per liter (mg/L).

Soil Class 2

Chemicals of Concern	Ground Water to Outdoor Air		
	Residential	Non-Residential	Excavation Worker
Benzene	860.00	541.00	5,800.00
Toluene	34,000.00	55,600.00	72,000.00
Ethylbenzene	86,300.00	141,000.00	183,000.00
o, m and p-Xylenes	8,960.00	14,600.00	18,900.00
Methyl tertiary-butyl ether (MTBE)	885,000.00	>1E^+6	>1E^+6
Benzo(a)anthracene	31,600.00	19,900.00	645,000.00
Benzo(a)pyrene	8,200.00	5,170.00	167,000.00
Benzo(b)fluoranthene	2,720.00	1,710.00	55,500.00
Benzo(k)fluoranthene	>1E^+6	>1E^+6	>1E^+6
Chrysene	286,000.00	180,000.00	>1E^+6
Dibenz(a,h)anthracene	38,700.00	24,400.00	789,000.00
Indeno(1,2,3-c,d)pyrene	131,000.00	82,400.00	>1E^+6
Naphthalene	1,430.00	2,340.00	3,030.00

All chemical concentrations expressed in milligrams per liter (mg/L).

Soil Class 3

Chemicals of Concern	Ground Water to Outdoor Air		
	Residential	Non-Residential	Excavation Worker
Benzene	1,350.00	848.00	9,080.00
Toluene	51,500.00	84,100.00	109,000.00
Ethylbenzene	129,000.00	211,000.00	273,000.00
o, m, and p-Xylenes	13,600.00	22,200.00	28,800.00
Methyl tertiary-butyl ether (MTBE)	>1E^+6	>1E^+6	>1E^+6
Benzo(a)anthracene	33,000.00	20,800.00	673,000.00
Benzo(a)pyrene	3,870.00	2,440.00	78,900.00
Benzo(b)fluoranthene	9,560.00	6,020.00	195,000.00
Benzo(k)fluoranthene	642,000.00*	405,000.00*	>1E^+6
Chrysene	991,000.00	625,000.00	>1E^+6
Dibenz(a,h)anthracene	7,210.00	4,540.00	147,000.00
Indeno(1,2,3-c,d)pyrene	61,500.00	38,700.00	>1E^+6
Naphthalene	4,030.00	6,590.00	8,540.00

All chemical concentrations expressed in milligrams per liter (mg/L).

*Concentration listed in OAC 1301:7-9-13(J)(3) were incorrectly calculated. The concentrations listed in the above table should be utilized.

Table 3.7- Direct Contact Action Levels

Chemicals Of Concern	Direct Contact		
	Residential	Non-Residential	Excavation Worker
Benzene	9.8	100	310
Toluene	590	5,900	24,000
Ethylbenzene	1,500	17,000	160,000
o, m and p-Xylenes	660	6400	7,000
Methyl tertiary-butyl ether (MTBE)	5,300	57,000	57,000
Benzo(a)anthracene	11	63	810
Benzo(a)pyrene	1.1	6.3	81
Benzo(b)fluoranthene	11	63	810
Benzo(k)fluoranthene	110	630	8,100
Chrysene	1,100	6,700	41,000
Dibenz(a,h)anthracene	1.1	6.7	41
Indeno(1,2,3-c,d)pyrene	11	67	410
Naphthalene	54	530	1,900

All chemical concentrations expressed in milligrams per kilogram (mg/kg).

Table 3.8- TPH Action Levels

Petroleum Fraction	Soil Class 1	Soil Class 2	Soil Class 3
Light Distillate Fraction (C6-C12)	1,000	5,000	8,000
Middle Distillate Fraction (C10-20)	2,000	10,000	20,000
Heavy Distillate Fraction (C20-C34)	5,000	20,000	40,000

All chemical concentrations expressed in milligrams per kilogram (mg/kg).

Table 3.9- Soil to Indoor Air, Drinking Water Leaching and Non-Drinking Water Leaching

Soil Class 1

Chemicals of Concern	Soil to Indoor Air		Soil to Outdoor Air			Soil to Drinking Water Leaching	Soil to Non-Drinking Water Leaching
	Residential	Non-Residential	Residential	Non-Residential	Excavation		
Benzene	1.04	6.50	32.70	20.60	221.00	0.149	12.80
Toluene	61.30	994.00	1,930.00	3,150.00	4,090.00	49.10	760.00
Ethylbenzene	199.00	3,230.00	6,280.00	10,300.00	13,300.00	45.50	2,480.00
o, m and p-Xylenes	15.70	254.00	494.00	806.00	1,040.00	469.00	194.00
Methyl tertiary-butyl ether (MTBE)	1,240.00	20,200.00	39,300.00	64,200.00	83,100.00	0.470	14,600.00
Benzo(a)anthracene	476,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	22.20	>1E^+6
Benzo(a)pyrene	245,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	50.60	>1E^+6
Benzo(b)fluoranthene	165,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	55.30	>1E^+6
Benzo(k)fluoranthene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	501.00	>1E^+6
Chrysene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	4,410.00*	>1E^+6
Dibenz(a,h)anthracene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	94.00*	>1E^+6
Indeno(1,2,3-c,d)pyrene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	244.00	>1E^+6
Naphthalene	54.00	877.00	1,710.00	2,790.00	3,610.00	39.80	632.00

All chemical concentrations expressed in milligrams per kilogram (mg/kg).

*Concentration listed in OAC 1301:7-9-13(J)(3) were incorrectly calculated. The concentrations listed in the above table should be utilized.

Soil Class 2

Chemical of Concern	Soil to Indoor Air		Soil to Outdoor Air			Soil to Drinking Water Leaching	Soil to Non-Drinking Water Leaching
	Residential	Non-Residential	Residential	Non-Residential	Excavation		
Benzene	1.15	7.22	51.00	32.10	344.00	0.252	21.60
Toluene	70.80	1,150.00	3,130.00	5,110.00	6,610.00	105.00	1,630.00
Ethylbenzene	233.00	3,780.00	10,300.00	16,800.00	21,800.00	83.00	4,530.00
o, m and p-Xylenes	18.00	291.00	793.00	1,300.00	1,680.00	825.00	342.00
Methyl tertiary-butyl ether (MTBE)	1,370.00	22,200.00	60,500.00	98,900.00	128,000.00	0.788	24,400.00
Benzo(a)anthracene	596,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	18,600.00	>1E^+6
Benzo(a)pyrene	306,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Benzo(b)fluoranthene	206,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Benzo(k)fluoranthene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	738,000.00	>1E^+6
Chrysene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	451,000.00*	>1E^+6
Dibenz(a,h)anthracene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Indeno(1,2,3-c,d)pyrene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Naphthalene	67.30	1,090.00	2,980.00	4,860.00	6,300.00	84.20	1,340.00

All chemical concentrations expressed in milligrams per kilogram (mg/kg).

*Concentration listed in OAC 1301:7-9-13(J)(3) were incorrectly calculated. The concentrations listed in the above table should be utilized.

Soil Class 3

Chemical of Concern	Soil to Indoor Air		Soil to Outdoor Air			Soil to Drinking Water Leaching	Soil to Non-Drinking Water Leaching
	Residential	Non-Residential	Residential	Non-Residential	Excavation		
Benzene	1.42	8.86	267.00	168.00	1,800.00	0.937	82.30
Toluene	86.00	1,400.00	16,200.00	26,500.00	34,300.00	479.00	7,610.00*
Ethylbenzene	282.00	4,570.00	53,100.00	86,800.00	112,000.00	313.00	17,500.00
o, m and p-Xylenes	21.70	353.00	4,100.00	6,700.00	8,670.00	3,060.00	1,300.00
Methyl tertiary-butyl ether (MTBE)	1,970.00	32,000.000	368,000.00	601,000.00	778,000.00	3.440	109,000.00
Benzo(a)anthracene	716,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Benzo(a)pyrene	366,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Benzo(b)fluoranthene	251,000.00	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Benzo(k)fluoranthene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Chrysene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Dibenz(a,h)anthracene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Indeno (1,2,3-c,d)pyrene	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6	>1E^+6
Naphthalene	82.80	1,340.00	15,400.00	25,100.00	32,500.00	362.00	5,890.00

All chemical concentrations expressed in milligrams per kilogram (mg/kg).

*Concentration listed in OAC 1301:7-9-13(J)(3) were incorrectly calculated. The concentrations listed in the above table should be utilized.

3.9.4 Multiple Chemical Adjustments

A multiple chemical adjustment calculation needs to be conducted when 10 or more non-carcinogenic or carcinogenic COCs are present when analyzing for Analytical Groups 4 and/or 5. Table F.6 of Appendix F, Action Level Development, contains a list of chemicals along with their associated toxicological data. Toxicological data for COCs not listed in Appendix F can be obtained through such other resources as Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), etc.

COCs having carcinogenic effects shall not exceed a cumulative risk of $1x10^{-5}$ (i.e., one excess cancer in a population of 100,000) and those having non-carcinogenic effects shall not exceed a hazard index of 1.0.

For COCs having carcinogenic effects, a cancer risk ratio for each chemical must be determined by dividing the maximum concentration of each carcinogenic chemical identified on the UST site by the appropriate action level for a specific exposure pathway (e.g., soil to indoor air, ground water to indoor air). Carcinogenic action levels listed in Tables 3.4 through 3.9 were calculated to 10^{-5} risk. The cancer risk ratios for all of the carcinogenic chemicals identified at the UST site must be added to calculate a cumulative risk ratio for each individual exposure pathway.

Example:
The soil to indoor air action level (for a residential receptor, Soil Class 1 scenario) is 1.04 mg/kg for benzene, 245,000 mg/kg for benzo(a)pyrene, and 15.4 mg/kg for tetrachloroethylene. Note that all of these action levels were calculated using BUSTR spreadsheets. If the maximum soil concentration is 0.6 mg/kg for benzene, 1.0 mg/kg for benzo(a)pyrene, and 2.0 mg/kg tetrachloroethylene, the multiple chemical calculation is as follows:

$$\underset{\text{benzene}}{\frac{0.6}{1.04}} + \underset{\text{benzo(a)pyrene}}{\frac{1.0}{245{,}000}} + \underset{\text{tetrachloroethylene}}{\frac{2.0}{15.4}} + \ldots \leq 1$$

NOTE: the example above only shows three of the ten or more COCs that would be included in the actual calculation.

For COCs having non-carcinogenic effects, the non-carcinogenic risk ratio for each chemical must be determined by dividing the maximum concentration of each chemical identified on the UST site that has a non-carcinogenic action level value by the appropriate action level for a specific exposure pathway. The non-cancer risk ratios for all of the COCs must be added to calculate a cumulative risk ratio. The calculation is similar to the carcinogenic risk ratio calculation previously described.

If the sum of the carcinogenic risk ratios exceeds 1×10^{-5} and/or the sum of the non-carcinogenic risk ratios exceeds 1.0, further corrective actions are required. All COCs are assumed to affect the same target organ.

For situations where a COC poses both a carcinogenic and non-carcinogenic risk, the COC must be evaluated in the adjustment calculation for both the carcinogenic and non-carcinogenic effects.

A cumulative adjustment shall be made for each of the following pathways: Direct Contact with Soil; Soil to Indoor Air; Soil to Outdoor Air; Ground Water Ingestion; Ground Water to Outdoor Air; and Ground Water to Indoor Air.

For COCs not listed in 3.9.3, Action Level Tables, action levels for ground water ingestion and direct contact with soil can be located in OAC 3745-300-08 (Generic Numerical Standards) and the Ohio EPA, DERR VAP, Supplemental Generic Numerical Values. Action levels for soil to indoor air and ground water to indoor air can be calculated using BUSTR's Spreadsheets.

3.10 Interim Response Action

If an IRA is selected, it must be implemented within 90 days of the completion and approval of Tier 1 Delineation, a Tier 2 Evaluation, or a Tier 3 Evaluation. Having implemented an IRA, O/O should then re-evaluate previously identified complete exposure pathways. The IRA may include source removal or short-term actions not exceeding three months.

Submit an IRA Notification Form to BUSTR at least 10 days before beginning the IRA. The IRA Notification Form is located in Appendix E, Forms. Examples of an IRA include, but are not limited to, enhanced fluid recovery (EFR), over excavation, and pump-and-treat. The O/O must secure all permits and handle any flammable or combustible materials in accordance with Federal, state, or local regulatory agencies.

Obtain prior approval from BUSTR if *any* of the following situations exist:

- Combined total volume of soil to be excavated for all tier evaluations is greater than 800 yd^3;
- Combined anticipated time to initiate and complete all IRAs is greater than three months; or
- More than one IRA will be conducted.

The O/Os request for IRA approval must include *all* of the following:

- Description of the activities to be conducted;
- Site map identifying the limits of soil excavation (if applicable);
- Estimation of soil and ground water volumes to be managed;
- Estimation of the anticipated time to completion;
- Confirmatory sampling plan; and
- Comparison of the selected IRA technology to other corrective action options, including an evaluation of costs.

Confirmatory Sampling

After completing an IRA, the O/O must collect a sufficient number of samples for determining the COC concentrations remaining in the soil or ground water. If requesting a no further action from BUSTR, the O/O must demonstrate that all of the COC concentrations remaining in the soil or ground water are at or below the ALs or the site-specific target levels for all applicable pathways. When determining the appropriate quantity and quality of samples to be collected,

consider the spatial distribution of sampling locations and the temporal variations of the COC concentrations.

Confirmatory Sampling for Soil

Collect soil samples from the excavation's side walls and bottom using a ratio of one sample per 100 ft^2. A minimum of one soil sample must be collected from each side wall and from the bottom of the excavation. These samples must be biased towards areas with the highest contamination. If the excavation is less than 400 yd^3, a minimum of one soil sample per wall and one from the bottom of the excavation (total of five samples), with the highest field screening results, must be submitted to the laboratory for analysis.

If the excavation is greater than 400 yd^3, a minimum of two soil samples per wall and two from the bottom of the excavation (total of ten samples), with the highest field screening results, must be submitted to the laboratory for analysis.

Confirmatory Sampling for Ground Water

If the IRA addressed localized ground water contamination, a ground water sampling program must be developed to demonstrate that the IRA was effective. This may require the re-installation of monitoring wells destroyed during the IRA process. At a minimum, collect a ground water sample from each MW within the affected area. At a minimum, at least two months of confirmatory sampling must be conducted in the previously contaminated areas. BUSTR may require additional confirmatory sampling in the previously contaminated area.

IRA Reporting

Within 60 days of completing the IRA, the O/O must prepare and submit the Interim Response Action Report Form prescribed by BUSTR and include the required information. (See Appendix E, Forms.)

3.11 Tier 2 Evaluation

Conduct a Tier 2 Evaluation when COC concentrations are above applicable ALs and upon approval of completeness of the Tier 1 Investigation Report (including Tier 1 Source Investigation and Tier 1 Delineation). The purpose of Tier 2 Evaluation is to:

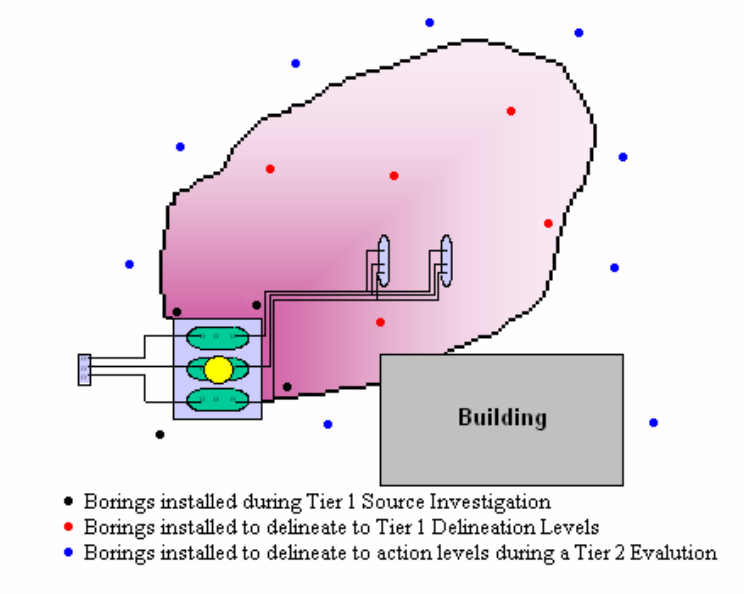
- Define the distribution of COCs to applicable ALs;
- Determine the current and potential future land-use of the UST site and surrounding properties;
- Develop a site conceptual exposure model (SCEM); and
- Develop SSTLs using spreadsheets and models approved by BUSTR.

3.11.1 Determination of the Distribution of Chemicals of Concern

The likely distribution of COCs must be defined according to the lowest applicable Tier 1 action level determined for the UST site for each identified environmental medium. To determine the distribution of COCs in each environmental medium, the O/O must install SBs and ground water MWs. The figure below, Figure 3.9- Typical Well Placement for Delineation of COCs. During a

Tier 2 Evaluation, provides an example of where to place SBs and ground water MWs to determine the likely distribution of COCs. (See Appendix A, Data Collection.)

Figure 3.9 – Typical Well Placement for Delineation of COCs during a Tier 2 Evaluation



If the concentration of a COC is below detection limits (BDL) and below ALs, then that COC may be excluded from future assessment. Obtain off-site access if the distribution of COCs is determined to have migrated to off-site areas. Off-site access agreements must be obtained from the affected property owner. Off-site access denial documentation must be submitted to BUSTR within 45 days of receipt.

3.11.2 Land-Use Determination

The generic site conceptual exposure model, developed for the Tier 1 ALs, assumes that the current and future land-use for the UST site and the adjacent properties is residential. During the Tier 2 Evaluation, a determination may be made for a non-residential land-use.

Determine the current and reasonably anticipated future land-use for the UST site and adjacent properties as either residential or non-residential based on:

- Historical land-use of the UST site and adjacent properties;
- Current land-use of the UST site and adjacent properties;
- Historical zoning or planning designation for the UST site and adjacent properties; and
- Current zoning or planning designation for the UST site and adjacent properties.

Residential Land-use

Examples of residential land-uses include, but are not limited to, housing (single and multiple dwellings), educational facilities, day care facilities, agricultural land, correctional facilities, and custodial or long-term health care facilities.

For residential land-use, adults and children are assumed to be full-time residents living and sleeping on the property. The residents are potentially subject to inhalation of vapors, both indoors and outdoors, direct contact with surface soil (i.e., ingestion, inhalation of vapors, dermal contact, and inhalation of particulates), and ingestion of drinking water from a well on the property. (See Section 3.11.4- Site Conceptual Exposure Model: Point(s) of Exposure.)

Non-Residential Land-use

To classify the UST site as non-residential, the Land-Use Survey Form must be completed *and* one of the following must be true:

- The UST site is non-residential and 75% of the area within 300 ft. of the UST site's property boundary is non-residential land-use. The area of the UST site is not included in land-use calculations. The surface area of all roadways within the 300 ft. area must be included in the land-use calculations. Roadways must be divided in half and counted towards the land-use of the adjoining property. For example, if a roadway separates residential and non-residential properties, half of the roadway will be counted as residential land-use and half as non-residential land-use. Figure 3.10- Example of Land-use Determination below shows an example of land-use determination; or
- A land-use restriction as approved by BUSTR for the UST site has been implemented and recorded in the county where the UST site is located or the O/O has entered into an environmental covenant with BUSTR. (See Appendix C, Use Restrictions.)

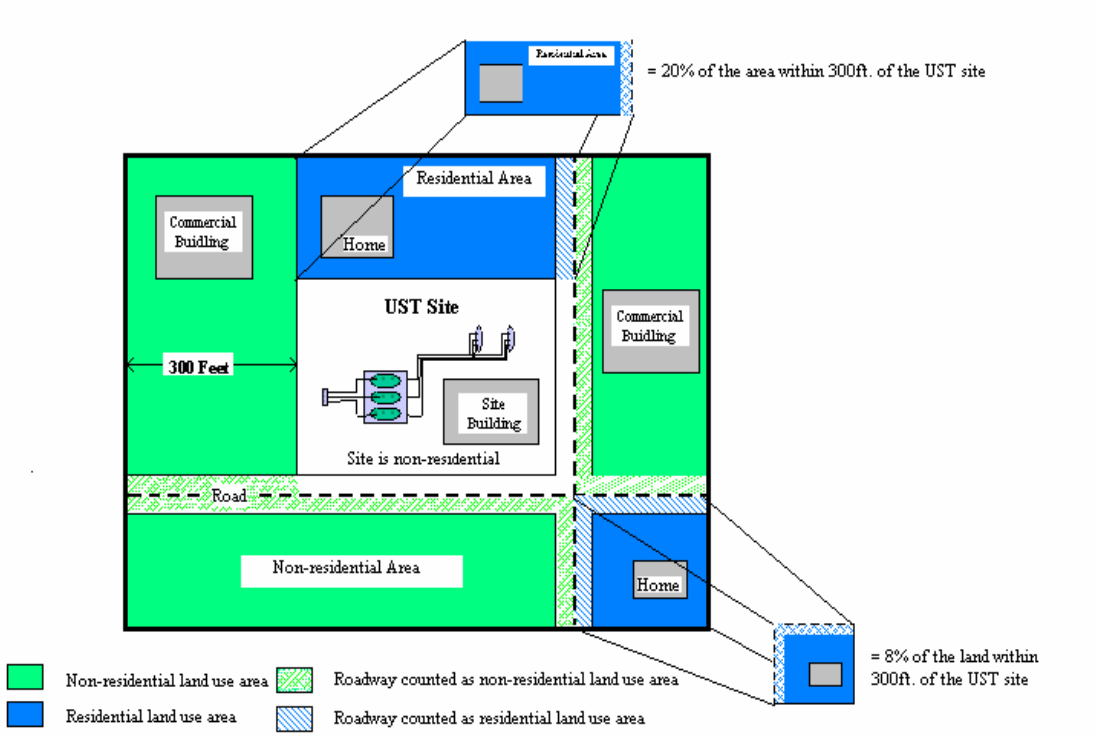
Non-residential land-use includes, but is not limited to, commercial and industrial land. Examples include facilities that supply goods and/or services and are open to the public, such as warehouses, retail gasoline stations and automobile service facilities, office buildings, retail businesses, hospitals, religious institutions, hotels, and parking facilities.

For non-residential land-use, adult workers are assumed to spend a typical work week on the property. The commercial worker is potentially subject to inhalation of vapors, both indoors and outdoors, and to direct contact with surface soil (i.e., ingestion, inhalation of vapors, dermal contact, inhalation of particulates).

Land-Use Survey

A land-use survey of all properties within 300 ft. of the release site property boundaries will be necessary when trying to determine non-residential land-use for the UST site. The survey must include, but not be limited to, the Land-Use Survey Form, prescribed by BUSTR, to all property owners within 300 ft. of the UST site property boundaries. The information submitted to BUSTR should include a map of all properties within 300 ft. of the UST site and documentation of all correspondence from the land-use survey. If such correspondence is inconclusive, and less than 75% of the surrounding properties respond to the survey, BUSTR may require that additional survey methods (i.e., phone call, door-to-door) be conducted. BUSTR will evaluate overall survey results for each site on a case-by-case basis. (See Appendix E, Forms.)

Figure 3.10 – Example of Land-use Determination



NOTE: Because 28% of the area within 300 ft. of the UST site is classified as residential, the UST site is classified as residential

3.11.3 Action Level Determination

Non-residential Action Levels

If the UST site meets a non-residential land-use determination, the O/O must compare the COC concentrations to the appropriate non-residential ALs and ground water use ALs, as follows:

- If all COC concentrations are at or below the ALs for all applicable pathways, then NFA is required. The O/O must prepare a Tier 2 Evaluation Report;
- If the maximum concentration of a specific COC is at or below the applicable AL, then no further evaluation is necessary for that COC and for the corresponding complete exposure pathway; or
- If one or more of the COC concentrations are above non-residential land-use and/or ground water use ALs for any applicable pathway, the O/O must develop a site conceptual exposure model.

If COCs have migrated off the UST site, ALs must be developed for each impacted property according to the corresponding land-use. For example, if a down-gradient property is classified as a residential land-use, then residential exposure scenarios must be evaluated starting at that property's boundary.

Residential Action Levels

If the UST site does not meet the non-residential land-use determination, the O/O must develop a site conceptual exposure model. (See Section 3.11.4, Site Conceptual Exposure Model.)

3.11.4 Site Conceptual Exposure Model

The generic exposure model used in the Tier 1 Evaluation is based on a very specific exposure scenario that could not be modified. In the Tier 2 Evaluation, the O/O may modify the generic exposure model by considering such site-specific characteristics as activity and land-use, types of receptors, and transport mechanisms.

During a Tier 2 Evaluation, a SCEM must be developed to clearly describe the exposure pathways and points of exposure under which an exposure to COCs may occur. A SCEM is required if *either* of these conditions exists:

- One or more of the COC concentrations is above the applicable ground water use ALs;
- One or more of the COC concentrations is above the non-residential land-use ALs; or
- One or more of the COC concentrations is above the residential land-use ALs and the site is classified as residential.

Pathway Evaluation

Exposure Pathway Identification

The Tier 2 Pathway Evaluation must identify all exposure pathways that exceed applicable action level(s). Pathway Evaluations must include identifying all receptors, media, transport mechanisms, and routes of exposure. The SCEM must include *all* the following steps:

1. Evaluate *all* current and potential future receptors that may be exposed to the release, including:

- Adults and children for residential scenarios;
- Adults for non-residential scenarios;
- Adults for excavation worker scenarios; and
- Aquatic life and recreational receptors in a surface water body within 300 ft.

2. Include *all* environmental media that are likely to contain COC concentrations identified for evaluation. Evaluate the following environmental media, as appropriate:

- Soil;
- Ground water;
- Surface water;
- Indoor air; and
- Outdoor air.

3. Identify *all* fate and transport mechanisms for all COCs, to include:

- Atmospheric dispersion;
- Volatilization;
- Enclosed space vapor accumulation;
- Soil leaching; and
- Ground water transport.

4. Evaluate routes of exposure, to include:

- Ingestion;
- Inhalation; and
- Direct contact.

Pathway Completeness

Evaluate exposure pathways to determine if the exposure pathways identified in the SCEM are complete. An exposure pathway is incomplete when *any* of the following criteria are true:

- There is no POE for a COC in an identified environmental media;
- Site-specific data demonstrates that there is no transport mechanism in the identified environmental media to move COCs from the source areas to the POE;
- Site-specific data demonstrates that there are no routes of exposure for the identified receptor;
- POEs are eliminated by ground water use restrictions enforceable by local government, regulatory agencies, or an environmental covenant with BUSTR; and
- POEs are eliminated by land-use restrictions enforceable by local government, regulatory agencies, or an environmental covenant with BUSTR.

Environmental media, routes of exposure, and transport mechanisms may be eliminated by mechanisms which include, but are not limited to, environmental covenants, zoning restrictions, or engineering controls (e.g., slurry walls, capping, vapor control, point of use water treatment) that are maintained by environmental covenants. Engineering controls must be designed, implemented, and approved in a Remedial Action Plan. (See Section 3.13, Remedial Action.) A potable water well may be eliminated as a POE, if that well is properly sealed (i.e., a sealant report is submitted). If the well is not in existence and a sealant report cannot be obtained, an affidavit may be submitted to eliminate that well as the POE. Although this affidavit has eliminated this well as a POE, other POEs must be evaluated.

Land-use Restrictions

Where points of exposure are to be eliminated based on a land-use restriction, the O/O must enter into an environmental covenant with BUSTR to restrict the land-use. This may include, but is not limited to, a restriction on the installation of a basement or the prohibition of building on certain portions of the UST site.

Ground Water Use Restrictions

Where points of exposure are to be eliminated based on a ground water use restriction, the O/O must enter into an environmental covenant with BUSTR to restrict the drinking water use.

Pathway Evaluation Conclusions

If an exposure pathway is determined to be complete, then the O/O must evaluate the POE.

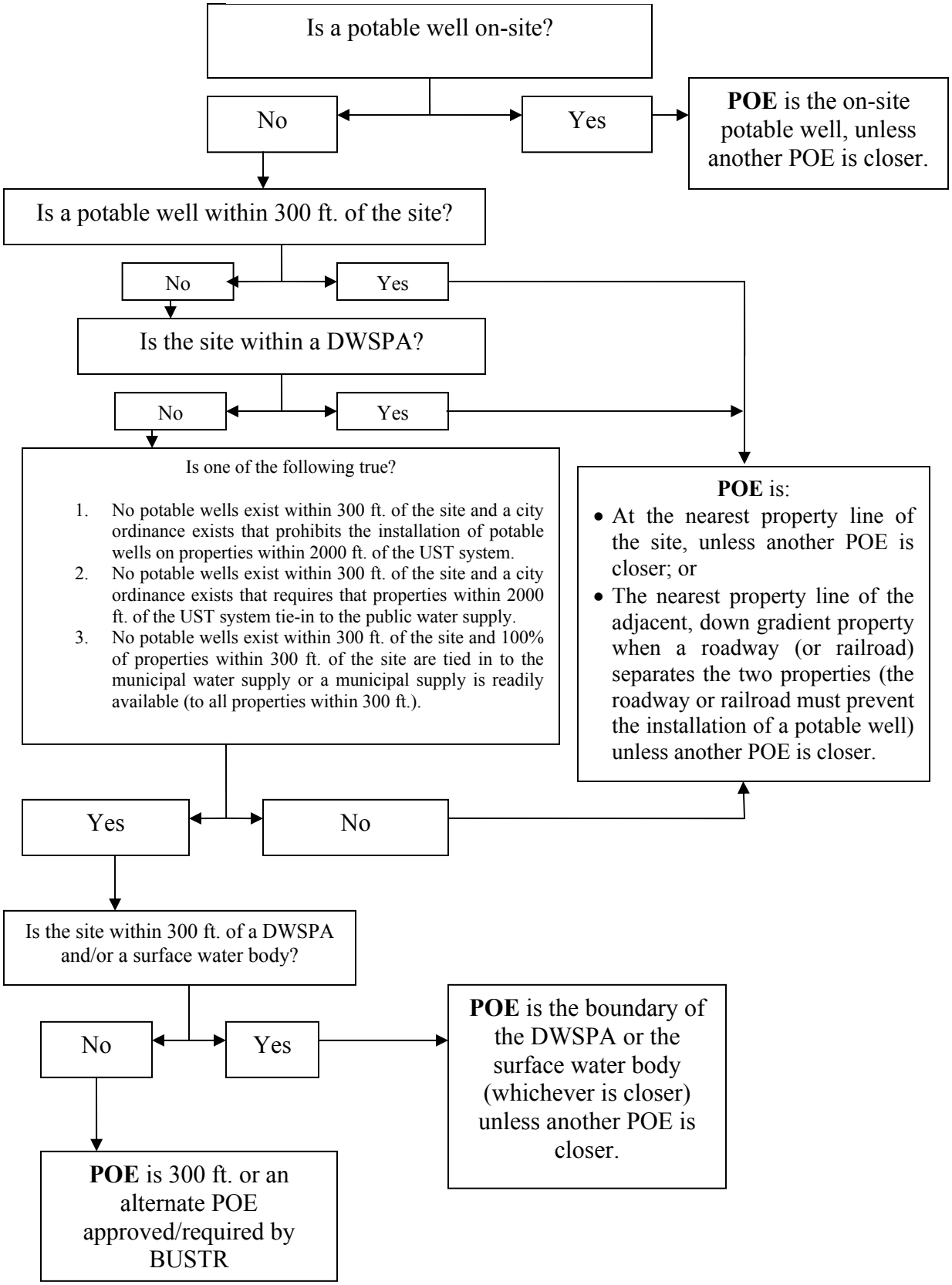
If an exposure pathway is determined to be incomplete, there is no further evaluation required for that exposure pathway. An incomplete exposure pathway must be fully documented and based on information and data collected during the Tier 1 and the Tier 2 Evaluations.

If an exposure pathway cannot be conclusively determined to be incomplete, then the exposure pathway must be considered as complete in the Tier 2 Evaluation.

Points of Exposure

Collect sufficient data to determine if COC concentrations at the POE are above or are likely to be above the appropriate ALs. In some instances this may require the installation of SBs or MWs at each POE. In some cases, samples must be collected from existing drinking water wells. Identify all POEs based on the current and future land-use for the UST site and those properties that may be affected by the release. The POE closest to the source area will be used in the evaluation. (See Flowchart 3.4, Points of Exposure.)

Flowchart 3.4- Points of Exposure



* All POEs must be evaluated. The closest of all POEs will be used to evaluate the site.

POE for Ground Water Ingestion and Soil Leaching to Ground Water (classified as drinking water) Pathway

Where ground water is determined to be drinking water, the POE shall be *one* of the following, whichever is closest to the source area(s):

- Any potable well located on the UST site (see Figure 3.11);
- The property line when a potable well exists within 300 ft. of the UST site (see Figure 3.12);
- The property line when the UST site is located in a DWSPA (see Figure 3.13);
- The DWSPA boundary if a DWSPA is within 300 ft. of the UST site (see Figure 3.14);
- The property line, unless *one* of the following can be demonstrated (see Figure 3.15);
    - No potable wells are located within 300 ft. of the UST site, based on a physical survey, (see Section 3.8.2, Potential Drinking Water Use) and an ordinance requiring a mandatory tie-in to a public water supply for all properties within the surrounding area exists;
    - No potable wells are located within 300 ft. of the UST site (based on a physical survey) and an ordinance prohibiting the installation of potable water wells at all properties within the surrounding area exists; or
    - No potable wells are located within 300 ft. of the UST site (based on a physical survey) and 100 % of the properties within 300 ft. of the UST site are connected to a municipal water source or a municipal source is readily available.
- A roadway or railroad separates the source from the **down gradient** property where a well could be installed, in which case the POE must be the property line of that property (see Figure 3.16);
- If a closer POE has not been identified, the POE must be 300 ft. from the source area(s) or an alternate POE approved by BUSTR. Also, BUSTR may require additional investigation of POE other than those listed above (see Figure 3.17); or
- Surface water where a surface water body exists within 300 ft. of the UST site. The POE must be the point where the ground water containing COC concentrations discharges to the surface water (see Figure 3.18).

Figure 3.11– Example of POE When a Potable Well Exists on the UST Site

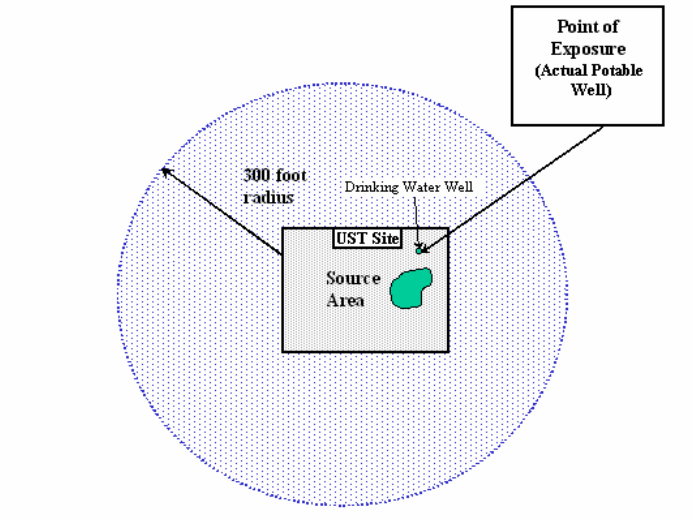


Figure 3.12 – Example of POE When a Potable Well Exists Within 300 ft. of the UST Site

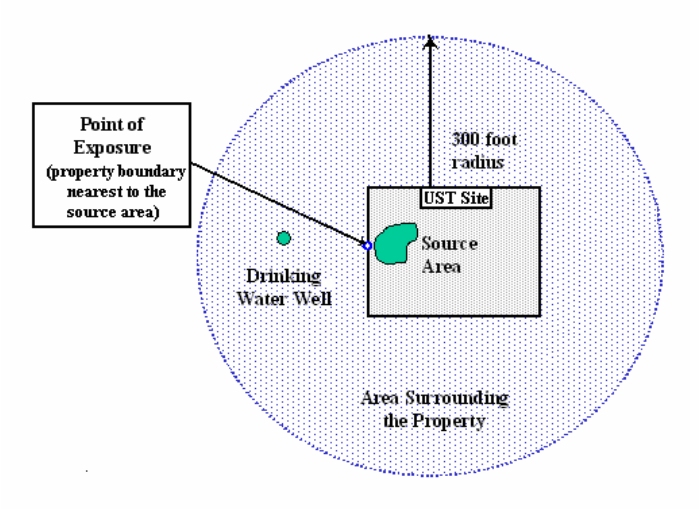


Figure 3.13- Example of POE When the UST Site is in a DWSPA

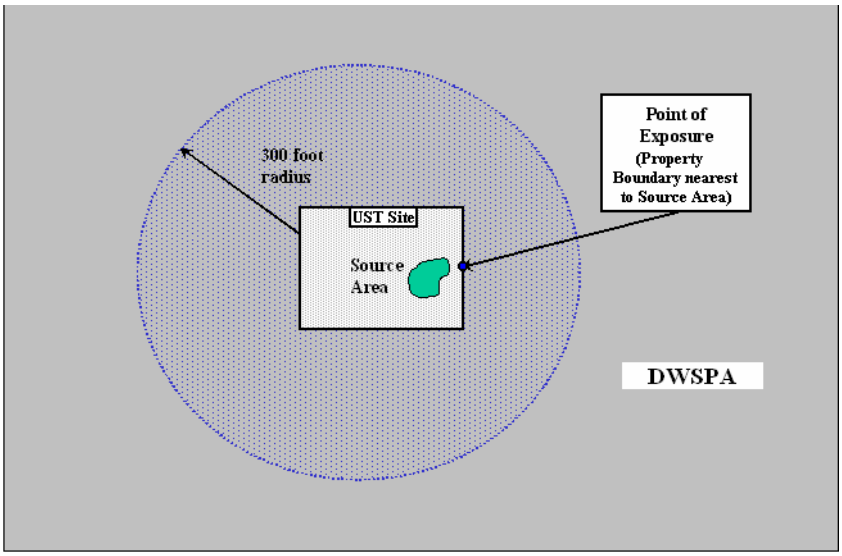


Figure 3.14– Example of POE When a DWSPA Exists Within 300 ft. of the UST Site

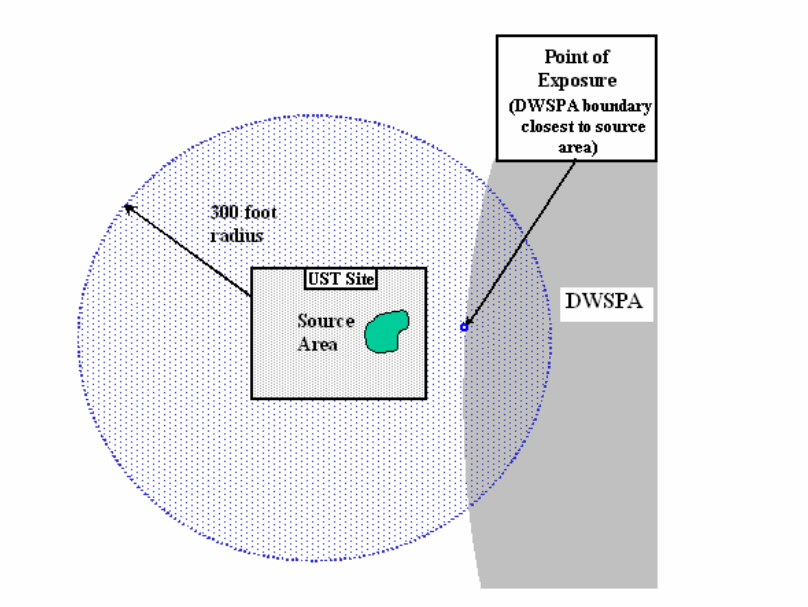


Figure 3.15– Example of POE When No Potable Wells Exist On or Within 300 ft. of the UST Site and <u>None</u> of the Following Is True:

- An ordinance exists that requires a mandatory tie-in to the municipal water supply for all properties within 2,000 ft. of the UST system;
- An ordinance exists that prohibits the installation of potable water wells at all properties within 2,000 ft. of the system; and
- 100% of the properties within 300 ft. are connected to a municipal water source or a municipal water source is readily available.

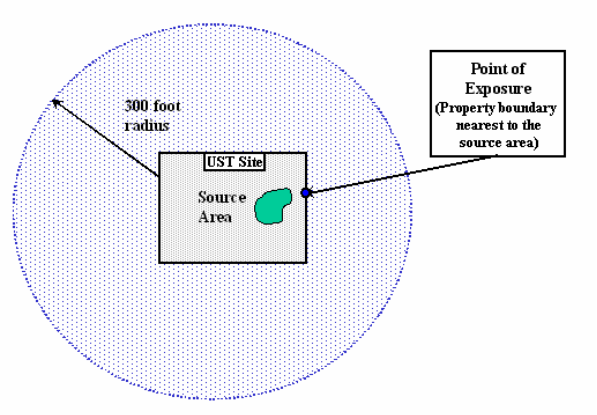


Figure 3.16 – Example of POE Where a Roadway Separates the Source Area from the Down Gradient Property Where a Potable Well Can Be Installed

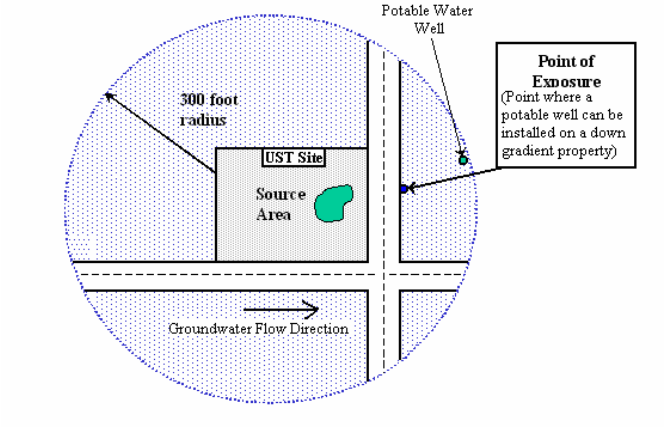


Figure 3.17 – Example of POE When No Other POE Has Been Identified

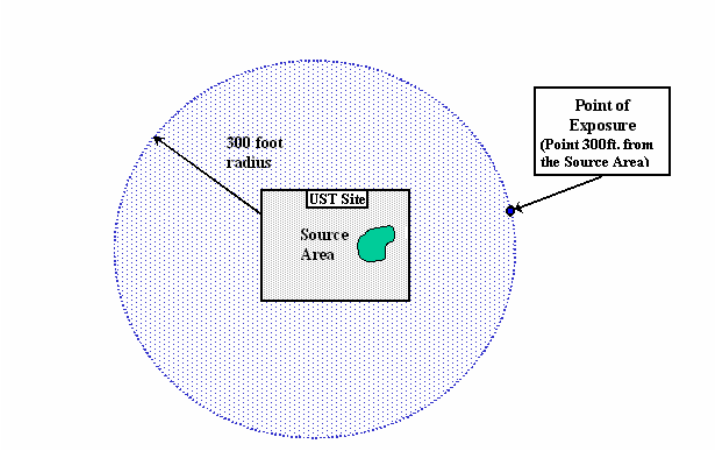
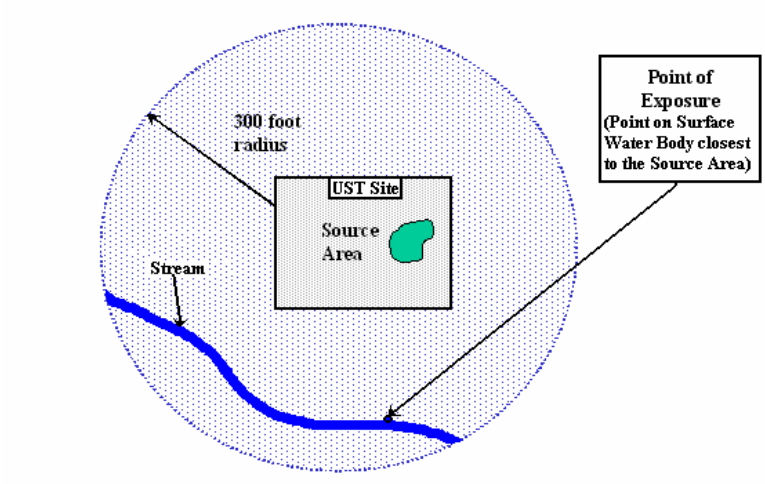


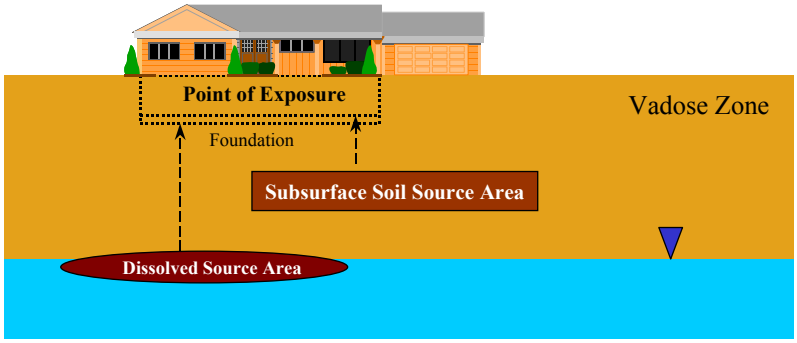
Figure 3.18 – Example of POE When a Surface Water Body Exists Within 300 ft. of the UST Site



POE for Indoor Air Pathways (soil and ground water)

- Residential and/or other buildings located or anticipated to be located above soil or ground water containing COC concentrations. In certain instances it may be appropriate to evaluate the horizontal movement of vapors in the soil (e.g., contaminated soil located under a building set-back area); or
- For subsurface structures, such as utility man-ways and underground tunnels located or anticipated to be located directly above COC concentrations, the POE is the area within the subsurface structures.

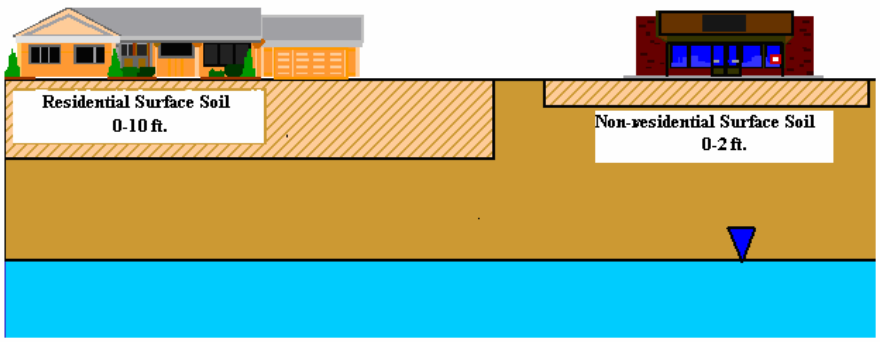
Figure 3.19- Point of Exposure Where Building Is to Be Located Directly Above the Source Area



POE for Direct Contact Pathway (surface and subsurface soil)

- 0 - 10 feet- When the land-use has been determined to be residential; or
- 0 - 2 feet- When the land-use has been determined to be non-residential.

Figure 3.20 – POE for Residential and Non-residential Surface Soil (Direct Contact Pathway)



If the distribution of COCs cannot be defined on properties that are impacted or potentially impacted by the release, the POE must be located at the UST site property boundary. The concentrations of the COCs at the UST site property boundary must meet the appropriate ALs

based on the land-use of the adjacent properties. However, if a road or railway separates the UST site and adjacent, down gradient property, the POE is the property line of the adjacent property.

3.11.5 Site-Specific Target Level Development

BUSTR spreadsheets must be used to evaluate COC fate and transport when the COC concentrations exceed ALs for complete exposure pathways. The fate and transport of COCs may be evaluated by conducting *one or a combination* of the following three options:

1. Develop SSTLs by replacing default values with site-specific data in the BUSTR Spreadsheets;
2. Utilize analytical fate and transport modeling (i.e., BUSTR-Screen) to predict COC concentrations in ground water at each POE; and/or
3. Back calculate SSTLs by utilizing a combination of BUSTR-Screen and BUSTR Spreadsheets.

BUSTR spreadsheets are located on the website at www.com.state.oh.us/sfm/bust
or by contacting BUSTR at (614) 752-7938 for an electronic version available on a CD.

SSTL Development in BUSTR Spreadsheets (Option 1)

SSTLs can be calculated by replacing the default values used in action level calculations with site-specific values for certain geological and hydrogeological parameters. Site-specific values may *only* be substituted for the following parameters:

- Total porosity in vadose zone;
- Volumetric water content in vadose zone;
- Volumetric air content in vadose zone;
- Volumetric air content in capillary fringe soil;
- Volumetric water content in capillary fringe soil;
- Total organic carbon;
- Dry bulk density;
- Saturated hydraulic conductivity; and
- Ground water Darcy velocity.

NOTE: All field methods and calculations used to obtain site-specific values must be clearly documented and referenced in all reports submitted to BUSTR. Also, if site-specific data is obtained, it must be used for all future SSTLs calculations, regardless if it is more or less conservative then the BUSTR default values.

Other values that were determined during the Tier 1 and Tier 2 investigations, such as depth to ground water, soil type, building type, depth from source to ground water, and land-use classification, may be changed with supporting documentation. Exposure parameters can only be changed from residential to non-residential based upon the land-use determination.

When developing SSTLs based on the land-use determination and/or surface water quality standards, assume that the exposure pathways identified in the Tier 1 Evaluation apply, and compare the SSTL to the highest concentration for each COC for each exposure pathway. As in the Tier 1 Evaluation, assume that the SSTLs are located at the POE. This approach is also appropriate for calculating SSTLs for chemicals that have no calculated Tier 1 action levels.

BUSTR spreadsheets include soil to indoor air, soil to outdoor air, ground water to indoor air, ground water to outdoor air, and soil leaching to ground water (or drinking water). Direct contact and total petroleum hydrocarbon (TPH) values are listed in OAC Rule 1301:7-9-13(J)(2)(d) and (J)(2)(e). These values cannot be recalculated using site-specific data therefore a combination of an IRA, RAP, or Tier 3 Evaluation. For chemicals not listed in the direct contact table, reference Ohio EPA, DERR VAP, generic direct contact standards and supplemental generic direct contact standards. (See OAC 3745-300-08.)

Fate and Transport Modeling Using BUSTR-Screen (Option 2)

BUSTR-Screen may be used to predict COC concentrations at each point of demonstration (POD) or POE for ground water ingestion and ground water to indoor air pathways.

BUSTR-Screen is a ground water fate and transport model combining a user interface with Bioscreen, a Microsoft® Excel based modeling program created by the United States Environmental Protection Agency (USEPA). The purpose of the BUSTR-Screen interface to the Bioscreen model is to simplify presentation of input parameters and output results for BUSTR corrective action sites.

Bioscreen and BUSTR-Screen are Microsoft® Excel based modeling programs based on Domenico fate and transport equations. The equations and calculations used in the BUSTR-Screen model are identical to those used in the Bioscreen model, version 1.4. Both models predict the amount of natural attenuation of dissolved hydrocarbons in confined or unconfined aquifers. The models are designed to predict only horizontal flow with a constant seepage velocity.

BUSTR requires that BUSTR-Screen be used if ground water fate and transport modeling is performed during the Tier 2 Evaluation process. (See OAC 1301:7-9-13, effective March 1, 2005.)

BUSTR-Screen can be downloaded through the BUSTR website at www.com.state.oh.us/sfm/BUST. (For additional information, see Appendix G, BUSTR-Screen.)

Back Calculation Using BUSTR Spreadsheets and BUSTR-Screen (Option 3)

Another option for calculating SSTLs is using a combination of the BUSTR Spreadsheets and BUSTR-Screen to evaluate the fate and transport of COCs in the environmental media for leaching or volatilization pathways. For example, the O/O may use a combination of the soil to ground water leaching spreadsheet and BUSTR-Screen spreadsheet to predict acceptable soil and ground water SSTLs in the source area which are protective of the POE. This would be done by first predicting the maximum COC concentration in the ground water in the source area which would still be protective of the POE, and then using that predicted maximum COC concentration as the target concentration in the leaching spreadsheet.

Surface Water Quality Standards

If there is a surface water body within 300 ft. of the UST site, the O/O may develop SSTLs that are protective of aquatic life and recreational standards, in accordance with OAC 3745-1-01 through 3745-1-54.

OAC 3745-1-08 through 3745-1-30 must be used to determine which drainage basin and water body segment apply to the UST site. These rules specify which water quality standards (i.e., aquatic life, public water supply, recreational use, etc.) apply to specific surface water bodies. After determining which water quality standards are applicable, Tables 33-2 and 34-1 must be used to identify the appropriate values for the applicable water quality standards.

Land and Ground Water Use Restrictions

Where SSTLs have been developed based on land-use other than residential land-use and non-residential land-use could not be established in accordance with Section 3.11.2- Land-use Determination, the O/O must enter into an environmental covenant approved by BUSTR. (See Appendix C, Use Restrictions.)

Where SSTLs have been developed based on ground water use other than drinking water use and non-drinking water use is not established in accordance with Section 3.8.2, Potential Drinking Water Use, the O/O must enter into an environmental covenant approved by BUSTR.

3.11.6 Tier 2 Decisions

After determining the SSTLs, the maximum COC concentrations for each complete exposure pathway must be compared to the calculated SSTLs. This comparison must be documented in the required Tier 2 Evaluation Report. Upon submission, BUSTR will evaluate the Tier 2 Evaluation Report for completeness and technical adequacy.

If all COC concentrations are at or below the ALs or SSTLs for all applicable pathways and no monitoring is required, then NFA is required. If a monitoring plan is required, it must be submitted with the Tier 2 Evaluation Report to demonstrate that all COCs will remain at or below Tier 2 SSTLs.

If the maximum concentration of a particular COC is at or below the action level or SSTL for a particular pathway, then no further evaluation is necessary for that COC and its corresponding exposure pathway.

If one or more COC concentrations are above Tier 2 SSTLs for one or more exposure pathways, the O/O must conduct *one or a combination* of the following to address the COCs and the corresponding complete exposure pathway:

- Interim Response Action, Section 3.10;
- Remedial Action Plan, Section 3.13;
- Tier 3 Evaluation Plan Section 3.12; and/or
- Plan for approval by BUSTR to calibrate or disprove the assumptions used in the BUSTR-Screen fate and transport model this plan must be submitted with the Tier 2 Evaluation Report. (See Appendix G, BUSTR-Screen.)

3.11.7 Tier 2 Evaluation Report

The O/O must prepare and submit the Tier 2 Evaluation Report on a form prescribed by BUSTR (see Appendix E, Forms), within 18 months from the approval of the Tier 1 Investigation Report. BUSTR will approve the Tier 2 Evaluation Report if it is determined to be complete and

technically accurate. The Tier 2 Evaluation Report Form provides an outline to be followed when completing the Tier 2 Evaluation.

3.12 Tier 3 Evaluation

If SSTLs are to be developed beyond the scope of a Tier 2 Evaluation, a Tier 3 Evaluation may be conducted. A Tier 3 Evaluation may include:

- Numerical fate and transport modeling (e.g., MODFLOW ground water transport model);
- Analytical fate and transport modeling not used in a Tier 2 Evaluation (e.g., SESOIL [soil leaching model], AT123D [ground water transport model], RBCA Toolkit);
- Complex aquifer studies (e.g., pumping tests to evaluate the connectivity of two aquifers)*;
- Statistical evaluation of COC contamination*; or
- Site-specific evaluation of TPH (e.g., risk calculation):
    - Perform a statistical analysis of the source area and demonstrate that the 95% upper confidence limit (UCL) value of TPH does not exceed the TPH action level*; or
    - Perform a site-specific risk analysis of the chemical constituents comprising the TPH parameter using the methodology developed by the TPH Criteria Working Group or using the approach identified as "Method A" in Section 6.3 of BUSTR's Risk Assessment Guidance Document (1995 draft). Surrogates should be n-hexane, naphthalene, and pyrene for the 3 distillate fraction if "Method A" is used.

*NOTE: When completing complex aquifer studies reference Ohio EPA, *Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring*, February 1995, et seq. The 95% UCL should be calculated as described in USEPA, 1992 *Statistical Methods for Evaluating the Attainment of Clean-up Standards*. (EPA/230/R-94/004.)

Model Selection

Fate and transport modeling helps describe the distribution and movement of COCs in the environmental media and can be used to predict COC concentrations at the source, PODs and POEs. Models used in a Tier 3 Evaluation must be selected by considering environmental media, geometric constraints, temporal variability, transport mechanisms, exposure pathways, and other factors such as assumptions used in the model and limitations of the model. Models used in a Tier 3 Evaluation must be publicly available and generally accepted by the USEPA.

Many input parameters in fate and transport models relate to site-specific dimensions and characteristics. Fate and transport models should use site-specific data whenever practical, but default values may be used for the input parameters that have not been measured. Default values are typically used for chemical and physical properties of COCs and for some properties of the environmental media. BUSTR default values are preferred, but other default values may be used when properly justified.

BUSTR requires that a sensitivity analysis be performed with all Tier 3 models. Sensitivity testing is performed to determine how the output of a fate and transport model changes as values of the input parameters are changed. A model is considered *sensitive* to a given input parameter if the model's output changes significantly when the value of the input parameter is changed slightly. For models that are highly sensitive to an input parameter, the model must use site-specific data or present sufficient justification to support the use of literature or default values.

All Tier 3 models must be reproducible by BUSTR. Calibration and verification monitoring should be addressed in the Tier 3 Evaluation Plan.

3.12.1 Tier 3 Evaluation Plan

If SSTLs are to be developed in a Tier 3 Evaluation, then a Tier 3 Plan must be submitted to BUSTR for approval with the Tier 2 Evaluation Report. The plan must include, but is not limited to, the following:

- Description of the objective and activities to be conducted in the Tier 3 Evaluation;
- Discussion of the effectiveness, cost, and the rationale for selecting the Tier 3 Evaluation compared to other remedial action alternatives; and
- Implementation schedule and projected completion date.

3.12.2 Public Notice

For each release where a Tier 3 Evaluation is submitted to BUSTR, the O/O must provide notice to the public in a format approved by BUSTR so those members of the public directly affected by the release are notified. The notice may include, but is not limited to, public notice in local newspapers, block advertisements, public service announcements, publication in a state register, letters to individual households, or personal contacts by field staff. At a minimum, public notice must include notification to all adjacent property owners, all owners of properties impacted by the release, all properties impacted by the proposed Tier 3 activities, and the unit of local government.

If sufficient public interest exists, or for any other reason, BUSTR may hold a public meeting to consider comments on the proposed Tier 3 Evaluation before approving it.

Upon approval of the Tier 3 Evaluation Plan by BUSTR, the O/O must conduct the activities in accordance with the approved plan.

3.12.3 Tier 3 Decisions

If the maximum concentration of a particular COC is at or below Tier 3 SSTLs, then no further evaluation is necessary for that COC and for the corresponding complete exposure pathway. If necessary, a Monitoring Plan must be developed for ground water. The Monitoring Plan must be submitted with the Tier 3 Evaluation Report to demonstrate that COC concentrations will remain at or below Tier 3 SSTLs.

If COC concentrations are above Tier 3 SSTLs, the O/O must conduct *one or a combination* of the following to eliminate a complete exposure pathway or to reduce COC concentrations at the source area to below the SSTLs:

- Interim Response Action, Section 3.10; or
- Remedial Action Plan, Section 3.13.

3.12.4 Tier 3 Evaluation Report

Within 90 days from the projected completion date stated in the approved Tier 3 Evaluation Plan, a report summarizing the activities conducted in accordance with the Tier 3 Evaluation Plan and the results of the Tier 3 decisions must be submitted to BUSTR for approval.

3.13 Remedial Action

If remedial action is appropriate, the O/O must choose a method that would effectively achieve the appropriate ALs or SSTLs, as determined in the tier evaluation. More than one remedial action may be appropriate for a particular UST site based on the exposure pathways and COCs to be addressed by the remedial action. Remedial options include source removal, design and installation of clean-up equipment, natural attenuation processes, and engineering controls. As engineering controls are considered a remedial action, the O/O must submit a Remedial Action Plan (RAP). The RAP must describe the implementation of the engineering controls used to eliminate pathways. Additionally, a monitoring plan and/or environmental covenant may be required to demonstrate the effectiveness and maintenance of the engineering control. (See Section 3.14, Monitoring Plan.)

3.13.1 Remedial Action Plan

A RAP must be prepared and submitted to BUSTR within 90 days of the approval of the Tier 1 Investigation Report, approval of the Tier 2 Evaluation Report, or approval of the Tier 3 Evaluation Report. The O/O must also submit the RAP for cost pre-approval to the Petroleum Underground Storage Tank Release Compensation Board (PUSTRCB) for sites that are eligible for reimbursement. The RAP must include, at minimum, *all* of the following information:

- Description of the remedial activities to be implemented;
- Proposed target levels, identified by COCs and environmental media
- Conceptual design of the remedial action system; detailed engineering drawings are not necessary;
- Brief description of remedial action alternatives considered, including a discussion of the reliability, effectiveness, cost, and time needed for completion, and the rationale for the selected program;
- Monitoring Plan (see Section 3.14, Monitoring Plan);
- Description of reporting frequency and proposed content of reports;
- Description of all permits or other governmental approval required for implementation of the plan;
- Description of activities and studies, if any, required to be performed prior to implementation of the proposed remedial action; and
- Implementation schedule, projected completion date, and the submittal date for the completion report of the proposed remedial action.

3.13.2 Public Notice

For each release where a RAP is submitted, BUSTR will send a letter to the O/O requesting public notice. The O/O must provide notice to the public in a format approved by BUSTR so those members of the public directly affected by the release may be notified. The notice may include, but is not limited to, public notice in local newspapers, block advertisements, public

service announcements, publication in a state register, letters to individual households, or personal contacts by field staff. At a minimum, public notice must include notification to all adjacent property owners, all owners of properties impacted by the release, all properties impacted by the proposed RAP, and the unit of local government.

If sufficient public interest exists, or for any other reason, BUSTR may hold a public meeting to consider comments on the proposed RAP before approving it. Upon receiving documentation of the public notice requirement, evaluating all comments from the public, and determining the RAP is technically adequate and complete, BUSTR will issue a letter approving or denying the plan. The O/O must likewise give similar public notice if an approved RAP is not achieving its established clean-up levels and BUSTR is considering a termination of that plan.

3.13.3 Implementation of Remedial Action Plans

Upon approval of the RAP, the O/O must implement the plan according to the approved actions. The O/O must monitor, evaluate, and report the results of the implementation efforts to BUSTR.

Following implementation of the approved RAP, if the remedial activities are unable to reduce the COC concentrations to at or below ALs or SSTLs, the O/O must:

- Re-evaluate and revise the remedial action alternatives, assumptions, and parameters, and resubmit a revised RAP; or
- Submit a RAP summary report and conduct a Tier 2 Evaluation or Tier 3 Evaluation, as appropriate.

3.13.4 Completion Report

Following completion of remedial action, the O/O must prepare and submit a completion report no later than the submittal date provided in the approved plan, which demonstrates that the remedial action objectives have been met. The report must contain documentation supporting termination of the RAP. Upon review of the report for technical adequacy and completeness, BUSTR may issue to the O/O written notice that no further action is required.

3.14 Monitoring Plan

3.14.1 Purpose

A monitoring plan must be developed to:

- Verify fate and transport model assumptions and predictions related to the development of ground water SSTLs; and
- Monitor the progress of a remedial action and demonstrate that a remedial action has achieved the reduction of COC levels at or below ALs or SSTLs.

Before NFA is appropriate, BUSTR may require a monitoring plan to demonstrate that COCs will remain below SSTLs upon completion of a Tier 2 Evaluation, Tier 3 Evaluation, RAP, or IRA.

Monitoring Plan Contents

When developing a monitoring plan, the data collection approach must consider the spatial distribution of sampling locations, temporal variations of the COC concentrations, and COC concentrations in the environmental media. Submit a monitoring plan with a Tier 2 Evaluation Report, Tier 3 Evaluation Report, or RAP, as appropriate. The monitoring plan must include, at a minimum, *all* of the following:

- Description of the purpose and objective of the monitoring activity;
- Description of planned monitoring activities, including those conducted to implement and to verify the effectiveness of engineering controls, remedial actions, etc.;
- Locations of the POD(s) and POE(s);
- Summary of the sampling procedures;
- Description of the anticipated length and frequency of the monitoring activity;
- Identification and description of the termination criteria for remedial or monitoring activities, as appropriate; and
- Operation and maintenance data for equipment and engineering controls.

If the objectives of the monitoring plan are not met, BUSTR may require that the O/O conduct *one or more* of the following:

- Continue monitoring activities;
- Conduct an Interim Response Action (see Section 3.10);
- Develop a Remedial Action Plan (see Section 3.13); and/or
- Re-evaluate assumptions and parameters used in developing SSTLs (in the Tier 2 or Tier 3 Evaluations) or RAP target levels.

3.14.2 Point(s) of Demonstration

PODs are used to monitor the progress of a RAP and verify predictions of a fate and transport model. The O/O must both locate the POD(s) between the source area(s) and the POE, and locate the POD(s) sufficiently up-gradient from the POE to act as an early warning for continuing COC migration and to validate the fate and transport model.

Selecting the POD depends on the POE location (including the receptor and exposure route), the transport mechanism (e.g., ground water migration, vapor migration), and the estimated travel time from the source to the POE. In cases where the POE is located within the source area (the area of highest concentration of the COCs), the POD and the POE will be the same.

Historical data may be used in some cases to verify model assumptions and predictions or to reduce the time period of the monitoring plan.

3.14.3 Completion Report

Following completion of monitoring, the O/O must prepare a completion report that demonstrates the monitoring objectives have been met. The report must contain documentation indicating that the monitoring objectives have been met. Upon review of the report for technical adequacy and completeness, BUSTR may issue to the O/O written notice that no further action is required.

3.15 Requests for Extensions

If the O/O desires an extension of time for compliance with any portion of BUSTR requirements, the O/O must provide a written request for an extension that contains *all* of the following:

- Date the information was to be submitted;
- Reasons for requesting the extension;
- Length of time for which the extension is requested;
- Name and complete address of the UST site that is the subject of the extension request;
- Name of the BUSTR employee that is assigned to monitor the corrective action activities at the UST site; and
- Release number assigned by BUSTR regarding the UST site that is the subject of the extension request.

The O/O must submit a written request for extension to BUSTR prior to the expiration of the time period that is the subject of the extension request. BUSTR may grant, modify, or deny any extension request at its sole discretion.

3.16 Alternate Technologies

Technologies, procedures, or methods other than those specified in the Rule or TGM *may* be used if the O/O:

- Demonstrates an alternate is at least as effective as those required; and
- Obtains written approval from BUSTR to use the alternate technology before the actual implementation of such technology, procedure, or method. If the alternate technology is approved by BUSTR, the O/O using such alternate technologies must comply with any conditions imposed by BUSTR on its use.

BUSTR may approve the alternate technology for use at a specific UST site or for use at all UST sites. If BUSTR approves an alternate technology for use at all UST sites, the O/O must comply with any conditions imposed by BUSTR on the use of the alternate technology.

4.0 Petroleum Contaminated Soil Requirements Under OAC 1301:7-9-16 and 1301:7-9-17

4.1 Introduction

OAC 1301:7-9-16 and 17 (effective March 1, 2005) rules govern petroleum contaminated soil PCS generated from UST systems regulated by BUSTR. PCS is defined as soil that contains COC concentrations that exceed one or more of the re-use ALs and excludes soil defined as hazardous waste. OAC 1301:7-9-16 establishes standards for reporting, characterizing, storing, transporting, handling, treating, disposing, and re-using PCS.

OAC 1301:7-9-17 establishes standards for sampling and analyzing excavated soil from UST systems containing petroleum substances. To fully comply with these rules, the O/O must read and meet the requirements in OAC 1301:7-9-16 and 17.

4.2 Applicability

The PCS rules apply to the O/O for soil generated at **petroleum** UST sites regulated by BUSTR under OAC Chapter 1301:7-9. Some examples when PCS may be encountered include the following activities:

- UST removals;
- UST upgrades;
- Soil boring (SB) and MW installations;
- Immediate and interim response actions; or
- Corrective action activities (e.g., excavating, remedial system trenching).

Soil generated from excavation activities at the UST systems that are listed as exempt in Section 2.2, Regulated UST Systems and Exemptions, are exempt from the PCS rules. In addition, non-O/Os who choose not to use the PCS rules must consult with Ohio EPA, Division of Solid and Hazardous Waste, for proper disposal of excavated soil.

4.3 Characterization

The O/O must manage the excavated soil as PCS (unless analytical data proves otherwise). The O/O must also characterize and sample excavated soil within 48 hrs. of completing an excavation.

During characterization, the O/O must determine whether the soil is PCS or a hazardous waste. To evaluate whether or not soil is a hazardous waste, contact the Ohio EPA, Division of Hazardous Waste Management, regarding Ohio's hazardous waste regulations.

OAC 1301:7-9-17 requires segregating the soil based on the "apparent degree of contamination." Soil piles with the same apparent degree of contamination may be combined. Each pile must be characterized and sampled, including soil piles that are combined. In situations when two or more laboratory results are required from one soil pile, the highest analytical result must be used to determine the proper disposition for the entire stockpile. In addition, excavated soil from different facilities may be combined for purposes of characterizing the soil pile. However, if one

or more of the COCs exceed re-use ALs, the soil must be disposed of at a licensed disposal facility or treated in accordance with Section 4.7, Treatment of Petroleum Contaminated Soil.

4.3.1 Calculating Stockpile Volume

The volume of excavated soil for each soil pile or container must be calculated to determine the number of soil samples required for compliance with OAC 1301:7-9-17. *In-situ* soil volume must be converted to excavated soil volume by multiplying the *in-situ* volume by an expansion factor of 1.25.

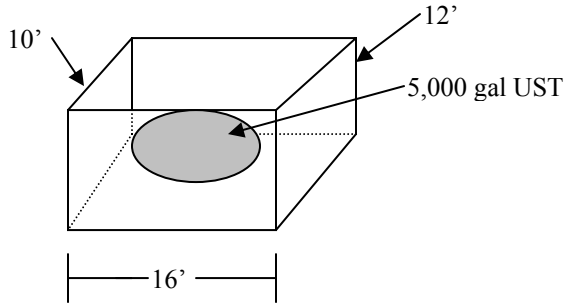
Any of the following methods can be used to calculate stockpile volume.

Method 1 – Rectangular-Shaped UST Cavity

The following steps are required for calculating the volume of a rectangular-shaped UST cavity:

- Measure the size of the excavation;
- Calculate the total volume of the cavity in cubic yards;
  - Length x width x depth = volume of cavity;
- Calculate the total volume of the UST in cubic yards;
- Subtract the total volume of all USTs removed from the excavation;
  - Volume of cavity – total volume of all USTs = in-situ volume of soil in cubic yards;
- In-situ volume removed x 1.25 (expansion factor) = total stockpile volume in cubic yards.

Conversion Factors
27 ft^3 = 1 yd^3
1 U.S. gal. = 0.1337 ft^3
1 U.S. gal. = 0.00495 yd^3



16 ft. x 10 ft. x 12 ft. = 1,920 ft^2
1,920 ft^3 x (1 yd^3/27 ft^3) = 71.1 yd^3
5,000 gal. x (0.00495 yd^3/1 U.S. gal.) = 24.75 yd^3 occupied by tank

71.1 cubic yards – 24.75 cubic yards = 46.35 cubic yards removed (in-situ volume)
46.35 cubic yards x 1.25 expansion factor = 57.94 cubic yards stockpiled

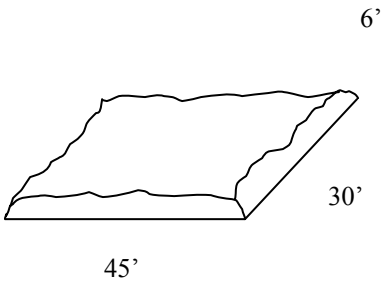
Method 2 – Rectangular or Conical-Shaped Soil Stockpile

Rectangular Stockpile

The following steps are required for calculating the volume of a rectangular-shaped soil stockpile:

- Calculate the total volume of material;
  - Length x width x depth = volume of the stockpile in cubic feet.
- Convert cubic feet into cubic yards;
  - Volume of stockpile in cubic feet x (1 yd^3/ 27 ft^3) = total volume of stockpile in yd^3

Example 1:



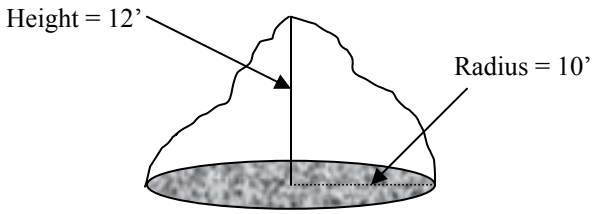
Volume = length x width x height
8,100 ft^3 = 45 ft. x 30 ft. x 6 ft
8,100 ft^3 x (1 yd^3 / 27 ft^3) = 300 yd^3

Conical Shaped Stockpile

The following steps are required for calculating the volume of a conical-shaped soil stockpile:

- Calculate the total volume of material;
  - Volume of stockpile in cubic feet = (⅓π) x ($radius^2$) x (height)
- Convert cubic feet into cubic yards;
  - Volume of stockpile in ft^3 x (1 yd^3 / 27 ft^3) = total volume of stockpile in cubic yards.

Example 2:



Volume = (⅓π) x ($radius^2$) x (height)
Volume (ft^3) = (1.047)(10^2)(12) = 1,256 ft^3
Volume (yd^3) = 1,256 ft^3 x (1 yd^3 / 27 ft^3) = 46.52 yd^3

*NOTE: ⅓π = 1.047

4.3.2 Sampling Requirements

After calculating the volume of the soil stockpile, collect soil samples in accordance with OAC 1301:7-9-17. Table 4.1, Stockpile Sampling Requirements, below, indicates the number of soil samples to collect, field screen, and submit for laboratory analysis.

To determine the locations of the samples to be collected for field screening, visually divide the stockpile into sections equal to the number of soil samples required in Row 1 of Table 4.1, Stockpile Sampling Requirements, shown below. Collect individual soil samples from the center of each stockpile section at a minimum depth of 12 in. below the surface of the stockpile. The O/O must submit the highest field screened samples for laboratory analysis. The minimum number of soil samples submitted for laboratory analysis is presented in Row 2 of Table 4.1, Stockpile Sampling Requirements, below.

If field screening is not conducted, all soil samples collected must be submitted for laboratory analysis.

Table 4.1– Stockpile Sampling Requirements

	Cubic Yards of Soil and Backfill Material Generated				
	<25*	**26-100**	**101-250**	**251-450**	**>450**
1. Minimum number of grab samples to collect and field screen	3	6	12	18	18 plus 1 sample per each additional 50 yd^3 (or fraction thereof)
2. Minimum number of grab samples to submit to the laboratory	2	3	6	8	8 plus 1 sample per each additional 100 yd^3 (or fraction thereof)

* For excavated soil in containers having a capacity of 55 gal. (0.27 yd^3) or less, one grab sample must be collected from the center at mid-depth of the soil in the container and submitted to the laboratory for analysis.

4.4 Re-Use of Excavated Soil

If excavated soil that is sampled and analyzed pursuant to OAC 1301:7-9-17 does not exceed the re-use ALs (see Table 4.2, Re-Use Action Levels) for any COC, then the O/O may use the soil for any lawful purpose. This paragraph may not be interpreted as an authorization to use such soil for purposes prohibited or otherwise restricted by any applicable Federal, state, or local laws and regulations. In the case where analytical results exceed the re-use ALs or where the analytical results have not been received, *one* of the following is applicable:

- If excavated soil sampled in accordance with OAC 1301:7-9-17 does not exceed the applicable ALs listed in OAC 1301:7-9-13, then the excavated soil may be deposited in the original excavation without further treatment. Following placement in the excavation, the soil shall be covered with a minimum of one foot of clean fill;
- Following approval from the fire marshal, excavated soil that exceeds the applicable ALs listed in OAC 1301:7-9-13 may be deposited in the original excavation for the purpose of remediation pursuant to the corrective action requirements of OAC 1301:7-9-13. If the excavated soil was deposited in the original excavation, and the excavation is lined with a synthetic liner having a minimum thickness of 0.01 in. (10 mil thick), and samples analyzed

pursuant to OAC 1301:7-9-12(I) are below ALs developed in OAC 1301:7-9-12(I)(3), then the O/O may prepare and submit a PCS Treatment Plan; or

- When soil samples have been collected, but the analytical results have not been received, the excavated soil may be deposited in the original excavation, if the excavation is lined with a synthetic liner having a minimum thickness of 0.01 in. (10 mil thick).

Table 4.2- Re-Use Action Levels

CHEMICAL OF CONCERN ACTION LEVEL	
Benzene	0.015
Toluene	4.910
Ethylbenzene	4.550
o, m, and p Xylenes	15.700
Methyl tertiary butyl ether (MTBE)	0.047
Benzo(a)anthracene	2.200
Benzo(b)fluorathene	5.530
Benzo(k)fluoranthane	1.970
Benzo(a)pyrene	1.100
Chrysene	1.270
Dibenz(a,h)anthracene	0.940
Indeno(1,2,3-cd)pyrene	0.150
Naphthalene	3.980
TPH (C6-C12)	1,000
TPH (C10-C20)	2,000
TPH (C20-C34)	5,000

All chemical concentrations expressed in milligrams per kilogram (mg/kg)

4.5 Storage of Petroleum Contaminated Soil

The O/O may choose to store PCS either on or off the UST site. Once excavated, the O/O may store PCS on-site in properly labeled portable containers for no more than 180 days or in properly protected stockpiles for no more than 120 days. The O/O must submit the PCS Form (see Appendix E, Forms) within 10 days of on or off-site storage of PCS. The O/O may store PCS off-site for no more than 90 days from the date of excavation.

The O/O must inspect all on or off-site PCS storage areas monthly for damage to or unauthorized removal of drums, drum lids, labels, covers, berms, fences, barriers, or signs used to deter unauthorized entry. The O/O must keep a written log of these inspections and be able to produce it within 24 hrs, if requested by BUSTR. An O/O must maintain for a period of five years any record of the estimated excavated soil volume being stored and the date the soil was originally containerized or placed in a stockpile.

4.6 Disposal of Petroleum Contaminated Soil

PCS may be disposed according to *any* of the following:

- Excavated PCS may not be disposed on-site without first being treated to reduce COCs to below ALs or SSTLs;
- Excavated PCS may not be disposed of off-site without first being treated to reduce COCs to below re-use ALs, unless the soil is disposed at a licensed disposal facility. If the PCS is disposed at a licensed disposal facility, the O/O must prepare a PCS Form that describes the final disposition of the excavated soil; or
- All excavated PCS containing COC concentrations must be managed so as to comply with applicable Federal, state, and local requirements.

4.7 Treatment of Petroleum Contaminated Soil

An O/O may choose to remediate PCS either on-site or off-site. On-site treatment is limited to the UST site or any adjoining parcels of land owned or under the control of the O/O. Off-site treatment must occur at a *designated facility* which is land not open to the public and owned or under the control of the UST O/O. Each treatment zone may contain PCS from only one UST site where the PCS was excavated.

Treatment options include, but are not limited to:

- Landfarming- the spreading of PCS in a layer over the treatment zone that is tilled into the native soil; the soil should be spread during the summer months and periodically be tilled during the year;
- Biopiles– the treatment of PCS above ground in piles to stimulate microbial activity through aeration and/or minerals, nutrients, and moisture;
- Low-temperature thermal desorption (LTTD) – the treatment of PCS by means of applying heat to achieve temperatures sufficient to cause COCs to desorb and volatilize from the soil;
- Other treatments - including alternative methodologies (e.g., road base and asphalt batching, soil shredding, soil washing, high temperature thermal desorption).

Please reference USEPA publication: *How to Evaluate Alternative Clean-up Technologies for Underground Storage Tank Sites, May 2004 (EPA 510-R-04-002).*

Prior to treatment, BUSTR must approve a PCS Treatment Plan. At the conclusion of treatment the O/O must demonstrate through sampling and analysis that COC concentrations have been reduced to a level at or below the re-use ALs.

4.7.1 Guidelines for PCS Treatment Plans

The O/O must submit a PCS Treatment Plan to BUSTR within 90 days of the UST system removal date or the date of generating the PCS stockpile. Treatment target concentrations shall be the re-use ALs, unless a variance is granted by BUSTR. The PCS Treatment Plan shall include, at minimum, *all* the following information:

- Name of owner or operator of the UST site;
- Name, address, and facility number of the UST site;

- Address of the designated facility;
- Contact person for the PCS Treatment Plan;
- Volume, in cubic yards, of soil to be treated;
- Description of the PCS treatment process to be implemented;
- Conceptual design of the PCS treatment system (detailed engineering drawings are not necessary);
- Brief description of the treatment alternatives considered, including a discussion of the reliability, effectiveness, cost, time needed for completion, and the rationale for the selected program;
- Monitoring plan that describes the monitoring to be used to determine whether treatment target concentrations are being achieved;
- Description of the reporting frequency and proposed content of reports;
- Description of any permits (e.g., air emission, water discharge) or other governmental approvals required for implementation of the plan;
- Implementation schedule and the projected completion date of the proposed PCS treatment activities;
- Site maps or drawings that accurately depict the location of the designated facility, the property boundaries, street locations, above ground structures, underground structures and utilities, soil stockpiles, PCS treatment areas, and other pertinent features including drainage ditches, creeks, roads, potable wells, and residential dwellings.

If the O/O elects to conduct landfarming, in addition to the criteria and evaluation described in the USEPA publication above, *all* the following requirements and restrictions apply and must be met and included in the PCS Treatment Plan:

- Landfarming cannot be conducted in residential areas or near daycare, long term health care , or educational facilities;
- Landfarming cannot be conducted in a Drinking Water Source Protection Area or a Sensitive Area;
- Soils from Analytical Groups 4 & 5 (used oil, unknowns and others) cannot be landfarmed;
- Multiple applications of PCS in the same treatment zone is not permitted;
- The PCS shall be mixed by tilling a maximum of 6 in. of PCS into the top 4 to 6 in. of native soil within 48 hrs. of application. Application to frozen ground is prohibited;
- Soil profiles, organic carbon content, and depth to ground water must be determined by an on-site investigation;
- Drainage and field tiles must be plugged;
- Plans to control drainage and soil erosion (run-off and run-on) are to be included in the design. If a vegetative cover crop is used, the cover crop may not be used for human or livestock consumption;
- The potential for and abatement of odors, vapors, or nuisance conditions must be addressed;
- The treatment plan must demonstrate that the leaching of contaminants from the soil will not impact ground water. Otherwise, monitoring wells must be installed on the site and a Ground Water Monitoring Plan must be submitted (see Section 3.14, Monitoring Plan);
- If multiple treatment zones exist at the site, ground water MWs must be able to monitor the potential migration of COCs from each treatment zone; and
- A confirmation soil sampling plan for the treatment zone and the native soil under the treatment zone must be included with the treatment plan.
- If a groundwater sample from a monitoring well indicates COCs above action levels a Tier 1 Source Investigation will be required.

If the O/O elects to treat PCS using non-landfarming techniques, in addition to the criteria and evaluation described in the USEPA publication above, the following additional requirements and restrictions apply and *are required* to be included in the PCS Treatment Plan:

- The treatment zone must be designed to prevent the discharge of leachate, vapors, odors, and soils;
- Confirmatory sampling must include the treated soil and any areas where the impermeable surface has been breached. If the impermeable surface is a synthetic liner or cannot be inspected after treatment, then confirmatory sampling of the native soils will be required;
- The treatment zone must be located in an area not open to the public and have restricted access; and
- The site must have signs posted that identify the O/O, an emergency contact phone number and the treatment area.
- If soil samples taken from below an impermeable barrier indicate that COCs above action levels exist, a Tier 1 Source Investigation will be required.

4.7.2 Public Notice

For each PCS Treatment Plan submitted, BUSTR will send a letter to the O/O requesting public notice. The O/O must provide notice to the public in a format approved by BUSTR so the members of the public directly affected by the release and planned treatment activities are notified. This notice may include, but is not limited to, public notice in local newspapers, block advertisements, public service announcements, publication in a state register, letters to individual households, or personal contacts by field staff. At a minimum, public notice must include notification to all adjacent property owners, all owners of properties impacted by the release, all properties impacted by the PCS Treatment Plan, and the unit of local government.

Upon receiving documentation of the public notice requirement, evaluating all comments from the public, and determining the PCS Treatment Plan is technically adequate and complete, the fire marshal will issue a letter approving or denying the plan.

4.7.3 Implementation and Reporting

Upon approval of the PCS Treatment Plan, the O/O must implement the plan. The O/O must monitor, evaluate, and report to BUSTR implementation efforts in accordance with the reporting requirements contained in the plan. If the treatment technology approved by BUSTR in the plan has been installed and operated for a minimum of one year and the technology is unable to reduce the COC concentrations to a level at or below applicable ALs, the O/O must:

- Re-evaluate the assumptions and parameters used in the PCS Treatment Plan;
- Re-evaluate the treatment alternatives; and
- Submit a revised PCS Treatment Plan.

If treatment is able to reduce COC concentrations to a level at or below the applicable ALs, then no further treatment is required and a PCS Treatment Completion Report must be submitted to BUSTR. The PCS Treatment Completion Report must include *all* applicable items listed in 4.7.1, Guidelines for PCS Treatment Plans. In addition, the O/O must provide a description of the final disposition of the excavated soil, on the PCS Form prescribed by BUSTR.

4.8 Releases from PCS Treatment and Storage Facilities

When directed by BUSTR, the O/O must assess the soil and ground water under any designated facility or UST site if the treatment or storage of PCS poses a current or potential threat to human health or the environment. Upon the discovery of a petroleum impact suspected to be the result of the treatment or storage of PCS, the O/O must conduct *all* of the following:

- Cease all additional applications of PCS until otherwise instructed by BUSTR;
- Notify BUSTR within 24 hrs. of the discovery of the soil or groundwater contamination; and
- Perform immediate corrective action in accordance with the requirements listed in Section 3.6, Immediate Corrective Actions, above, and continue with the corrective action process, as necessary, to contain and clean-up the release.

4.9 Variances

O/Os may submit a variance request to BUSTR to deviate from any method or requirements specified in this section by demonstrating the proposed variance is at least as effective as those required by this section. BUSTR may grant, modify, or deny any variance request.

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Appendix A: Data Collection

Table of Contents **Page**

Figures and Tables **Page**

Acronyms

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
BUSTR	Bureau of Underground Storage Tank Regulation
CFR	Code of Federal Regulations
COC(s)	chemical(s) of concern
DOT	United States Department of Transportation
DWSPA	Drinking Water Source Protection Area
FOC	fraction of organic carbon
HAZWOPER	Hazardous Waste Operations
HSA	hollow-stem auger
Ohio EPA	Ohio Environmental Protection Agency
MW	monitoring well
NFPA	National Fire Protection Association
NIOSH	National Institute for Safety and Health
ODNR	Ohio Division of Natural Resources
OSHA	United States Occupational Safety and Health Administration
PID/FID	photo ionization detector/flame ionization detector
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RQD	rock quality designation
TGM	Technical Guidance Manual (BUSTR)
USCS	Unified Soil Classification System
UST	underground storage tank
VAP	Voluntary Action Program

For additional information concerning many of these topics, see the Ohio Environmental Protection Agency's (Ohio EPA) *Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring* (February 1995) or subsequent revisions and the *State of Ohio Technical Guidance for Sealing Unused Wells* (1996) or subsequent revisions issued by the State Coordinating Committee on Ground Water.

A.1 Drilling Technologies

When selecting the primary drilling method used to investigate underground storage tank (UST) release sites, consider the following factors:

- Hydrogeological and geological conditions;
- Contaminant type and concentrations;
- Scope of the investigation;
- Future use of the boring as a monitoring well; and
- Physical site limitations (e.g., overhead obstructions, subsurface utilities, service station canopies).

If a drilling method is selected other than hollow stem augering, direct push, or air rotary, an alternate technology request must be submitted to the Bureau of Underground Storage Tank Regulations (BUSTR) for approval. (See Section 3.16, Alternate Technology.)

Hollow Stem Augers

Hollow-stem augers (HSA) are the primary choice for subsurface investigations of UST release sites involving the installation of monitoring or recovery wells. When applying this technique, soil samples must be collected by using clean split-spoon samplers driven through the hollow-stem augers according to American Society for Testing and Materials (ASTM) D1586-99: *Standard Method for Penetration Test and Split-Barrel Sampling of Soil*. Split-spoon samplers should be driven continuously throughout the depth of the borehole. For BUSTR purposes, a 2 ft. sample interval must be used (i.e., 0 to 2 ft., 2 to 4 ft.).

Direct Push

Direct push technology (e.g., Geoprobe®, Powerprobe®, hand-held sampling systems) may be used for evaluating soil and water during a subsurface investigation where accelerated assessment is applicable and recovery wells will not be necessary. For BUSTR purposes, use a 2-ft. sample interval (i.e., 0 to 2 ft., 2 to 4 ft.). Rod refusal with this technology does not necessarily mean bedrock has been encountered (i.e., auger refusal). An auger rig might be required to confirm bedrock/auger refusal. If soil borings are converted to ground water monitoring wells, construction must conform to pre-packed well installation requirements in accordance with ASTM D 6725-04: *Standard Practice for Direct Push Installation of Pre-packed Screened Wells in Unconsolidated Aquifers*.

Air Rotary Drilling

Air rotary or rock coring methods must be used to conduct subsurface investigations involving the installation of monitoring or recovery wells into bedrock. Use caution when considering air rotary drilling, as this specialized type of drilling requires personnel with substantial experience in air rotary methods. Installation of boring/monitoring wells using air rotary or rock coring methods must be conducted in accordance with ASTM D 5782-95: *Standard Guide for Use of Direct Air Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Wells*.

Bedrock Coring (Optional)

When diamond-bit drilling is used to retrieve a continuous sample, it can show the characteristics of a specified interval, but core losses frequently occur. Core losses can occur in relatively consolidated materials when the rock that is being cored is highly fractured and broken, or when a fragment of the rock becomes wedged in a portion of the core bit or barrel. Carefully monitor every core run to determine the percent (%) recovery; amount and location of core loss; and the actual depth at the beginning and end of each core run.

During coring activities, keep a core log that contains all relevant information obtained during the drilling and coring, and a field description of the core. Core log forms are more specialized than standard soil boring log forms, and generally will contain columns for recording percent (%) core recovery, rock quality designation (RQD), and number and orientation of fractures.

After removing each core from the core barrel, it must be inspected, logged, and carefully placed into a properly labeled core box. Include the following information: depth to top and bottom of core, core loss zones, and identification of fractures. Fractures made after removing the core from the core barrel should be distinguished from fractures that are interpreted as in-place fractures. Place spacers inside the core boxes to mark ends of core runs and the positions of core loss zones.

A.2 Soil Boring/ Monitoring Well Installation

During the corrective action, process soil borings and monitoring wells are used to investigate the source and the extent of contamination for a release or suspected release. Soil borings and monitoring wells must be installed as follows:

- Extend soil borings/monitoring wells (MWs) to bedrock, the uppermost-saturated zone, or 50 ft., whichever is encountered first:
    - If bedrock is encountered and chemicals of concern (COCs) in the soil exceed soil to drinking water leaching action levels, then a minimum of one monitoring well must be installed in the source area(s) to ground water to determine if the ground water has been contaminated;
    - If the bedrock is a known drinking water source within the surrounding area, then BUSTR reserves the right to request a bedrock monitoring well at depths greater than 50 ft.;
    - If ground water contains detectable concentrations of COCs, then all soil borings/monitoring wells must extend to such ground water, regardless of depth.
- Continuously sample soil borings. Describe the stratigraphy on soil boring logs for each soil boring;
- Characterize soil encountered during drilling according to ASTM D 2488-00: *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* or the Unified Soil Classification System (USCS);
- For monitoring wells, include data collection that at minimum includes the depth to free product, free product thickness, depth of water below the top of casing, and elevation of top of casing; and/or
- Extend ground water monitoring wells at least 5 ft. into the saturated zone and screen them to the bottom of the saturated zone to accommodate seasonal fluctuations in the ground water table.

Monitoring Well Installation

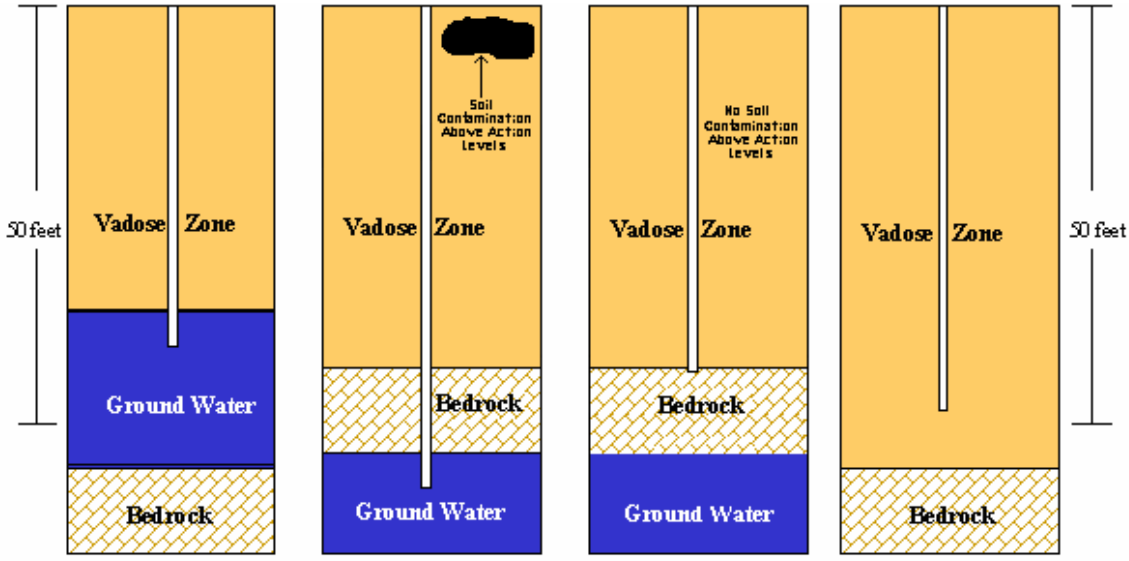
Details must be provided describing well installation materials, techniques used and the field conditions encountered via "as-built" monitoring well construction diagrams. In the corresponding report, the actual monitoring well installation procedures must be included. Additionally, Ohio Revised Code requires that all boring logs and construction diagrams for all monitoring wells installed in Ohio be submitted to the Ohio Department of Natural Resources (ODNR) Division of Water. For additional information concerning this requirement and the applicable Well Log Form, please contact ODNR.

Upon completing the borehole to the required depth, the following well installation procedures must be used:

- If necessary, the hole must be backfilled with 1 ft. of sand/gravel prior to installing the screen and casing into the borehole;
- Assemble the well screen and casing, and lower the assembled well to the necessary depth. Keep the well screen casing plumb in the hole. Threaded joints are required because glued or solvent welded joints might alter the chemistry of future water samples. The well screen should be new, machine-slotted (typically 0.010 in. slot size) or continuously wrapped wire wound, and should be composed of Schedule 40 polyvinyl chloride (PVC) material;
- Install a sand/gravel pack (with a grain size appropriate for the well screen) in the annular space between the well and the side of the borehole. Install the sand/gravel pack 2 ft. above the top of the well screen;
- Place a 1 ft. (minimum) bentonite/cement seal above the sand/gravel pack to form a seal;
- Fill the remaining annular space in the borehole with bentonite/cement grout to a depth of approximately 1 to 2 ft. below the ground surface;
- Seal the well from surface contamination with a 1 to 2 ft. concrete layer;
- Place a water-resistant, bolt-down manhole cover or protective casing within a 2 ft. x 2 ft. square concrete pad overlying the well location; and
- Cap the top of the well casing with a tightly fitted, locking well cap to prevent vandalism; and to prevent surface water, debris, and/or other contaminants from entering the well.

Examples of soil boring and monitoring well installations are shown in Figure A.1- Examples of Soil Boring and Monitoring Installation, below.

Figure A.1- Examples of Soil Boring and Monitoring Well Installation



Pre-Packed Wells Installed Using Direct Push

BUSTR accepts the use of pre-packed monitoring wells greater than or equal to one inch inner diameter as an approved method for obtaining ground water samples. Pre-packed wells allow for an accelerated assessment of the release site, and can be installed in areas where access is restricted. However, use of these wells is limited to collecting ground water samples, measuring water levels, and observing wells during pump tests. These wells are not recommended for use in determining hydraulic conductivity (i.e., slug tests). The one-inch, pre-packed wells must be installed according to manufacturer's recommendations. BUSTR must approve the use of pre-packed wells less than one inch in diameter. A request to use an alternate technology must be submitted to BUSTR for approval. (See Section 3.16, Alternate Technologies.)

A.3 Soil Boring Sampling

Subsurface Soil Sampling

Wear clean protective gloves (i.e., latex) when handling soil samples retrieved from the borehole. All samples must be undisturbed, discrete samples. Samples from each interval must be split into two representative soil samples. Each split sample should be placed in a jar or small, sealable plastic bag and used for field screening. (See Section A.5, Field Screening.) The other sample must be immediately placed into a laboratory-supplied glass jar (with a Teflon-lined lid) and preserved on ice to 39° F. The sample containers must be filled completely and submitted for laboratory analysis. Affix sample labels to each jar; labels must correspond to the site sample log and chain-of-custody. Either deliver the sample jars directly or send via overnight shipper to a laboratory using standard chain-of-custody procedures. (See Section A.9, Geotechnical Sampling.) This process must be completed for all sampling locations.

If ground water is encountered:

- Submit the sample from above the soil/water interface, exhibiting the highest headspace reading/ concentration plus a sample from immediately above the soil/ground water interface as encountered during drilling;
- If the highest headspace reading is the sample immediately above the soil/ground water interface, submit the highest and the second highest samples from above the soil/ground water interface; or
- If no soil samples exhibit headspace readings above background for the headspace technique, submit a sample from immediately above the soil/water interface as encountered during drilling.

If ground water is not encountered:

- Submit the sample with the highest headspace readings plus the sample from the bottom of the boring; or
- If no soil samples exhibit headspace readings above background for the headspace technique, submit a sample from the bottom of the boring only.

Establish data quality objectives consistent with the intended use of the analytical data (e.g., low detection limits to demonstrate meeting action levels or higher detection limits for screening samples).

Subsurface Soil Re-sampling

When re-sampling an area with historical soil contamination to determine current concentrations of COCs, soil borings must be installed and sampled as follows:

- Install the soil boring/ monitoring well as described in Section A.2, Soil Boring/ Monitoring Well Installation;
- Follow field screening procedures as described in Section A.5, Field Screening;
- Submit samples for laboratory analysis as described in Section A.3, Soil Boring Sampling-Subsurface Soil Sampling; and
- Collect one soil sample from the same depth that is being re-evaluated, regardless of current groundwater depth, and submit it for laboratory analysis.

A.4 Open Excavation Sampling

Excavation Ground Water Sampling

When conducting a closure, any water encountered in the excavation must be evacuated. If an O/O chooses not evacuate water from an excavation, it will be considered ground water and must be sampled. If within 24 hrs. of pumping water out of the excavation, the water recharges, then a ground water sample must be collected. Collect ground water samples from any dispenser and piping trenches or tank cavity areas that contain ground water. If no water recharges within 24 hrs., then only soil sampling is required.

Before collecting a water sample from a closure excavation or trench, first recover any free product or sheen, and dispose of it properly. When collecting the sample, lower the container into the water in an horizontal position and slowly turn it upright just under the surface of the water. Collect the sample within the first 6 in. of the water surface. Carefully fill the sample jar to minimize turbulence and to minimize the amount of soil and foreign matter obtained. In certain circumstances, a bailer may be used to avoid entering an excavation to collect a water sample.

Excavation Soil Sampling

Wear clean latex gloves to handle soil samples retrieved from the excavation. Use a clean hand trowel to remove three to four inches of native soil from the bottom and/or sidewalls of the excavation. Collect undisturbed and discrete soil samples (i.e., no composites) from the exposed area using a stainless steel spoon or a sampling tube. Split each sample into two representative soil samples. Place one split sample into a jar or small, sealable plastic bag used for field screening. (See Section A.5, Field Screening.) Immediately place the other sample into a laboratory-supplied glass jar (with a Teflon®-lined lid); preserve it on ice to 39° F. Completely fill sample containers submitted for laboratory analysis. Affix sample labels to each jar; labels must correspond to the site sample log and chain-of-custody. Either deliver the sample jars directly, or send via overnight shipper to a laboratory; use standard chain-of-custody procedures. This process must be completed for all sampling locations.

A.5 Field Screening

A headspace analysis (e.g., photo ionization detector/flame ionization detector [PID/FID]) must be used when site investigation activities include soil sampling and/or field screening. Samples must be split from each interval into two representative soil samples. Place one split sample in a jar or small, sealable plastic bag for field screening. This container should be no more than half full and sealed to prevent the loss of volatiles. Allow this container with the soil sample to stand for a minimum of 10 - 15 min. at a minimum temperature of 70° F. Insert a calibrated field screening instrument probe into the container, being careful not to lose volatiles. Record the highest field screening reading. Typically, the highest field screening reading must be submitted for laboratory analysis. Sampling requirements vary with the investigation being performed.

For the other half of the sample, immediately place it into a laboratory-supplied glass jar (with a Teflon-lined lid); preserve on ice to a temperature of 39°F. Submit completely filled sample containers for laboratory analysis. If field screening is not performed, submit all samples for laboratory analysis.

A.6 Monitoring Well Sampling

Well Development and Maintenance

To ensure that representative ground water samples are collected, monitoring wells must be properly developed. Well development improves the hydraulic interface with subsurface strata and removes particulates produced during the well installation. Upon completion, develop the wells by using clean disposable bailers and dedicated polypropylene rope, a properly decontaminated centrifugal or submersible pump, or other suitable equipment. For development with a pump, initially use a bailer to remove accumulated sediments.

Development and purged fluids generated from the well should be containerized in United States Department of Transportation (DOT)-approved 17-H or 17-E 55-gallon drums and disposed of according to Federal, state, and local regulations.

Monitoring wells must be periodically redeveloped to ensure that representative samples can be collected. Maintenance should include inspections of hydraulic performance, and a comparison to baseline data. If hydraulic performance is diminished, redevelop the well. Perform frequent (monthly or quarterly) sampling or implement a well maintenance program to ensure appropriate well monitoring and sample integrity.

Ground Water Sampling from Monitoring Wells

Prior to sampling activities, perform appropriate measurements (i.e., static water level, total well depth, detection of free product or gases). Depth measurements must be accurate to within 0.01 ft. Additionally, survey all wells using a survey reference point (i.e., benchmark).

Characterize and record the presence and thickness of any free product. (See Section 3.6.3, Free Product Removal and Reporting.) Measure free product thickness using an oil/water interface probe. If free product is not detected, collect a ground water sample and submit it to the laboratory for analysis.

Monitoring wells must be properly developed prior to purging and sampling to ensure that representative ground water samples are collected. Use a clean hand bailer or other suitable equipment to purge the monitoring well of a minimum of three times its calculated volume of water. Allow the well to recover to near static water levels prior to collecting the sample, but sample as soon as possible. To avoid cross contamination of monitoring wells, use dedicated or disposable bailers.

Peristaltic and bladder pumps are generally acknowledged as good ground water sampling devices, but the need for a power source or compressed air limits their use. Typically, bottom-draining bailers are used for sampling ground water. Bailers should be lowered and raised slowly (not dropped) into the well to minimize disturbance and aeration of the ground water. Submerge bailers into the water only as far as necessary to collect the sample volume and minimize aeration. Place the sample into the appropriate laboratory supplied container and place in a cooler with ice.

Properly identify each sample with the appropriate location before submitting to the laboratory. At a minimum, field logging should include the identification and location of the samples; the number and quantity of well purging volumes; the date and time of sampling; and the results of pH, temperature and conductivity field measurements.

Collect a ground water sample from each monitoring well. Analyze the samples for COCs using one or more standard laboratory analytical methods. (See Table 3.1, Selected Chemical(s) of Concern in Section 3.7.1, Source Investigation.)

A.7 Sample Quality Assurance/ Quality Control

Data Quality Objectives

Quality assurance (QA) and quality control (QC) procedures help to minimize sources of errors and the potential for cross-contaminating samples and help to maximize the quality of the data collected. Establish data quality objectives that will be consistent with the intended use of the data (e.g., low detection limits to demonstrate meeting action levels or higher detection limits for screening samples). Data quality objectives should:

- Define the most appropriate types of samples to collect;
- Determine the most appropriate conditions to sample;
- Define the quality and quantity of required samples; and
- Define the quality and quantity of samples needed to support the sampling strategy.

Sample QA/QC

Blanks

Use field and trip blanks as controls for detecting field-introduced contamination of water samples or contamination occurring during transit to or from the sampling site. In situations where laboratory analytical data is suspect or inconsistent, use control samples (i.e., blanks) to validate/document the appropriate sampling and preservation methods.

Trip Blanks

Prepare trip blanks as samples of organic-free water, which must be prepared at the same location and time as the sample bottles. Keep trip blanks with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Upon return to the laboratory, trip blanks will be analyzed as if they were a regular sample. If these samples are accidentally opened, this must be recorded on the chain-of-custody form.

Field Blanks

Prepare field blanks by filling sample containers with deionized water at the site and preserving them with an appropriate reagent(s). Upon return to the laboratory, field blanks are analyzed as if they were a regular sample. If these samples are accidentally opened, this must be recorded on the chain-of-custody form.

Equipment Blanks

Prepare equipment blanks by pouring deionized water over or through the decontaminated sample collection device and collecting this water in a sample container. Upon return to the laboratory, equipment blanks will be analyzed as if they were a regular sample. If these samples are accidentally opened, this must be recorded on the chain-of-custody form.

Sample Preservation

Proper soil and water sample preservation is important for maintaining sample integrity and analytical data validity. Seal samples in glass jars that are tightly capped with Teflon-lined lids. Properly label and identify all sample containers. Once in containers, immediately place samples for laboratory analysis on ice, in a refrigerator, or in cooler maintained to a temperature of 4^{o} C for transport. Please contact the laboratory for information on the appropriate container sizes and preservation methods for the desired analyses. Improper sample handling, such as excessive holding times, might alter the analytical results and invalidate the data. Holding times vary according to the constituent being analyzed.

Chain-of-Custody

A chain-of-custody record tracks the transfer of custody for a sample from the time of its collection to its delivery to the laboratory. Fill out a chain-of-custody form immediately after collecting the samples. The person who is collecting, relinquishing, and receiving the samples must sign a chain-of-custody form each time the samples change hands. Most laboratories can provide a copy of a standard chain-of-custody form. Appropriate forms should include sample identification; sample type; date and time collected; analysis requested for each sample; preservation; and, in the case of soil samples, depth and location.

A.8 Decontamination Procedures

The main purposes of decontamination are to ensure that valid, representative samples are collected and to prevent cross-contamination among sample locations. The lack of effective and standardized procedures typically results in critical scrutiny of the generated data.

At a minimum, steam-clean or wash all sampling equipment (e.g., drill augers and rods, split spoons, bailers) in an area specifically set aside for decontaminating equipment (i.e., decon pad). Clean the sampling equipment before beginning to sample and between collecting each sample. Scrub soil sampling equipment with non-phosphatic soap and water, and rinse with distilled/deionized water. Collect/contain all decontamination fluids (rinseates) properly and transfer to labeled 55 gal. DOT-approved 17-H or 17-E steel drums. Characterize all contaminated soil and rinseates, and dispose of them (as necessary) according to Federal, state, and local regulations.

A.9 Geotechnical Sampling

Soil Sampling for Vadose Zone Geotechnical Analysis

Site-specific soil characteristics may be necessary during a Tier 2 or 3 Evaluations. If geotechnical analysis is necessary, select one or more soil boring locations (as appropriate) and collect a sample from each representative zone identified in each boring. Analyze samples to determine the following parameters shown in Table A.1- Geotechnical Parameters, below.

Table A.1 – Geotechnical Parameters

PARAMETER	TYPICAL TEST METHODS
Atterberg limits	ASTM D4318
Unified Soil Classification System (USCS) classification	ASTM D2487; ASTM C136 Sieve Analysis; ASTM D422;
Dry bulk density	Army Corps of Engineers EM-1110-2-1906
Grain size analysis	ASTM D422; ASTM C136 Sieve Analysis
Specific gravity	ASTM D854
Moisture content	ASTM D2216
Total porosity	Army Corps of Engineers EM-1110-2-1906
Volumetric air content	Army Corps of Engineers EM-1110-2-1906
Volumetric water content	Army Corps of Engineers EM-1110-2-1906
Vertical hydraulic conductivity	ASTM D5084; ASTMD2434
Total organic carbon (a.k.a. fraction of organic carbon [FOC])	Walkley-Black Method; ASTM D2974 (Total Organic Matter must be converted to FOC)

Soil samples for geotechnical analysis may be obtained by using split-spoon samplers, Shelby Tubes, California Samplers, or direct push sample tubes. However, analyses for many of these parameters require the collection of undisturbed soil using a thin-walled sampling device (e.g., Shelby Tube) according to ASTM D1587-00: *Standard Practice for Thin Walled Tube Sampling of Soils for Geotechnical Purposes* and the preservation and transport of samples according to ASTM D4220-00: *Standard Practice for Preserving and Transporting Soil Samples*.

Soil samples must also be classified according to USCS or ASTM D2488-93: *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*. In some cases, samples must be analyzed in a laboratory via ASTM D2487-00: *Standard Practice for Classification of Soils for Engineering Purposes*. For example, ASTM D2487-00 must be used when electing to use a soil type other than sand/gravel in closure assessments or when providing site-specific geotechnical data for Tier 2 pathway evaluations. Soil boring logs and monitoring well

construction diagrams should include, at minimum, the information listed in Appendix B, Data Presentation.

A.10 Yield Determination and Adjustments

Yield Determination for Ground Water Classification

To determine if a saturated zone meets the definition of ground water, the site's ground water yield and *in situ* hydraulic conductivity of the saturated zone must be evaluated. If the saturated zone is capable of yielding at least 1.5 gal./8 hrs., and has an *in situ* hydraulic conductivity greater than 5.0×10^{-6} cm/sec., then the saturated zone is ground water. However, if the initial field study for one of the criteria fails to meet the definition of ground water, then additional evaluation is not required.

If a saturated zone less than 5 ft. thick is encountered and is determined to yield less than 1.5 gal./8 hr., then BUSTR may require a ground water determination of the lower saturated zone.

Yield Determination for Drinking Water Classification

If the UST site is not in a Drinking Water Source Protection Area (DWSPA), sensitive area, does not have a drinking water source within the surrounding area, or does not have a surface water body within 300 ft., yield determination may be used to classify ground water as drinking or non-drinking water.

To determine if ground water is a drinking water source, pumping tests may be performed to determine whether a yield of more than 3 gal./min. can be sustained. However, the minimum pumping rate might need to be adjusted to account for seasonal fluctuations, well diameter, and partial penetration of the saturated zone. (See examples of such adjustments in the Yield Adjustments Section below.)

Yield Determination

Monitoring wells must be extended to the bottom of the saturated zone or to at least 5 ft. into the saturated zone, whichever is less. Screen monitoring wells to make sure they can accommodate seasonal fluctuations in the ground water table. However, monitoring wells installed only 5 ft. into a saturated zone might not provide suitable observation points, unless the appropriate adjustments are made to the minimum rate of 3 gal./min.

Conduct yield tests in properly located and installed wells. For wells used as observation points, the well depth, length and slot size of the screen, and the distribution of the filter pack must be known. The materials comprising the screened interval must be characterized (i.e., thickness and grain size).

Before conducting the field pump test, calculate any appropriate adjustments to the minimum pump rate. Determine the actual yield after the draw down stabilizes at the calculated (adjusted) pump rate. To satisfy the yield requirements for ground water, the calculated pump rate must be maintained for 15 min. Regardless of what the yield determination shows, all appropriate test data, including the actual pump rate, must be submitted for review.

If any monitoring wells installed during the Tier evaluation exceed the minimum pump rate for the yield determination, other monitoring wells do not need to be tested. All wastewater generated during the yield determination must be characterized and disposed of in accordance with state and federal regulations.

Yield Adjustments

Review the following factors to determine the appropriate minimum yield rate for the evaluation. Make potential adjustments as follows:

- If the yield determination is performed during high water level (March through May, per Ohio EPA Voluntary Action Program [VAP]), then no adjustment is needed. However, if the determination is made during the low water level (June through February), then an adjustment will be necessary. The recommended default multiplier (for the 3 gal./min. rate) will be 0.35, which reduces the minimum pump rate to 1.95 gal./min. This seasonal adjustment must also be made for the ground water determination (i.e., 1.5 gal./8 hrs.), as appropriate;
- 4-in. wells are preferred, however, if 2-in. diameter wells have been installed then a 0.85 adjustment factor must be used. Therefore, the minimum pump rate would be reduced to 2.6 gal./min; and/or
- If a well is installed only 5 ft. into a saturated zone for the yield determination, then make an adjustment to the yield target rate on a site-specific basis. Use the Walton & Butler equation (Walton, W. C., "Selected Analytical Methods for Well and Aquifer Evaluation", *Illinois State Water Survey*, Bulletin No. 49, 1962) to determine a multiplier by dividing the length of the saturated zone screen by the thickness of the aquifer. If the thickness can not be determined, then use a default thickness of 25 ft. Therefore, if 5 ft. of a saturated zone is screened and the 25 ft. default thickness is used, the multiplier would be 0.2. That would reduce the minimum pump rate from 3 gal./min. to 0.6 gal./min. Although various equations can be used to make this adjustment, apply the Walton & Butler equation as the default equation.

Note that one or more of these adjustments might be appropriate. Ensure that all the wells are evaluated and compared to the appropriately adjusted value. Contact BUSTR when using site-specific criteria or equations other than the default.

A.11 Boring/ Well Abandonment

Borehole Abandonment/Well Decommissioning

To prevent the potential downward migration of surface contaminants, properly abandon boreholes not completed as wells and wells on release sites that have received no further action status.

Borehole Abandonment

Borehole abandonment should consist of grouting the borehole. The basic equipment for most abandonment procedures is the same as for tremie-grouting of a monitoring well. Use a grout mixer or other method of mixing the grout and a positive displacement pump to deliver the mixture with positive pressure to the bottom of the borehole.

There are several alternative methods for borehole abandonment:

- Place bentonite pellets through a conductor pipe into water-filled, uncased boreholes;
- Use direct gravity placement in boreholes that are free of water and in deeper boreholes that have sufficient open diameter to prevent bridging; and
- With special precautions, bentonite pellets/chips may be used to abandon deep water-filled boreholes that have sufficient open diameter to prevent bridging. Removing all the fines should prevent the development of drilling mud that impedes proper settling of the bentonite chunks.

To be effective, a sealing material should not react with any contaminants, should form a tight seal with the borehole wall, should be resistant to cracking/shrinking, and should have an effective hydraulic conductivity less than the native materials. Two principal grouting materials, neat cement and bentonite, best meet the needs for abandonment.

Well Decommissioning

Measure the well's depth before it is sealed and record static water levels. This is completed to ensure that no obstructions might interfere with effective sealing.

To properly seal a well:

- Remove (pull or over-drill) or drill through the well casing with hollow stem augers); and
- Cut off casing 2 ft. below grade and grout in place.

Note that removal is the preferred method for well abandonment.

Use bentonite, neat cement, or a bentonite/cement mixture as the primary sealing material. Use a single, continuous operation to place such material upward from the bottom of the well to within 2 ft. of the surface. Backfill the remaining 2 ft. of annular space with materials that match the existing surface conditions (i.e., soil, asphalt, concrete).

The Ohio Revised Code requires that an abandonment report be filed with the ODNR Division of Water. Contact ODNR for the appropriate form (e.g., Water Well Sealing Report). BUSTR must be contacted prior to abandoning and/or decommissioning wells at sites still undergoing corrective action.

A.12 Personnel Safety (Site-Specific Health and Safety Plan)

A Site-Specific Health and Safety Plan must be prepared and implemented at all UST release sites. Additionally, all personnel working at a UST release site should have completed the United States Occupational Health and Safety Administration (OSHA) 40 hr. Hazardous Waste Operations (HAZWOPER) course and annual 8 hr. refresher courses. For additional information concerning health and safety issues, please see 29 Code of Federal Regulations (CFR) 1910.120, and other standard industry health and safety references (i.e., National Institute for Safety and Health - NIOSH, American National Standards Institute - ANSI, National Fire Protection Association - NFPA, and/or ASTM).

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Appendix B: Data Presentation

Table of Contents **Page**

Figures and Tables **Page**

B.1 Site Figures

This suggested list of figures may be included in reports, as applicable:

- Topographic Map;
- Closure Sample Locations Map;
- Site Map;
- Sample Location Map;
- Potentiometric Surface Map;
- Soil Analytical Data Map;
- Ground Water Analytical Data Map.;
- Soil Boring Logs and Monitoring Well Construction Diagrams;
- Cross Section Location Map;
- Cross Section; and/or
- Site and Area Within 300 Feet Map.

Each map should include the following general information:

- Site name and location (i.e., address, city, county);
- North directional arrow;
- Explanation or legend;
- Scale (i.e., 1 in. = 20 ft.);
- Preparation date; and
- Signature or initials of the person who prepared the map.

In addition, each map listed below should contain the following specific information:

B.2 Topographic Map

- Site location identified on a portion of the USGS 7.5 min. topographic map.

(See Figure B.1- Topographic Map for an example.)

B.3 Closure Sampling Map

- Sample locations;
- Analytical results for each sample location;
- Property boundaries;
- Street locations;
- Above-ground structures;
- The UST system location including the number of USTs;
- Adjacent properties and their use;
- Any known water wells located on the UST site;
- Any known monitoring wells located on the UST site;

- Any utilities uncovered as part of the excavation process; and
- Locations of any other known UST systems or portions thereof known to have been permanently removed or closed-in-place.

(See Figure B.2, Closure Sample Locations Map, for an example.)

B.4 Site Map

- Property boundaries of release site;
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations;
- The location of the suspected release source;
- Site structure and surface cover (i.e., buildings, asphalt, concrete, grass);
- Nearby buildings, street names, and business name(s);
- Buried and overhead utility locations on or adjacent to the UST release site;
- The location of other potential release sources, such as nearby service stations; and
- Exact locations of drinking water wells within 50 ft. of the UST system.

(See Figure B.3, Site Map, for an example.)

B.5 Sample Location Map

- Property boundaries of release site;
- UST system locations (tanks, piping, dispensers) and former UST system locations with dimensions noted;
- The location of the suspected release source;
- Nearby buildings, street names, and business name(s);
- Buried and overhead utility locations on or adjacent to the UST release site;
- The location of other potential release sources, such as nearby service stations;
- The limits of any excavations;
- All soil boring, trench, and monitoring well locations, marked and designated appropriately (e.g., MW-l or SB-3);
- All soil and water sample collection points within an excavation marked and designated appropriately; and
- Exact locations of drinking-water wells within 50 ft. of the UST system.

(See Figure B.4, Sample Location Map, for an example.)

B.6 Potentiometric Surface Map

- Property boundaries of release site;
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations with dimensions noted;
- The location of the suspected release source;
- Nearby buildings, street names, and business name(s);
- Buried and overhead utility locations on or adjacent to the UST release site;

- The location of other potential release sources, such as nearby service stations;
- The limits of any excavations;
- All soil boring, trench, and monitoring well locations, marked and designated appropriately (e.g., MW-l or SB-3);
- All soil and water sample collection points within an excavation marked and designated appropriately;
- Exact locations of drinking water wells within 50 ft. of the UST system;
- Groundwater flow direction; and
- Data points and potentiometric surface contour lines.

(See Figure B.5, Potentiometric Surface Map, for an example.)

B.7 Soil Analytical Data Map

- Property boundaries of release site;
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations with dimensions noted;
- The location of the suspected release source;
- Nearby buildings, street names, and business name(s);
- All soil boring, trench, and monitoring well locations, marked, and designated appropriately (e.g., MW-l or SB-3);
- Buried and overhead utility locations on or adjacent to the UST release site;
- The location of other potential release sources, such as nearby service stations;
- The limits of any excavations;
- All soil and water sample collection points within an excavation marked and designated appropriately;
- Exact locations of drinking water wells within 50 ft. of the UST system; and
- Soil analytical results in tabular form for each sample location.

(See Figure B.6, Soil Analytical Data Map, for an example.)

B.8 Ground Water Analytical Data Map

- Property boundaries of release site;
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations with dimensions noted;
- The location of the suspected release source;
- Nearby buildings, street names, and business name(s);
- All soil boring, trench and monitoring well locations, marked and designated appropriately (e.g., MW-l or SB-3);
- Buried and overhead utility locations on or adjacent to the UST release site;
- The location of other potential release sources, such as nearby gas stations;
- The limits of any excavations;
- All water sample collection points within an excavation marked and designated appropriately;
- Exact locations of drinking water wells within 50 ft. of the UST system; and
- Ground water analytical results in tabular form for each sampling point.

(See Figure B.7, Ground Water Analytical Data Map, for an example.)

B.9 Soil Boring Logs and Monitoring Well Construction Diagrams

Use detailed diagrams to show soil boring logs and monitoring well construction. Soil boring and monitoring well logs should include the following information, as appropriate:

- Boring/well identification number;
- Site name and address;
- Latitude and longitude (e.g., global positioning system - GPS);
- Drilling and well installation dates, including dates started and completed;
- Name of person logging the boring/well;
- Name of drilling company;
- Type and size of drilling/sampling equipment (i.e., 4.25 in. ID hollow-stem augers (HSA), 24 in. split spoons);
- Type and size of well construction material (i.e., 2 in. ID Schedule 40 PVC casing and 0.010 slot PVC screen);
- Type of grout used to backfill the boring/well annulus;
- Detailed description of the soil sample for each interval, including soil type, color, moisture content, presence of fracturing, and any other pertinent observations and comments (i.e., staining, odors);
- Detailed description of bedrock samples collected, including rock type, color, bedding thickness, approximate dip angle and fracturing, moisture content, extent of weathering/competency, and any other pertinent observations or comments;
- Standard penetration test (i.e., blow count) data for each sampling interval;
- Sample recovery from each sampling interval;
- Results of field screening for each sample;
- Depth that ground water was encountered during drilling;
- Static water depth after the well has been developed (including date(s) of measurement);
- Ground surface elevation at the wellhead, and the elevation at the top of the well casing, measured from a marked point on the north side of the well. All monitoring well elevation measurements should be surveyed to within 0.01 ft. Ground surface elevations should be surveyed to within 0.1 ft;
- Graphical representation of well construction details;
- Graphical representation of soil/rock types as encountered;
- Identification of soil sample(s) submitted for laboratory analysis;
- Notable occurrences during drilling (i.e., the presence of heaving sand in the augers, difficult drilling conditions); and
- Any information associated with geotechnical soil characterization.

(See Figure B.8, Soil Boring Log and Monitoring Well Construction Diagram, for an example.)

B.10 Cross Sections

The term, "cross section", refers not only to cross sections constructed from boring logs and other information, but also to drawings of trench or tank cavity walls.

Cross sections should include the following information:

- Site name and address;
- Cross section name (i.e., A-A');
- An explanation of any symbols used (i.e., legend);
- Graphical representation of soil/bedrock encountered;
- The location of any samples collected;
- Field screen readings corresponding to sample intervals;
- Underground utilities;
- Static and encountered ground water elevations; and
- Horizontal and vertical scales.

(See Figure B.9, Cross Section Location Map and Figure B.10, Cross Section, for examples.)

B.11 Site and Area Within 300 Feet Map

- Property boundaries of the release site;
- The location of the suspected release source;
- Nearby buildings, street names, and business name(s);
- Buried and overhead utility locations on or adjacent to the UST release site;
- The location of other potential release sources, such as nearby service stations;
- Locations of drinking-water wells within 300 ft. of the UST system;
- Depiction of the current and reasonably anticipated land-use of the UST site and all properties within 300 ft. of the property boundary (i.e., historical and current land-use of the UST site and adjacent properties, historical and current zoning or planning designation for the UST site and adjacent properties);
- Roadways within 300 ft. of the property boundary, including centerlines;
- Total area calculations including all properties within 300 ft. of the property boundary, including percentages; and
- Lakes, streams, rivers and surface water bodies within 300 ft.

(See Figure B.11- Site and Area within 300 Feet Map, for an example.)

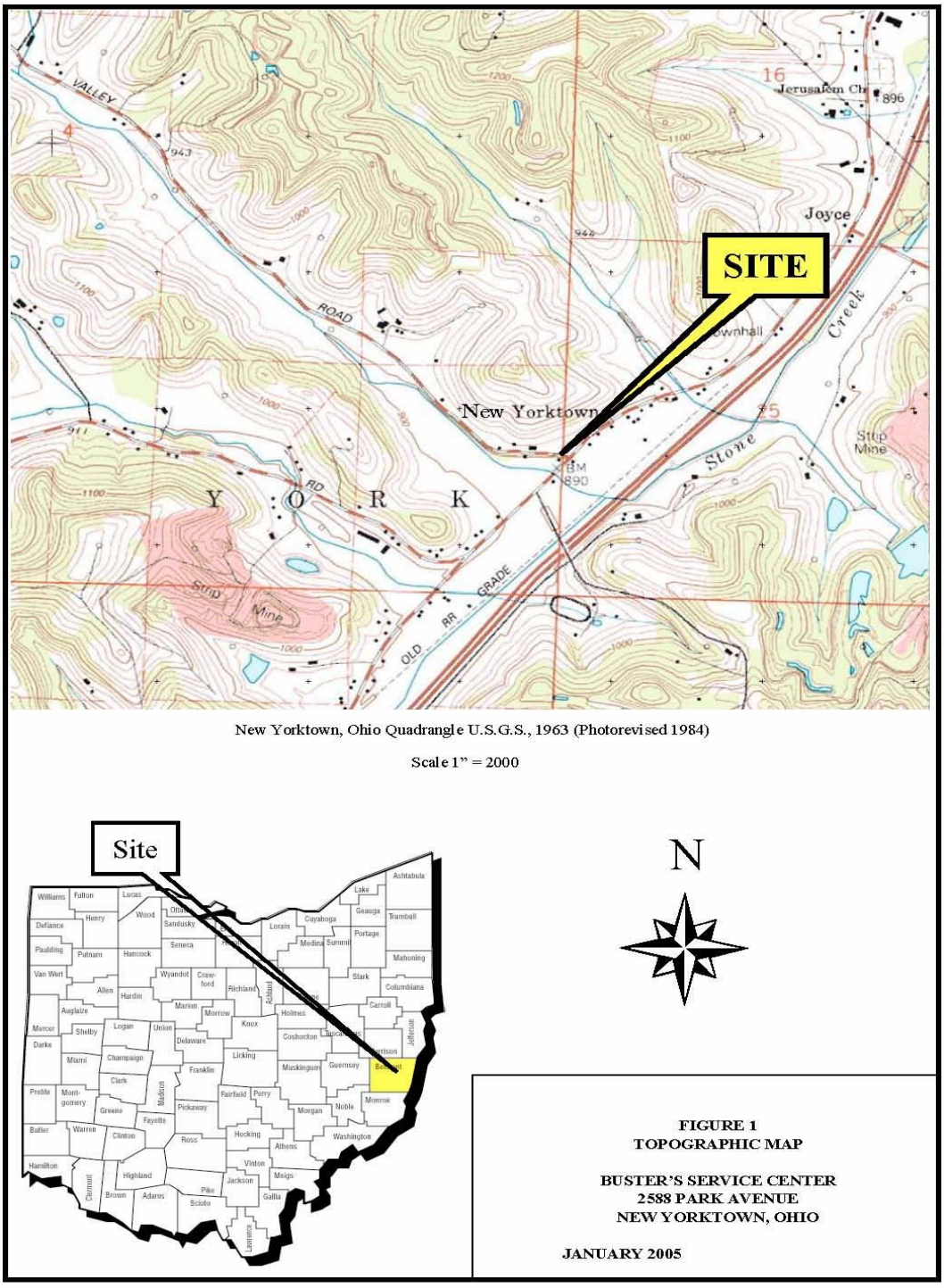

Figure B.1- Topographic Map

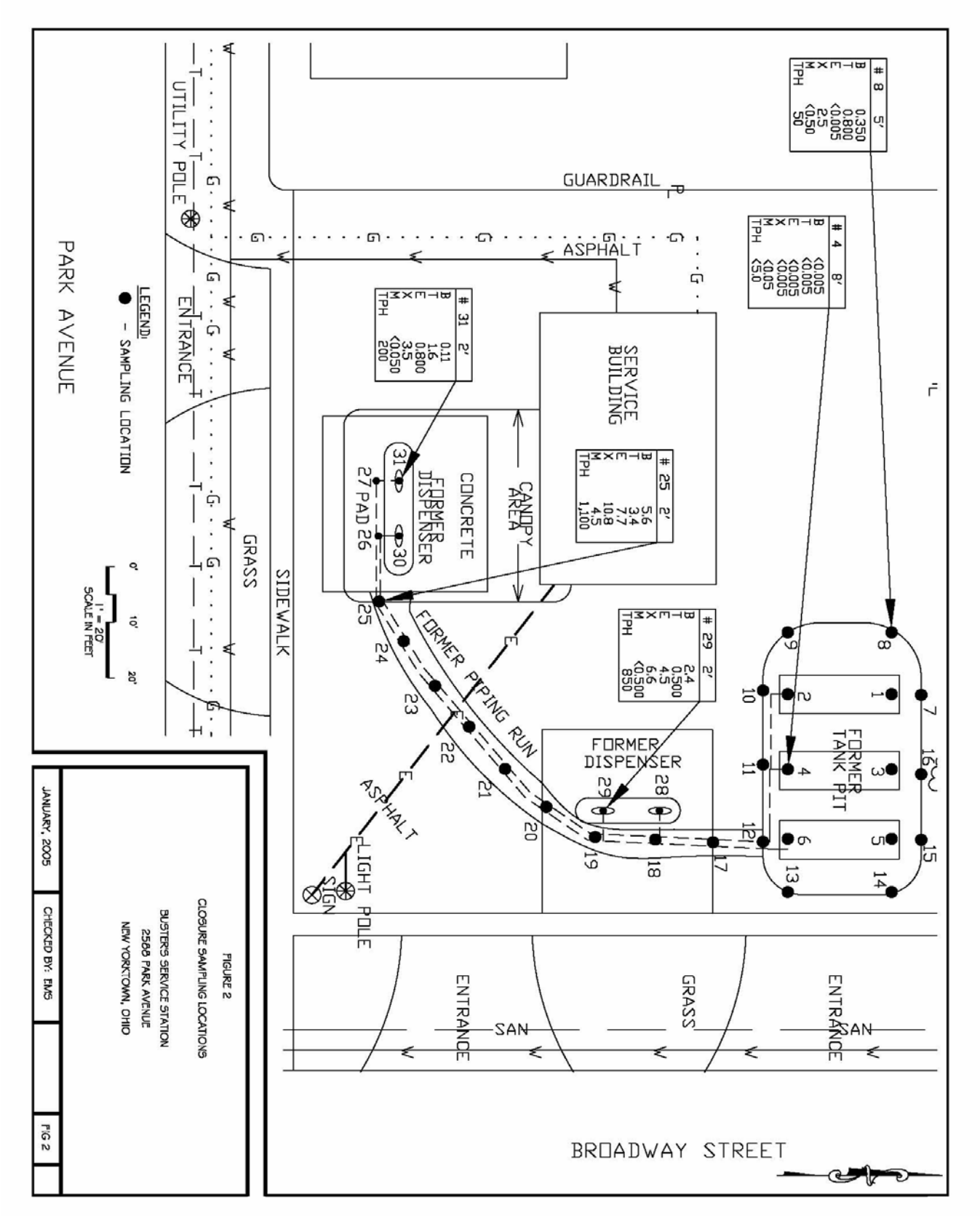

Figure B.2- Closure Sample Locations Map

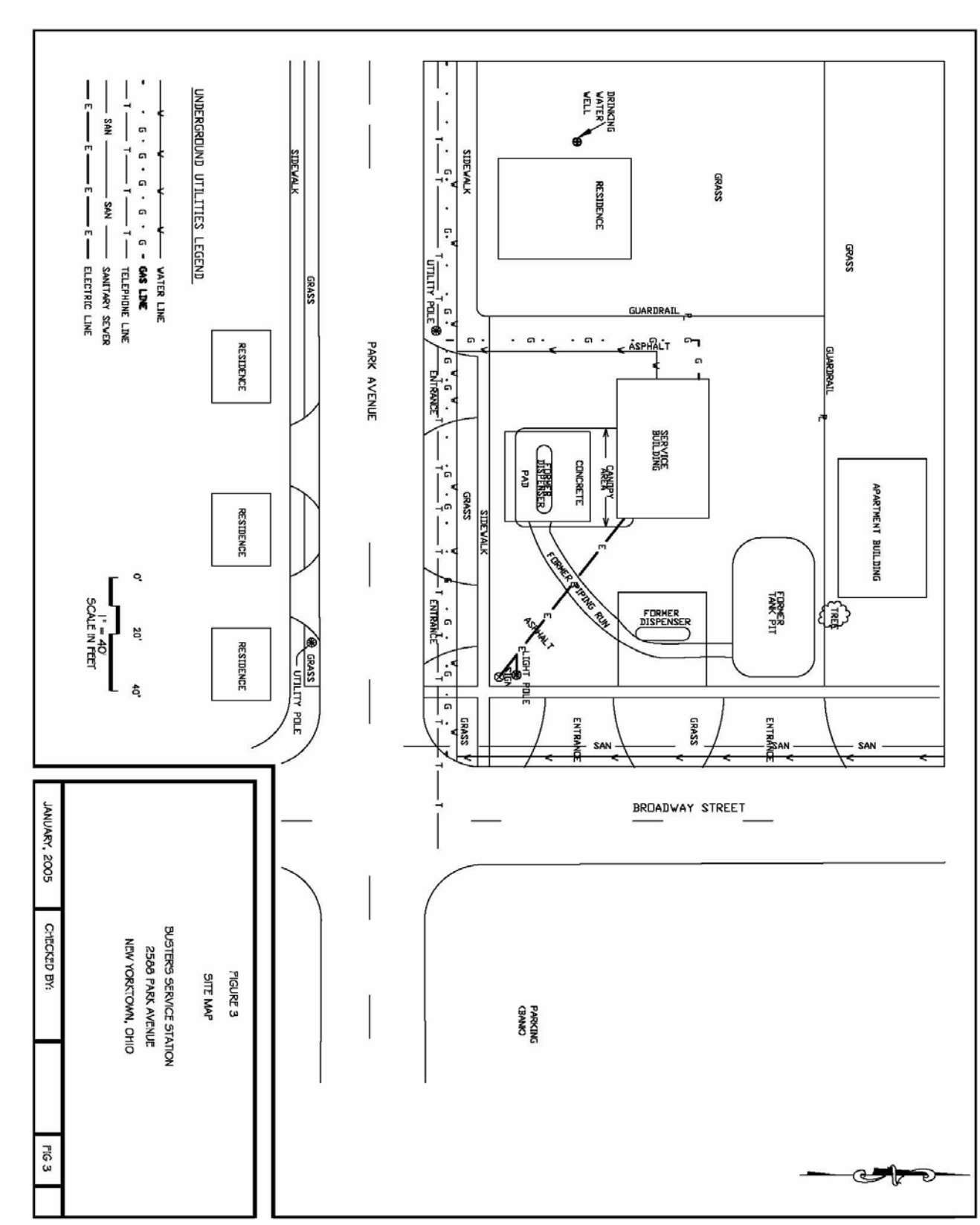

Figure B.3- Site Map

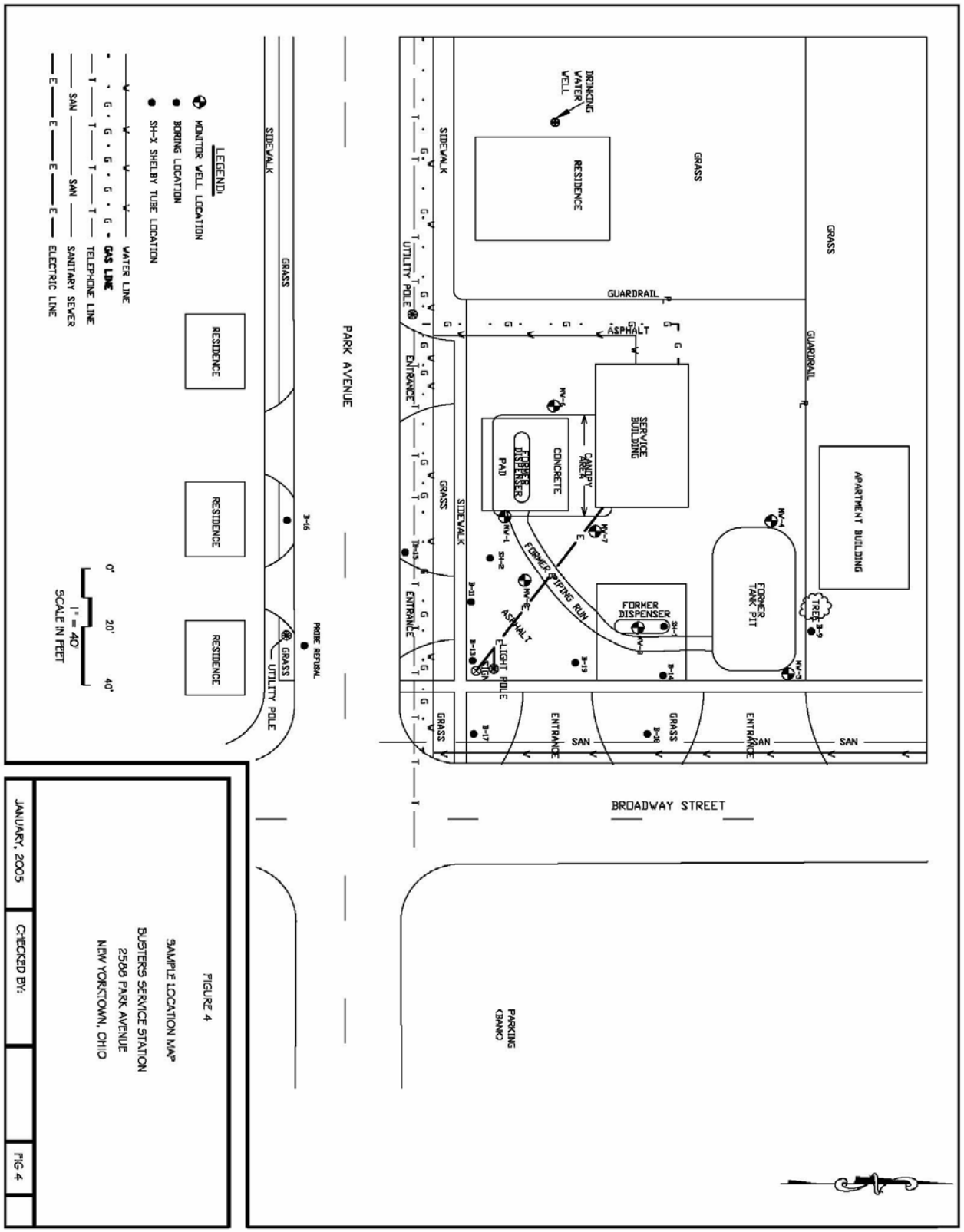

Figure B.4- Sample Location Map

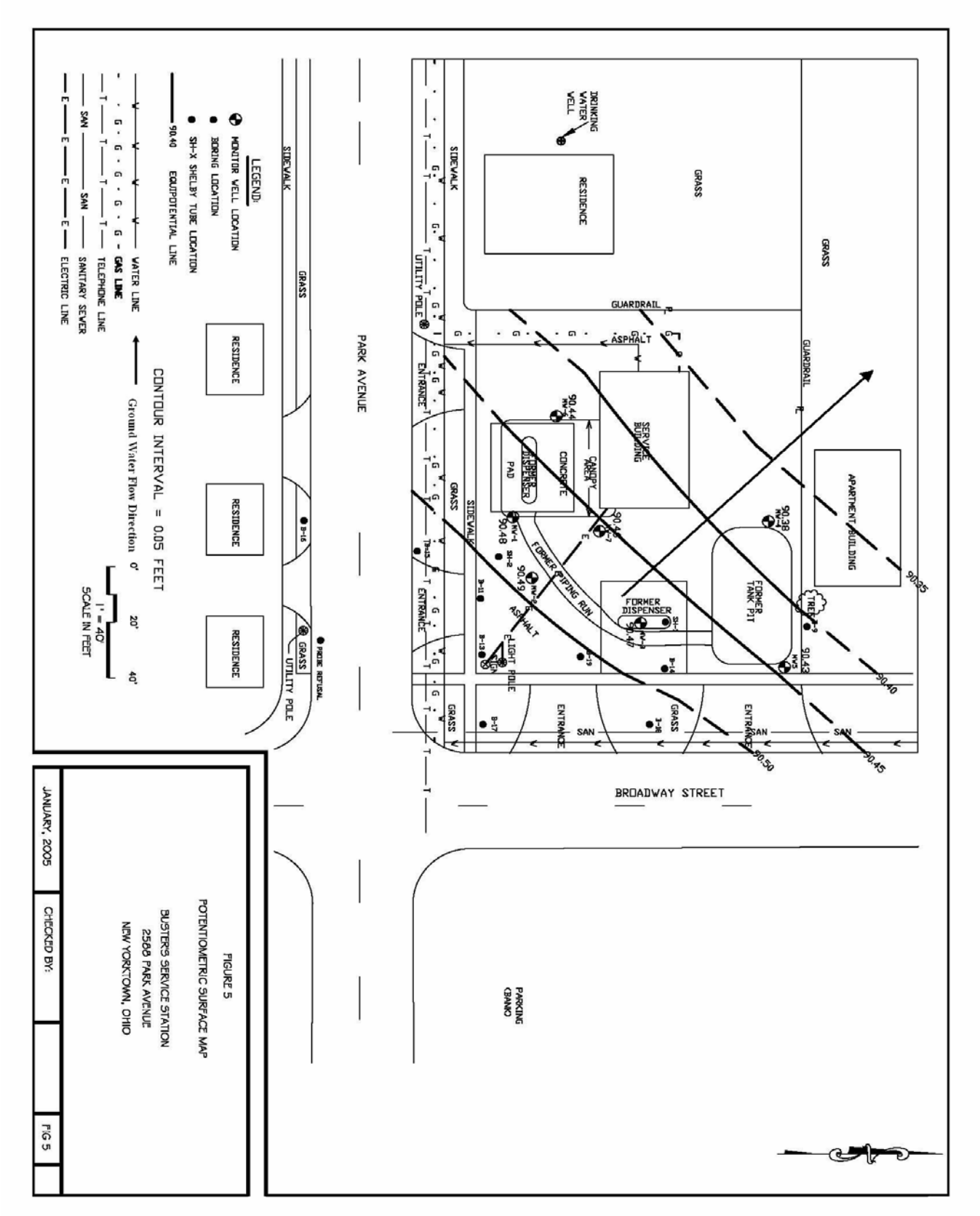

Figure B.5- Potentiometric Surface Map

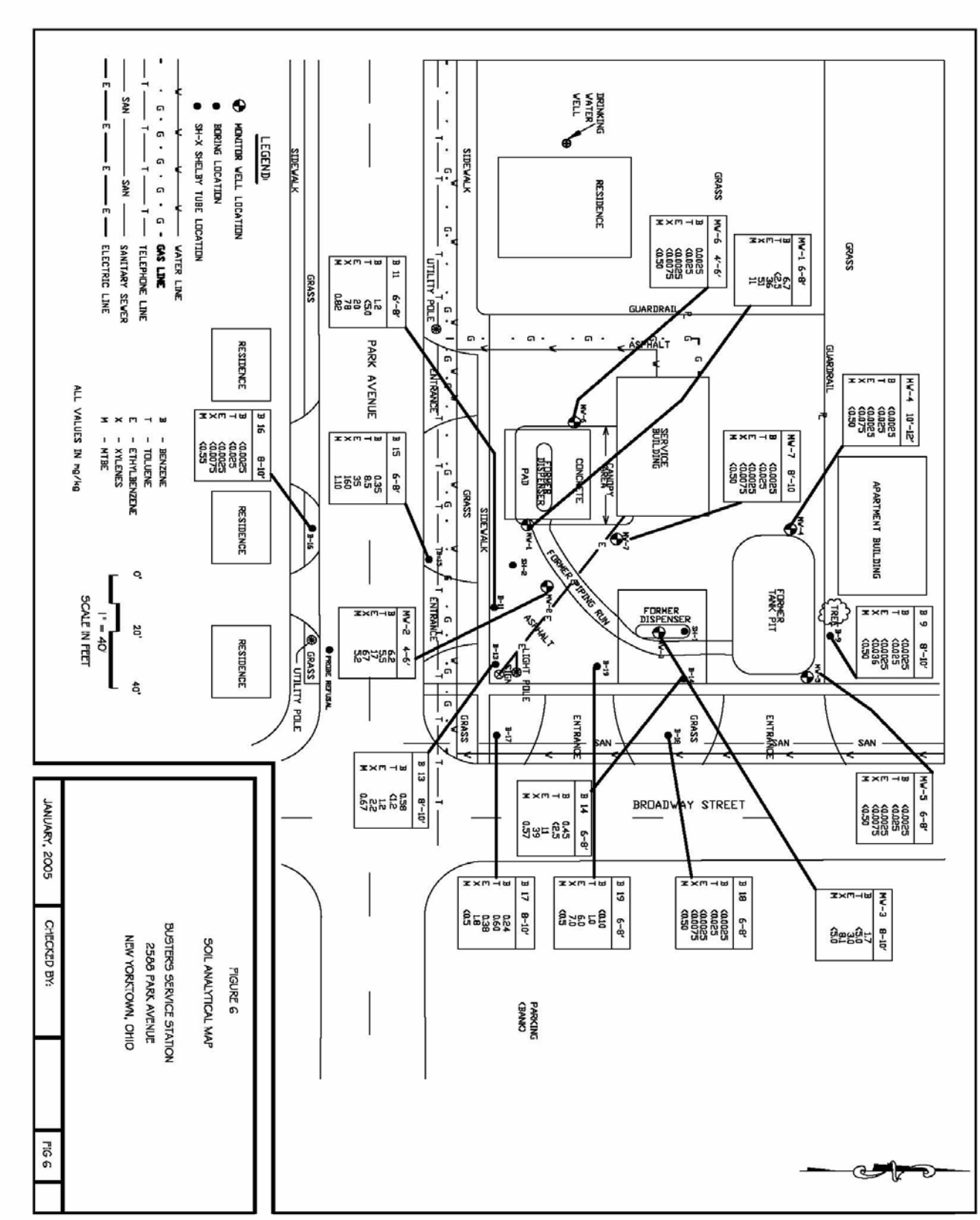

Figure B.6- Soil Analytical Data Map

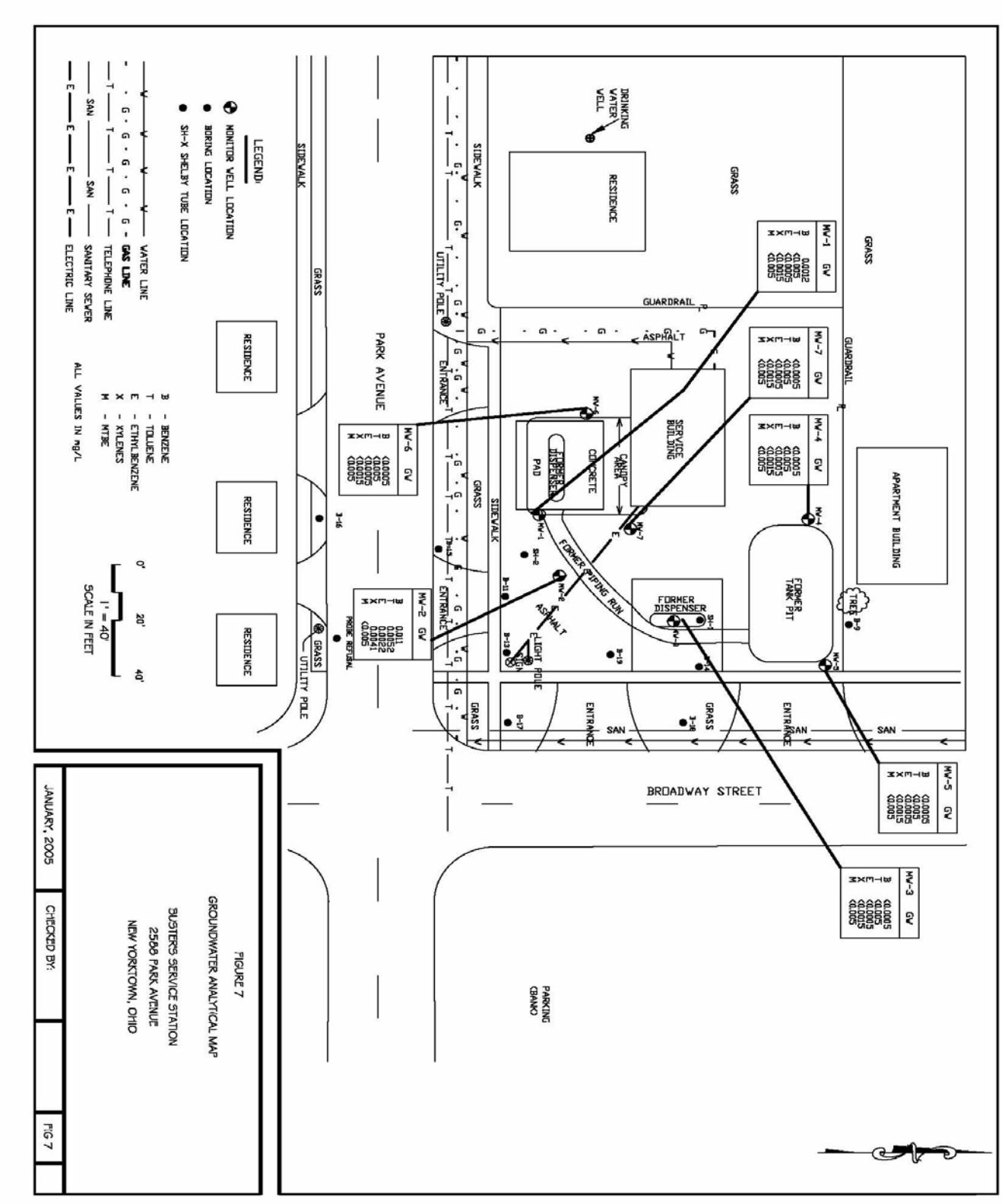

Figure B.7- Groundwater Analytical Data Map

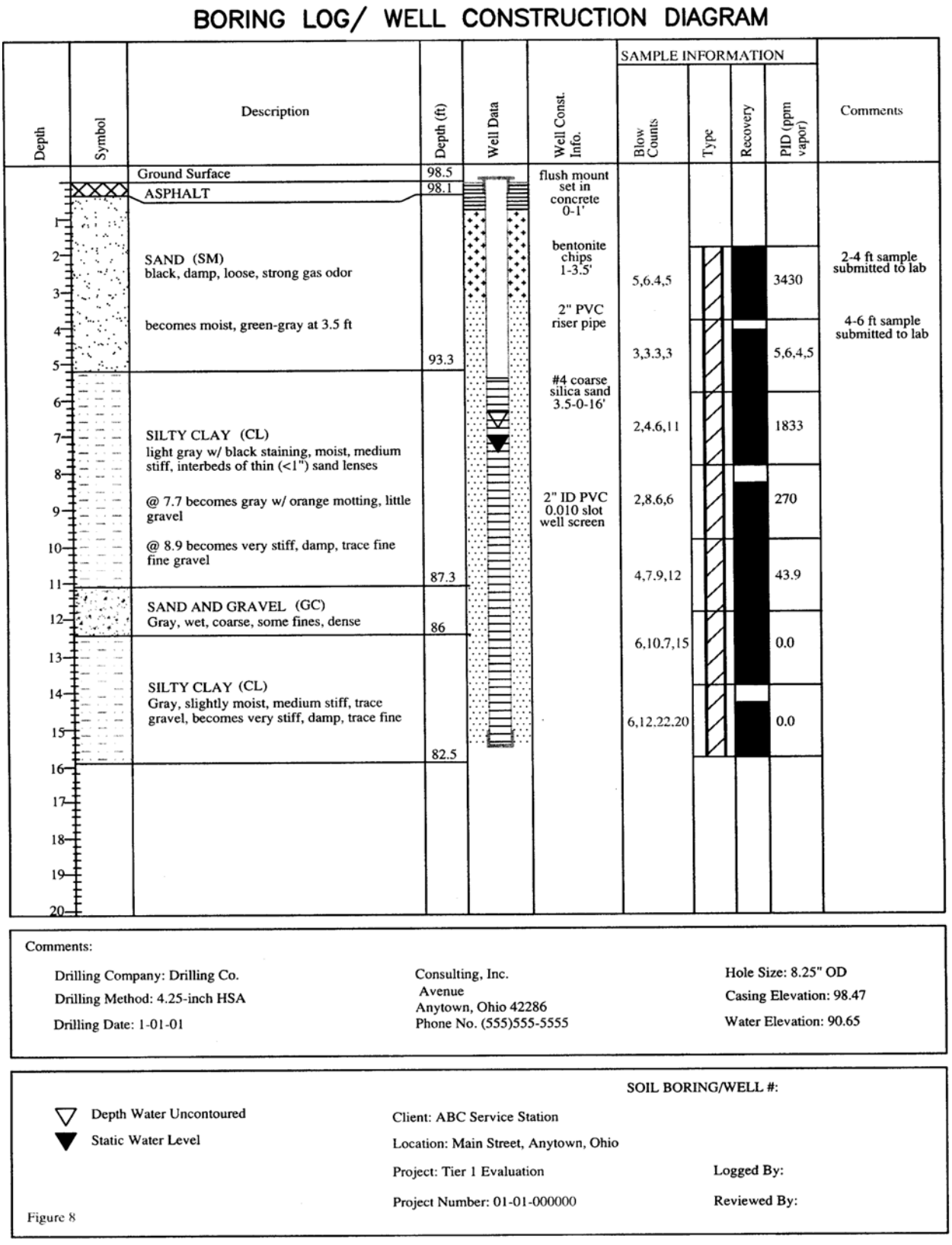

Figure B.8- Soil Boring Log and Monitoring Well Construction Diagram

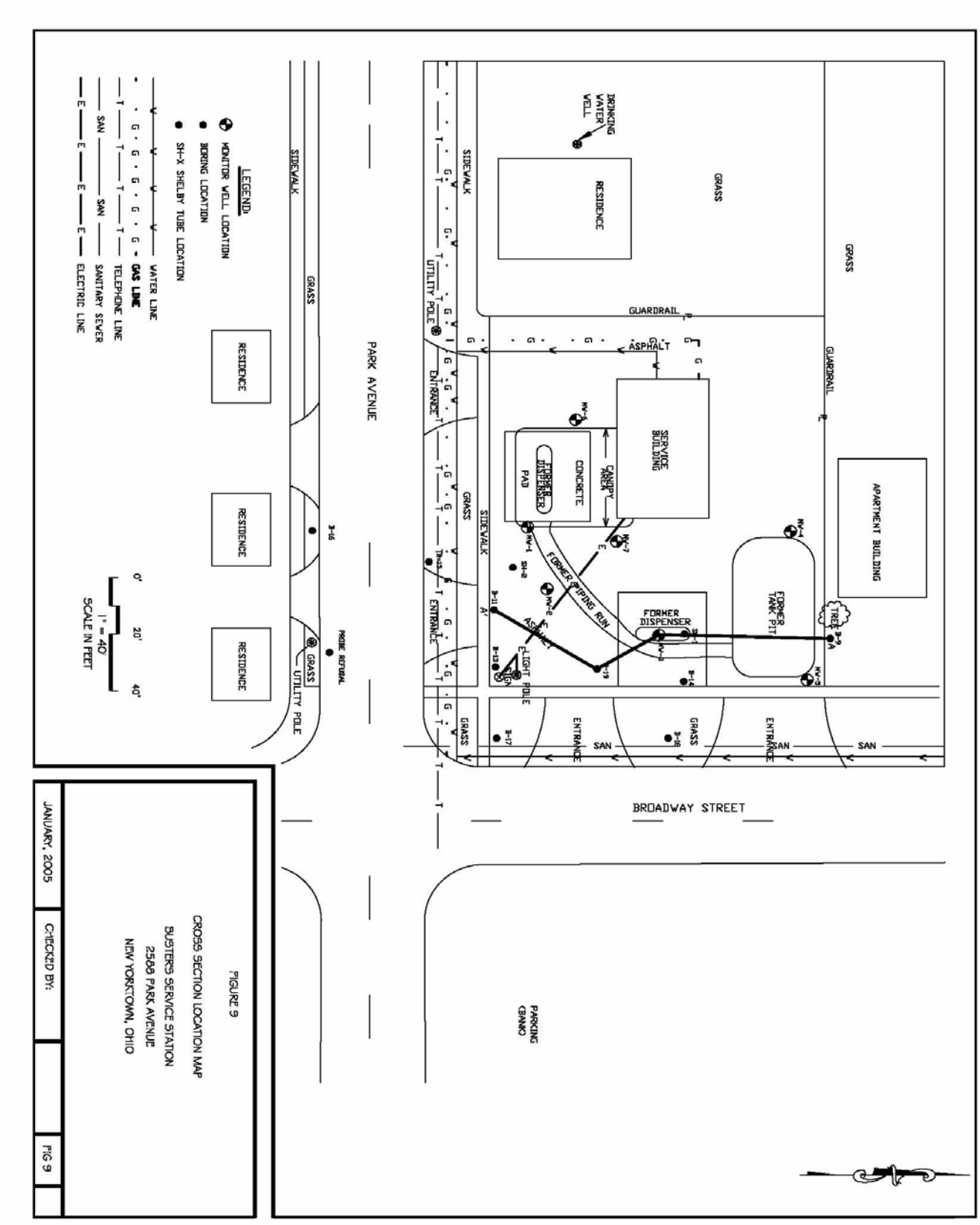

Figure B.9- Cross Section Location Map

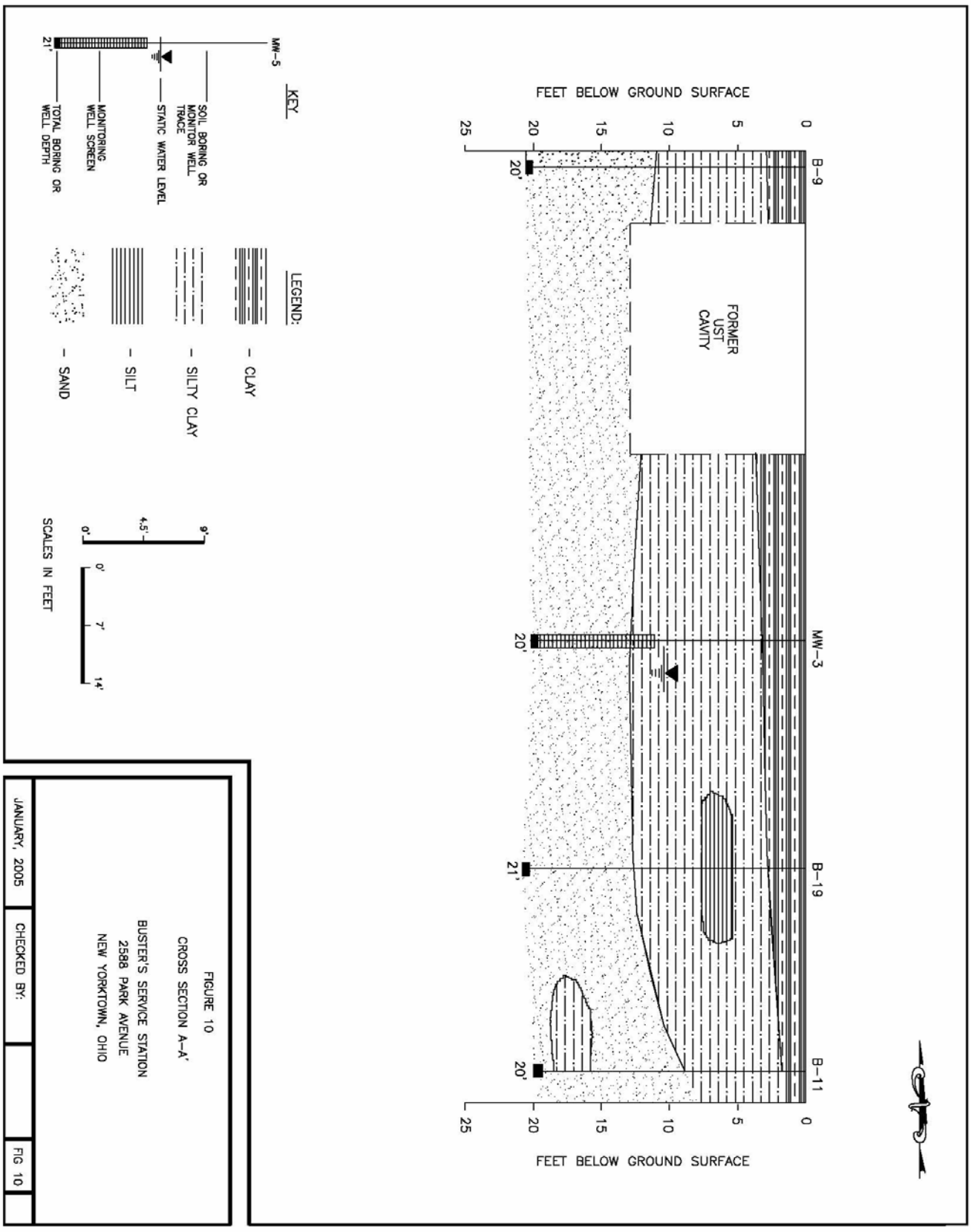

Figure B.10- Cross Section

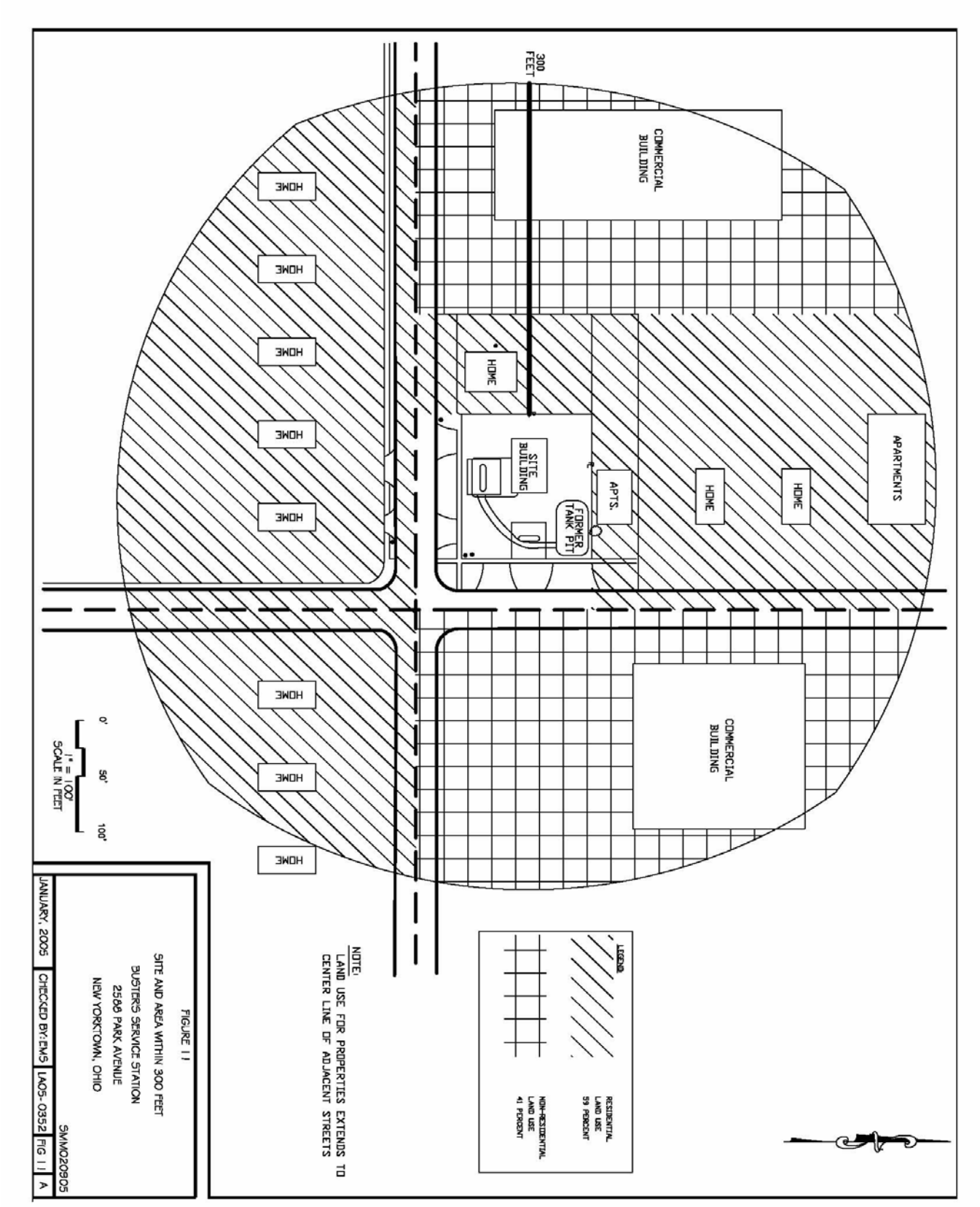

Figure B.11- Site and Area within 300 Feet Map

B.12 Tables

Use tables whenever possible to efficiently display analytical data. Include notes or comments below the table. Present data as an actual concentration or as less than the reporting limit, such as less than .005 ppm (parts per million). **Do not use notations such as below detection limit (BDL), below quantitation limit (BQL), and not detectable (ND).** See Tables B.1 and B.2 for examples.

Tables should include the following information:

- Site name and address;
- Media sampled;
- Date of sampling;
- Sample identification (i.e., MW-3, SB-l);
- Sample depth;
- Actual concentration of contaminants in ppm (parts per million); and
- Field screening measurement, if applicable.

B.13 Laboratory Analytical Reports

Submit copies of actual laboratory analytical results with each report. Table B.3, Laboratory Analytical Report, shows an example of an appropriate laboratory analytical report.

Laboratory analytical reports should include the following:

- Site name and address;
- Name, address, and phone number of the laboratory;
- Client name;
- Sample matrix (i.e., soil, water, air);
- Sample identification;
- Date of sample collection;
- Date of sample receipt by laboratory;
- Date of sample analysis;
- Analytical method used to analyze sample;
- Analyte (e.g., benzene, toluene);
- Concentration and units of analyte(s) present;
- Quantitation limit and units; and
- Name of analyst.

Table B.1- Field Screening Results

ABC Service Station
900 Main Street
Anytown, Ohio

Sample Interval	Sampling Date	SB-1 (ppm)	SB-2 (ppm)	SB-3 (ppm)
0-2’	3-10-05	0.0	0.0	0.0
2-4’	3-10-05	**75.0**	**87.0**	**99.0**
4-6’	3-10-05	32.0	35.0	53.0
6-8’	3-10-05	43.0	12.0	18.0
8-10’	3-10-05	22.0	31.0	33.0
10-12’	3-10-05	**55.0**	**67.0**	**78.0**

Bold= Submitted for laboratory analysis.

Table B.2- Soil Analytical Results

ABC Service Station
900 Main Street
Anytown, Ohio

Sample	Depth (ft)	Sampling Date	Benzene mg/kg	Toluene mg/kg	Ethylbenzene mg/kg	Xylenes mg/kg	MTBE mg/kg
SB-1	2-4	4-10-01	0.006	0.035	0.254	0.476	0.062
SB-1	10-12	4-10-01	0.054	0.037	0.027	0.092	0.354
SB-2	2-4	4-10-01	0.140	0.365	0.276	0.486	0.197
SB-2	10-12	4-10-01	**0.356**	0.476	0.957	0.746	**1.376**
SB-3	2-4	4-10-01	0.046	0.736	0.366	0.354	0.286
SB-3	10-12	4-10-01	0.098	0.228	0.336	1.900	0.098

Bold= Above action levels

Table B.3- Laboratory Analytical Report

Water and Soil Labs, Inc.
12345 Elm St., Anytown, OH 12345, (123) 456-7890

Client Name: ABC Service Station
Address: 900 Main Street
Anytown, OH

Client Sample Identification: SGC-019248B
Sample Matrix: Soil
Date Sample Collected: 10-March-05
Date Sample Received: 11-March-05
Date Sample Analyzed: 12-March-05

Purgeable Aromatics
Analytical Results

Lab No. 90979A
Sample ID# SB-1 (10-12')

Analyte	Concentration (mg/kg)	Quantitation Limit (mg/kg)
Benzene	0.054	<0.002
Toluene	0.037	<0.002
Ethylbenzene	0.027	<0.002
Total Xylenes	0.092	<0.002
MTBE	0.354	<0.002
Surrogate- a,a,a-Trifluorotoluene	95%	

Analytical method: SW 846 Method 8021

Analyst: Jane Doe
Verified: 12-March-05
Date Reported: 12-March-05

Appendix C: Use Restrictions

Table of Contents **Page**

Acronyms

BUSTR	Bureau of Underground Storage Tank Regulations
Ohio EPA	Ohio Environmental Protection Agency
O/O	owner/operator
ORC	Ohio Revised Code

C.1 Introduction

An Environmental Covenant acts very similar to the formerly used Deed Restrictions; however, it is designed to improve upon the weaknesses of Deed Restrictions. Just like the previously used Deed Restrictions, an Environmental Covenant is a legal device that restricts uses of a property and is used in connection with risk-based cleanups to control the potential risks presented by that residual contamination. The restrictions in the Environmental Covenant are used to prevent exposure of contaminants to people by limiting pathways of the contaminants such as drinking water from extraction of ground water on site or the exposure to vapors in a basement of a residential structure, etc.

An Environmental Covenant is not always necessary. It is used by BUSTR in situations where a property cannot meet the typical requirements under the BUSTR Corrective Action (CA) Rule to be automatically classified as a restricted use property (i.e. non-residential, non-drinking uses.). Typically, these are situations where the property is just outside of the parameters defining non-residential or non-drinking water site classifications according to the BUSTR CA Rule. An Environmental Covenant may be an appropriate device to use at a particular site to impose legal limitations of non-residential use or groundwater use.

The following are examples when an Environmental Covenant may be implemented:

- If the owner/operator (O/O) cannot meet the 75% non-residential land use scenario in accordance with Section 3.11.2, Land Use Determination, *Non-Residential Land Use,* the O/O may use an Environmental Covenant to eliminate the residential exposure scenarios;
- If the O/O cannot eliminate a soil to indoor air point of exposure, the O/O may use an Environmental Covenant to eliminate the point of exposure by preventing the installation of a basement on the property; or
- If the O/O is utilizing an engineering or institutional control that is not already recorded on the property deed, then an Environmental Covenant must be implemented to ensure the maintenance of the engineering or institutional control.

Environmental Covenants are created by a written and signed agreement in which the parties (known as "holders") demonstrate their intent to bind themselves and the future successors of the land to the conditions or restrictions of land-use in the Environmental Covenant. An Environmental Covenant is created and defined by statute in Ohio Revised Code § 5301.80 through § 5301.92.

As of **March 1, 2005**, BUSTR will **require** an Environmental Covenant to be used instead of a Deed Restriction. However, this does not invalidate Deed Restrictions that were previously used.

Below is an example of an Environmental Covenant template, as used by BUSTR. BUSTR recommends the use of an attorney experienced in Ohio property law and/or environmental law for drafting and implementing an Environmental Covenant under the BUSTR CA Rule.

Use of the language below does not guarantee that a property complies with BUSTR rules or applicable standards. Once the proposed Environmental Covenant is submitted to the BUSTR site coordinator and reviewed, BUSTR will advise as to its acceptability and return signed agreement for proper recording with the Recorder's Office in the county the property is located within.

C.2 Covenant

To be recorded with Deed Records - ORC § 317.08

Environmental Covenant

This Environmental Covenant is entered into by _____ ("**Owner**") *[name all Owners of the Property and add other "Holders," if any]* and the Ohio State Fire Marshal pursuant to Ohio Revised Code ("ORC") §§ 5301.80 to 5301.92 for the purpose of subjecting the Property to the activity and use limitations set forth herein.

NOTE: Additional parties without an interest is the property may be added as well as "holders", especially in cases where the Responsible Party is not the property owner or parties wish to include a lessee of the property and/or the operator of the Underground Storage Tanks.

Insert appropriate background information here:
1. Identify the "site" or "facility." (Name and Facility Number)
2. Describe the "environmental response project," (See, ORC § 5301.80(E)(e), which is 'the work performed for environmental remediation of the property' or the corrective action conducted pursuant to sections 3737.88, 3737.882, and 3737.89 of the Ohio Revised Code.)
3. Describe the nature of the contamination on or underlying the property and its remedy, including the contaminants of concern, the pathways of exposure, limits on exposure, and the location and extent of the contamination. (See, ORC § 5301.82(B)(2)), and

4. Identify the agency and location of the administrative record for the project. (*See ORC § 5301.82(A)(8).*) To do so, please insert the following language:

> ***All administrative records regarding the petroleum release and corrective action process, pursuant to chapter 3737 of the Ohio Revised Code, that occurred at the Property that is the subject of this Environmental Covenant may be obtained through a public records request by requesting information on [Insert Name of Facility and BUSTR Release Number]:***
>
> **Bureau of Underground Storage Tank Regulations**
> Division of State Fire Marshal
> Attention: Public Information Clerk
> 8895 East Main Street
> Reynoldsburg, OH 43068

Now therefore, the Owner (name all Owners of the Property and add other "Holders," if any*)* and Ohio State Fire Marshal agree to the following:

1. Environmental Covenant. This instrument is an environmental covenant developed and executed pursuant to ORC §§ 5301.80 to 5301.92.

2. Description of Property. This Environmental Covenant concerns [an approximately _____acre tract of real property; OR real property parcels numbered _____] owned by _____, located at , in _____ County, Ohio, and more particularly described in Exhibit A attached hereto and hereby incorporated by reference herein ("Property").

(*Note****: For purposes of this Environmental Covenant, the Subject Property shall be further defined in Exhibit A, which shall contain a sufficient Legal Description of Subject Property* **i.e. in metes and bounds****.)***

3. Owner(s). _____ ("**Owner**") (who resides; OR which is located) at ____ _____, _____, _____ is the owner of the Property.

4. Holder(s). The Ohio State Fire Marshal, the Owner(s), whose address(es) [is/are] listed above, [(if additional holders then add) and _____ (who resides; OR which is located) at _____, _____, _____] are the ("**Holders**") of this Environmental Covenant.

5. Activity and Use Restrictions. As part of the corrective action at the Subject Property and in consideration for the Ohio State Fire Marshal's forbearance to require unrestricted land use for the Subject Property and to issue a no further action status, Owner hereby imposes and agrees to comply with the following activity and use limitations:

[Insert the limitations appropriate for the Property. Several limitations may be appropriate as part of a remedial action or closure plan where cleanup to an unrestricted land use is not feasible. Each type of limitation must be considered on a site-specific basis to determine which limitation or combination of limitations is suitable for the particular circumstances of the site or facility, based on the nature of contamination, the affected media and the potential exposures. The types of limitations include.]

Prohibition Against Extraction of Groundwater. As a portion of the remedy under the State Fire Marshal's Bureau of Underground Storage Tank Regulations ("BUSTR") program to protect against exposure to petroleum in groundwater located at or underlying the Property described herein, no person shall extract the groundwater located at or underlying the Property or any portion thereof for any purpose, potable or otherwise, except for groundwater investigation or remediation.

Land Use Restriction. As a portion of the remedy under the State Fire Marshal's Bureau of Underground Storage Tank Regulations ("BUSTR") program to protect against exposure to petroleum on and underlying the Property described herein, the Property and any portion thereof is hereby restricted to Non-Residential Use only, as that term is defined in Ohio Administrative Code ("OAC") 1301:7-9-13(C)(17). (effective March 1, 2005) *See* Ohio Administrative Code ("OAC") 1301:7-9-13(C)(26) for the definition of Residential Use (effective March 1, 2005).

Prohibition against Basements. As a portion of the remedy under the State Fire Marshal's Bureau of Underground Storage Tank Regulations ("BUSTR") program to protect against exposure to petroleum on and underlying the Property described herein, no basement or other permanent subsurface or underground structure designed for routine human occupancy shall be constructed at the property.

6. Running with the Land. This Environmental Covenant shall be binding upon the Owner and all assigns and successors in interest, including any Transferee, and shall run with the land, pursuant to ORC § 5301.85, subject to amendment or termination as set forth herein. The term "Transferee," as used in this Environmental Covenant, shall mean any future owner of any interest in the Property or any portion thereof, including, but not limited to, owners of an interest in fee simple, mortgagees, easement holders, and/or lessees.

7. Compliance Enforcement. Compliance with this Environmental Covenant may be enforced pursuant to ORC § 5301.91. Failure to timely enforce compliance with this Environmental Covenant or the use limitations contained herein by any party shall not bar subsequent enforcement by such party and shall not be deemed a waiver of the party's right to take action to enforce any non-compliance. Nothing in this Environmental Covenant shall restrict the Ohio State Fire Marshal from exercising any authority under applicable law.

8. Rights of Access. Owner(s) hereby grants to State Fire Marshal, its agents, contractors, and employees *[and any "Holders;" the local government, etc.; see ORC §§ 5301.82(A)(6) and 5301.91(A)]* the right of access to the Property for implementation or enforcement of this Environmental Covenant.

9. Notice upon Conveyance. Each instrument hereafter conveying any interest in the Property or any portion of the Property shall contain a notice of the activity and use limitations set forth in this Environmental Covenant, and provide the recorded location of this Environmental Covenant. The notice shall be substantially in the following form:

> THE INTEREST CONVEYED HEREBY IS SUBJECT TO AN ENVIRONMENTAL COVENANT, DATED_____, 200__, RECORDED IN THE DEED OR OFFICIAL RECORDS OF THE _____COUNTY RECORDER ON _____, 200_, IN [DOCUMENT ____, *or* BOOK___, PAGE ____,]. THE ENVIRONMENTAL COVENANT CONTAINS THE FOLLOWING ACTIVITY AND USE LIMITATIONS: *[Insert the language that describes the activity and use limitations exactly as it appears in the Environmental Covenant.]*

Owner shall notify the State Fire Marshal *[and any "Holders" other than the Owner]* within thirty (30) days after each conveyance of an interest in any portion of the Property. Owner's notice shall include the name, address, and telephone number of the Transferee, a copy of the deed or other documentation evidencing the conveyance, and a survey map that shows the boundaries of the property being transferred.

10. Compliance Reporting. Owner(s) or any Transferee shall submit to the Ohio State Fire Marshal, every three years, written documentation verifying that the activity and use limitations remain in place and are being complied with.

11. Non-complying Use. If the Property or any potion of the Property is put to a use that does not comply with this Environmental Covenant, then the no further action status issued for the Property by the Ohio State Fire Marshal, pursuant to Chapter 3737 of the Ohio Revised Code and the regulations promulgated thereunder, is void on and after the date of the commencement of such non-complying use.

12. Representations and Warranties. Owner(s) hereby represents and warrants to the other signatories hereto that Owner has the power and authority to enter into this Environmental Covenant, to grant the rights and interests herein provided and to carry out all obligations hereunder; that the Owner holds fee simple title which is free, clear and unencumbered; that the Owner has identified all other parties that hold any interest (e.g., encumbrance) in the Property and notified such parties of the Owner's intention to enter into this Environmental Covenant; that this Environmental Covenant will not materially violate or contravene or constitute a material default under any other agreement, document or instrument to which Owner is a party of by which Owner may be bound or affected.

13. Amendment or Termination. This Environmental Covenant may be amended or terminated by consent of all of the following: the Owner or a Transferee; [*other "Holders," if any;*] and the Ohio State Fire Marshal,[1] pursuant to ORC § 5301.90 and other applicable law. The term, "Amendment," as used in this Environmental Covenant, shall mean any changes to the Environmental Covenant, including the activity and use limitations set forth herein, or the elimination of one or more activity and use limitations when there is at least one limitation remaining. The term, "Termination," as used in this Environmental Covenant, shall mean the elimination of all activity and use limitations set forth herein and all other obligations under this Environmental Covenant.

This Environmental Covenant may be amended or terminated only by a written instrument duly executed by the Ohio State Fire Marshal and the Owner or Transferee *[and other "Holders," if any]* of the Property or portion thereof, as applicable. Within thirty (30) days of signature by all requisite parties on any amendment or termination of this Environmental Covenant, the Owner or Transferee shall file such instrument for recording with the _____ County Recorder's Office, and shall provide a file- and date-stamped copy of the recorded instrument to Ohio Fire State Marshal.

[1] *See ORC § 5301.82 (B) (3), which allow for "limitations on amendment or termination."*

14. Severability. If any provision of this Environmental Covenant is found to be unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired.

15. Governing Law. This Environmental Covenant shall be governed by and interpreted in accordance with the laws of the State of Ohio.

16. Recordation. Within [thirty (30)] days after the date of the final required signature upon this Environmental Covenant, Owner shall file this Environmental Covenant for recording, in the same manner as a deed to the Property, with the _____ County Recorder's Office.

17. Effective Date. The effective date of this Environmental Covenant shall be the date upon which the fully executed Environmental Covenant has been recorded as a deed record for the Property with the _____ County Recorder.

18. Distribution of Environmental Covenant. The Owner shall distribute a file- and date-stamped copy of the recorded Environmental Covenant to: Ohio State Fire Marshal; the [*City, County, Township, Village*] of _____; *[any "Holder," any lessee, each person who signed the Environmental Covenant, each person holding a recorded interest in the Property; and any other person designated by Ohio State Fire Marshal; see ORC § 5301.83]*.

19. Notice. Any document or communication required by this Environmental Covenant shall be submitted to:

Bureau of Underground Storage Tank Regulations ("BUSTR")
Enforcement Section
Division of State Fire Marshal
8895 East Main Street
Reynoldsburg, OH 43068

The undersigned Owner (or representative of owners) *[and other "Holders," if any]* represent[s] and certif[y/ies] that *[he/she/they]* [*is/are*] authorized to execute this Environmental Covenant.

IT IS SO AGREED:

NAME OF OWNER(S)

_____
Signature of Owner

_____ _____
Printed Name and Title Date

State of Ohio :
: ss
County of_____ :

Before me, a notary public, in and for said county and state, personally appeared, _____ a duly authorized representative of _____, who acknowledged to me that he/she did execute the foregoing instrument on behalf of _____.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this day of _____, 20__.

_____
Notary Public

This instrument prepared by:
[name, address]

STATE FIRE MARSHAL OF OHIO

_____ _____
(Name), State Fire Marshal of Ohio Date

State of Ohio :
: ss
County of_____ :

Before me, a notary public, in and for said county and state, personally appeared _____, the State Fire Marshal of Ohio, who acknowledged to me that he did execute the foregoing instrument on behalf of the State of Ohio, Department of the State Fire Marshal.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this day of _____, 20__.

_____
Notary Public

This instrument prepared by:
[name, address]

[NAME OF ADDITIONAL HOLDER(S)]

_____
Signature of Holder

_____ _____
Printed Name and Title Date

State of _____)

County of_____)

Before me, a notary public, in and for said county and state, personally appeared _____ a duly authorized representative of _____, who acknowledged to me that *[he/she]* did execute the foregoing instrument on behalf of _____.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this _____day of _____, 20__.

_____
Notary Public

This instrument prepared by:
[name, address]

Appendix D: Sensitive Areas

Table of Contents **Page**

Acronyms

BUSTR	Bureau of Underground Storage Tank Regulation
OAC	Ohio Administrative Code
Ohio EPA	Ohio Environmental Protection Agency
O/O	owner/operator
ORC	Ohio Revised Code
USCA	United States Code Annotated
UST	underground storage tank

D.1 Introduction

The Bureau of Underground Storage Tank Regulations (BUSTR) rules define certain parts of Ohio as "Sensitive Areas" and establish technical standards for underground storage tanks (USTs) in those areas. Proximity to drinking water sources is the main criterion for designating areas as sensitive.

D.2 Defining Sensitive Areas

Ohio Administrative Code (OAC) rule 1301:7-9-09 defines the following as sensitive areas:

- Located within 50 ft. of a private water supply well or developed spring not located on the same site as the UST system;
- Located within one of the following and is not located on the same site as the UST system:
  - 100 ft. horizontal of a water supply well designated by Ohio Environmental Protection Agency (Ohio EPA) as a public water supply and which has a net production rate of less than or equal to 10,000 gal./day;
  - 200 ft. horizontal of a water supply designated by Ohio EPA as a public supply and which has a net rate of greater than 10,000 gal./day to less than or equal to 50,000 gal./day;
  - 300 ft. horizontal of a water supply designated by Ohio; or
  - EPA as a public water supply and which has a net production rate of greater than 50,000 gal./day.
- Within a semi-circular arc 1,000 ft. upstream of a public water supply water intake, where the base line of the half-circle is perpendicular to the stream at the intake (unless the UST owner or operator demonstrates that the system is located in a drainage area downstream of the intakes);
- Within 200 ft. of a lake or reservoir with an average surface area of at least 5 acres;
- Located within 100 ft. of a man-made underground structure, tunnel or cavity used primarily for pedestrian traffic or passenger-carrying vehicles; or
- Areas associated with an aquifer declared by the Federal government under the Safe Drinking Water Act (42 United States Code Annotated [USCA] 300f et. seq.);
  - Parts of the following counties are affected by this provision of the rule: Allen, Auglaize, Butler, Champaign, Clark, Clermont, Green, Hamilton, Logan, Mercer, Miami, Montgomery, Ottawa (Catawba Island only), Preble, Putnam, Shelby, Van Wert, and Warren; and

- OAC rule 1301:7-9-09(B) defines certain sensitive areas associated with sole source aquifers in these counties by reference to township sections and/or survey tracts. To determine if an UST is located within one of these sensitive areas, check the property deed or survey to identify the township section(s) and/or survey tract(s) where the UST is located. Then reference the appropriate county in OAC rule 1301:7-9-09(B) to see if the UST is located in one of the township section(s) and/or survey tract(s) listed as a sensitive area. If the number of the township section(s) and/or survey track(s) for the property in question cannot be located, consult the Sensitive Area Maps prepared by BUSTR. These maps can be purchased at the BUSTR office.

Appendix E: Forms

Table of Contents **Page**

This appendix includes the forms that must be used for the reporting, notification, and documentation requirements of OAC 1301:7-9-12, 1301:7-9-13, 1301:7-9-16, and 1301:7-9-17, and provides the O/O with the basic guidelines and content required within those rules. Please check the BUSTR website for updated versions of the following forms.

BUSTR CLOSURE FORM – 2005

(Due within ninety days from the date of sample collection)

OWNER/OPERATOR AND FACILITY DATA

UST OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____
PERMIT #: _____

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
LAT/LONG: _____
FACILITY ID#: _____
FIRE DEPARTMENT: _____

UST OPERATOR INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

PROPERTY OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

DATE THE UST WAS LAST USED: _____
PERSON (COMPANY) THAT LAST USED THE UST: _____

SITE HISTORY AND VISUAL SITE EVALUATION

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

CLOSURE CONCLUSIONS

Select one of the following:

☐ A TIER 1 SOURCE INVESTIGATION IS REQUIRED

☐ NO FURTHER ACTION REQUESTED

UNDERGROUND STORAGE TANK (UST) SYSTEM DATA

UST #	AGE	CAPACITY	PRODUCT	CONST. MATERIAL	UST STATUS	DATE LAST USED	PIPE STATUS	DISP. STATUS	DATE REMOVED

STATUS= OOS<90 *– Out of Service < 90 days* ***OOS>90*** *– Out of Service > 90 days* ***RE*** *- Replace* ***R*** *- Removed*
CIU *- Currently In Use* ***NA*** *- Not Applicable* ***CIS -*** *Change in Service* ***CIP*** *- Closed in Place*

SAMPLE DATA

SAMPLE COLLECTION PROCEDURES:

SAMPLE PRESERVATION: _____

SAMPLING EQUIPMENT: _____

SAMPLING METHOD: _____

FIELD SCREENING:

INSTRUMENT USED: _____

METHODOLOGY USED: _____

CALIBRATION PROCEDURES:

GROUNDWATER DATA

MARK THE CORRECT CHOICE:

SENSITIVE AREA: YES ☐ NO ☐

DEPTH TO GROUND WATER: < 15' ☐ 15-30' ☐ 31-50' ☐ > 50' ☐ ACTUAL DEPTH: _____

IF UNKNOWN DEPTH TO GROUND WATER, DEFAULT TO <15 FEET

IF A DEPTH TO GROUND WATER OTHER THAN <15' IS USED, DOCUMENTATION MUST BE PROVIDED.

WAS WATER PRESENT IN EXCAVATION? YES ☐ NO ☐
WAS A WATER SAMPLE TAKEN? YES ☐ NO ☐
WATER SAMPLE COLLECTED AFTER EXCAVATION EVACUATED? YES ☐ NO ☐

IF NO, EXPLAIN: _____

SOIL DATA

CIRCLE CORRECT CHOICE:

SOIL CLASSIFICATION:	SOIL CLASS 1	SOIL CLASS 2	SOIL CLASS 3
SOIL SYMBOL:	GW, GP, GM, GC, SW, SP, SM,	SC, ML, CL, OL, MH	CH, OH, PT

MARK THE CORRECT CHOICE: SOIL CLASS 1 ☐ SOIL CLASS 2 ☐ SOIL CLASS 3 ☐

NOTE: GEOTECHNICAL LAB ANALYSIS MUST BE PROVIDED IF SOIL CLASS 2 OR 3 IS USED

FIELD SCREENING DATA

DATE SAMPLE COLLECTED	SAMPLE ID	LOCATION	DEPTH	FIELD SCREENING READING	SUBMITTED TO LAB?
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐

					☐
					☐
					☐
					☐
					☐
					☐

NAME AND AFFILIATION OF PERSON COLLECTING SAMPLES:

DIMENSIONS OF EXCAVATION: _____

LABORATORY DATA

LABORATORY NAME: _____

ADDRESS: _____

PHONE #: _____

LABORATORY ANALYST NAME: _____

CHEMICAL OF CONCERN / TEST METHOD: _____

DATE SAMPLES RECEIVED BY LAB: _____

DATE SAMPLES ANALYZED BY LAB: _____

UST EXCAVATION ANALYTICAL RESULTS

SAMPLE ID:	WATER	WATER	ACTION LEVEL	SOIL	SOIL	SOIL	SOIL	ACTION LEVEL
CHEMICAL OF CONCERN:								
BENZENE			0.005					0.149
TOLUENE			1					49.1
ETHYLBENZENE			0.7					45.5
TOTAL XYLENES			10					15.7
MTBE			0.04					0.470
BENZO (a) ANTHRACENE			0.00026					11.0
BENZO (a) PYRENE			0.0002					1.1
BENZO (b) FLUORANTHENE			0.00017					11.0
BENZO (k) FLUORANTHENE			0.0017					110.0
CHRYSENE			0.047					1,100.0
DIBENZ (a,h) ANTHRACENE			0.0002					1.1
INDENO (1,2,3-cd) PYRENE			0.00022					11.0
NAPHTHALENE			0.14					39.8
TPH (C6-C12)			-					1,000.0
TPH (C10-C20)			-					2,000.0
TPH (C20-C34)			-					5,000.0
OTHER:								

Concentrations are reported in mg/kg for soil and mg/L for water

IF ACTION LEVELS ARE EXCEEDED, CONDUCT A TIER 1 SOURCE INVESTIGATION PURSUANT TO OAC 1301:7-9-13(H).

PIPING RUN, REMOTE FILL PIPE, DISPENSER ISLAND ANALYTICAL RESULTS

SAMPLE ID:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	ACTION LEVEL
CHEMICAL OF CONCERN:								
BENZENE								0.149
TOLUENE								49.1
ETHYLBENZENE								45.5
TOTAL XYLENES								15.7
MTBE								0.470
BENZO (a) ANTHRACENE								11.0
BENZO (a) PYRENE								1.1
BENZO (b) FLUORANTHENE								11.0
BENZO (k) FLUORANTHENE								110.0
CHRYSENE								1,100.0
DIBENZ (a,h) ANTHRACENE								1.1
INDENO (1,2,3-cd) PYRENE								11.0
NAPHTHALENE								39.8
TPH (C6-C12)								1,000.0
TPH (C10-C20)								2,000.0
TPH (C20-C34)								5,000.0
OTHER:								

IF ACTION LEVELS ARE EXCEEDED, CONDUCT A TIER 1 SOURCE INVESTIGATION PURSUANT TO OAC 1301:7-9-13(H).

STOCKPILE ANALYTICAL RESULTS

							ACTION LEVEL	RE-USE LEVEL
STOCKPILE ID:								
CUBIC YARDS:								
STOCKPILE DISPOSITION*								
CHEMICAL OF CONCERN:								
BENZENE							0.149	0.015
TOLUENE							49.1	4.91
ETHYLBENZENE							45.5	4.55
TOTAL XYLENES							15.7	15.7
MTBE							0.470	0.047
BENZO (a) ANTHRACENE							11.0	2.2
BENZO (a) PYRENE							1.1	1.1
BENZO (b) FLUORANTHENE							11.0	5.53
BENZO (k) FLUORANTHENE							110.0	1.97
CHRYSENE							1,100.0	1.27
DIBENZ (a,h) ANTHRACENE							1.1	0.94
INDENO (1,2,3-cd) PYRENE							11.0	0.15
NAPHTHALENE							39.8	3.98
TPH (C6-C12)							1,000.0	1,000.0
TPH (C10-C20)							2,000.0	2,000.0
TPH (C20-C34)							5,000.0	5,000.0
OTHER:								

***R**=*RETURNED TO CAVITY* **L**=*LANDFILL* **S**=*STOCKPILED* **T**=*TREATMENT BY O/O (requires PCS Treatment Plan)*

WASTE DISPOSAL DATA

UST SYSTEM DISPOSITION:

NAME:

ADDRESS:

CITY/STATE/ZIP:

PRODUCT DISPOSITION:

NAME:
ADDRESS:
CITY:
STATE/ZIP:
VOLUME/GALLONS:

WASTEWATER DISPOSITION:

NAME:
ADDRESS:
CITY:
STATE/ZIP:
VOLUME/GALLONS:

PETROLEUM CONTAMINATED SOIL (PCS) FORM

This form should be completed and submitted within 120 days of generating a stockpile, within 180 days of placing the soil in portable containers, or prior to storage or treatment, whichever comes first.
A separate PCS form shall be completed for each stockpile generated.

OWNER/OPERATOR INFORMATION		
OWNER/OPERATOR NAME	CONTACT PERSON	AREA CODE-PHONE
CITY	STATE	ZIP CODE

UST FACILITY INFORMATION	STORAGE FACILITY INFORMATION	FACILITY WHERE SOILS WILL BE DISPOSED OF OR TREATED
FACILITY ID#	FACILITY ID#	
FACILITY NAME	FACILITY NAME	FACILITY NAME
ADDRESS	ADDRESS	ADDRESS
CITY STATE ZIP CODE	CITY STATE ZIP CODE	CITY STATE ZIP CODE
TELEPHONE COUNTY	TELEPHONE COUNTY DATE TRANSFERRED	STOCKPILE DESIGNATION (e.g., pile #1, pile from waste oil cavity, etc.)

DATE STOCKPILE WAS GENERATED _____

Cubic Yards

_____ On-site treatment (requires a treatment plan)
_____ Off-site treatment (requires a treatment plan)
_____ Soil analysis falls below Rule 16 re-use levels (RUL)
_____ Returned to excavation (below site specific action levels) (RTE BAL)
_____ Returned to excavation (above site specific action levels) (RTE AAL)
_____ Disposal at a landfill (LFL)
_____ Disposal at a treatment facility (COM)
_____ Stockpile remains on-site (provide written explanation) (SOS)

MISCELLANEOUS DATA

ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-12 OR ADDITIONAL INFORMATION WHICH CLARIFIES CLOSURE ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

THE FOLLOWING ITEMS MUST BE ATTACHED:

Appendix A – Figures (includes Topographic & Site Maps)
Appendix B - Permit
Appendix C - Field inspection report
Appendix D - Laboratory analytical report
Appendix E - Chain of custody form
Appendix F - Disposal documentation
Appendix G – Miscellaneous Data

SITE MAP: Site maps, drawn to scale, must be included in Appendix A. Maps should include property boundaries, street locations, UST cavity dimensions, above ground structures, UST systems, adjacent properties, sample locations, any utilities, and the location(s) of previously closed UST systems.

CERTIFIED FIRE SAFETY INSPECTOR:

NAME: _____
COMPANY/FD: _____
ADDRESS: _____
PHONE #: _____
INSPECTOR ID #: _____

CERTIFIED INSTALLER:

NAME: _____
COMPANY _____
ADDRESS _____
PHONE # _____
ID #: _____

CLOSURE FORM PREPARED BY:

NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

Closure Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the closure form is legible and complete.

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

CHEMICALS OF CONCERN AND RECOMMENDED LABORATORY METHODS

Analytical Group 1 - light distillate products - including unleaded gasoline, leaded gasoline and aviation gasoline;

Analytical Group 2 - middle distillate products - including diesel, light fuel oils, stoddard solvents, mineral spirits, kerosene, and jet fuels;

Analytical Group 3 - heavy petroleum distillate products - including, but not limited to, lubricating and hydraulic oils;

Analytical Group 4 - used oil

Analytical Group 5 - unknown petroleum products or petroleum products other than those listed in analytical groups 1, 2, 3 and 4. Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

	Analytical Group Number	**1**	**2**	**3**	**4**	**5**	**Analytical Methods**
		Light Distillates	Middle Distillates	Heavy Distillates	Used Oil	Unknowns & Others	
	Chemical						
Aromatics	Benzene	x	x		x		8021/8260
	Toluene	x	x		x		
	Ethylbenzene	x	x		x		
	o, m and p-Xylenes	x	x		x		
Additives	Methyl tertiary-butyl ether (MTBE)	x			x		
Polynuclear Aromatics	Benzo(a)anthracene		x	x	x		8270/8310
	Benzo(a)pyrene		x	x	x		
	Benzo(b)fluoranthene		x	x	x		
	Benzo(k)fluoranthene		x	x	x		
	Chrysene		x	x	x		
	Dibenz(a,h)anthracene		x	x	x		
	Indeno(1,2,3-c,d)pyrene		x	x	x		
	Naphthalene		x	x	x		
Chlorinated Hydrocarbons	Volatile Organic Hydrocarbons				x		8260
Total Petroleum Hydrocarbons *1	TPH (C6 – C12)	x			x		8015
	TPH (C10 – C20)		x		x		
	TPH (C20 – C34)			x	x		
	Varies based on UST contents			x	x	*2	

*1 TPH analysis is not required for ground water samples.

*2 Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

BUSTR CLOSURE ACTION LEVELS					
Chemicals of Concern	**Soil Action Levels**			***Water***	**PCS Re-use**
	Class 1 Soils	**Class 2 Soils**	**Class 3 Soils**		
Benzene	0.149	0.252	0.937	0.005	0.015
Toluene	49.1	70.8	86.0	1	4.91
Ethylbenzene	45.5	83.0	282.0	0.7	4.55
Total Xylenes	15.7	18.0	21.7	10	15.7
MTBE	0.470	0.788	3.440	0.04	0.047
Benzo(a)anthracene	11.0	11.0	11.0	0.00026	2.2
Benzo(a)pyrene	1.1	1.1	1.1	0.0002	1.1
Benzo(b)flouranthene	11.0	11.0	11.0	0.00017	5.53
Benzo(k)flouranthene	110.0	110.0	110.0	0.0017	1.97
Chrysene	1,100.0	1,100.0	1,100.0	0.047	1.27
Dibenz(a,h)anthracene	1.1	1.1	1.1	0.0002	0.94
Indeno(1,2,3-cd) pyrene	11.0	11.0	11.0	0.00022	0.15
Naphthalene	39.8	54.0	54.0	0.14	3.98
TPH C_6-C_{12}	1,000.0	5,000.0	8,000.0	-	1,000.0
TPH C_{10}-C_{20}	2,000.0	10,000.0	20,000.0	-	2,000.0
TPH C_{20}-C_{34}	5,000.0	20,000.0	40,000.0	-	5,000.0

Soil contaminant levels in mg/kg

Water contaminant levels in mg/L

IMMEDIATE CORRECTIVE ACTIONS (ICA) REPORT FORM

(Due within twenty days of starting any immediate corrective actions)

OWNER/OPERATOR AND FACILITY DATA

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

UST OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____
OWNER ☐ OPERATOR ☐

IMMEDIATE CORRECTIVE ACTION ACTIVITIES

Date & time of release: _____

Address & locations of all affected buildings, sewers, surface water bodies: _____

Overview of activities leading towards discovery of free product: _____

Type & amount of product released: _____

UNDERGROUND STORAGE TANK (UST) SYSTEM DATA

Tank #	Date Installed	Capacity	Const. Material	Tank Status	Date Removed

STATUS= OOS<90 *– Out of Service < 90 days* ***OOS>90*** *– Out of Service > 90 days* ***RE*** *- Replaced* ***R*** *- Removed*
CIU *- Currently In Use* ***NA*** *- Not Applicable* ***CIS -*** *Change in Service* ***CIP*** *- Closed in Place*

Description of completed ICA activities: _____

Description of planned ICA activities: _____

The amount and disposition of any materials generated (e.g., soil and liquids): _____

MISCELLANEOUS DATA

THE FOLLOWING ITEMS MUST BE ATTACHED:

ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-13 OR ADDITIONAL INFORMATION WHICH CLARIFIES THE INVESTIGATION ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

FIGURES:
FIGURE 1 - TOPOGRAPHIC MAP
FIGURE 2 - SITE MAP

The Immediate Corrective Action Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the form is legible and complete.

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:
NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

FREE PRODUCT RECOVERY REPORT FORM

(Due monthly)

OWNER/OPERATOR AND FACILITY DATA

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

OWNER/OPERATOR INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____

FREE PRODUCT RECOVERY ACTIVITIES

Details of the free product recovery system: _____

Description of free product recovery system malfunctions _____

Description of changes or modifications to the free product recovery system: _____

FREE PRODUCT RECOVERY INFORMATION	
Type of free product:	
Initial date free product discovered:	
Date & method of notification:	
Estimated quantity released:	
Historic location(s) of free product:	
Current location(s) of free product:	
Product thickness per location:	
Gallons of product recovered current month:	
Gallons of product recovered (to date):	
Gallons of water discharged current month:	
Gallons of water discharged (to date):	
Disposition of recovered water:	

Additional Information: _____

Are free product recovery activities planned next month, if no, explain? Yes ☐ No ☐

MISCELLANEOUS DATA

THE FOLLOWING ITEMS MUST BE ATTACHED:

ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-13 OR ADDITIONAL INFORMATION WHICH CLARIFIES THE INVESTIGATION ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

TABLES:
TABLE 1 - MONITORING WELL GAUGING DATA
TABLE 2 – HISTORICAL FREE PRODUCT RECOVERY DATA

FIGURES:
FIGURE 1 - TOPOGRAPHIC MAP
FIGURE 2 - SITE MAP SHOWING THE LOCATION OF BUILDINGS, STRUCTURES, UTILITIES AND USTs
FIGURE 3 – SITE MAP SHOWING THE LOCATION OF STRUCTURES, FREE PRODUCT AND BORINGS

APPENDIX:
APPENDIX A – PERMITS
APPENDIX B – DISPOSAL DOCUMENTATION

The Free Product Recovery Report Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the form is legible and complete.

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:
NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

TIER 1 INVESTIGATION REPORT FORM

Due within one year of the occurrence of any of the following:

- Receiving analytical results, which exceed action levels, while conducting investigations pursuant to paragraph (F)(3)(b) of OAC 1301:7-9-13;
- Electing to conduct corrective actions pursuant to paragraph (B)(2) of OAC 1301:7-9-13;
- Receiving analytical results, which exceed action levels, from a closure assessment conducted pursuant to paragraph (F) of OAC 1301:7-9-12; or
- Conducting corrective action activities pursuant to paragraph (B)(3) and (B)(4) of OAC 1301:7-9-13.

OWNER/OPERATOR AND FACILITY DATA

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

UST OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____

UST OPERATOR INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

PROPERTY OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

UNDERGROUND STORAGE TANK (UST) SYSTEM DATA

Tank #	Date Installed	Capacity	Const. Material	Tank Status	Date Removed

STATUS= OOS<90 *– Out of Service < 90 days* ***OOS>90*** *– Out of Service > 90 days* ***RE*** *- Replace* ***R*** *- Removed*
CIU *- Currently In Use* ***NA*** *- Not Applicable* ***CIS -*** *Change in Service* ***CIP*** *- Closed in Place*

SITE HISTORY AND VISUAL SITE EVALUATION

(Include a description of the property, surrounding area, the date the release occurred, etc.)

TIER 1 SOURCE INVESTIGATION

POTENTIAL SOURCE(S):

POTENTIAL SOURCE AREA(S):

CHEMICALS OF CONCERN:

SUBSURFACE INVESTIGATION:

SOIL BORINGS INSTALLED DURING THIS INVESTIGATION / DATE:

PREVIOUSLY INSTALLED SOIL BORINGS / DATE:

MONITORING WELLS INSTALLED DURING THIS INVESTIGATION / DATE:

PREVIOUSLY INSTALLED MONITORING WELLS / DATE:

SB/MW	Install Date	Location	Installed With*	Total Depth	Depth to GW	Static GW	Depth to Bedrock	Screened Interval	MW Diameter

*HSA/SS – hollow stem auger/split spoon, DP – direct push, HA – hand auger

FIELD SCREENING

INSTRUMENT USED: _____

METHODOLOGY USED: _____

_____

_____

_____

CALIBRATION PROCEDURES: _____

_____

_____

_____

SB/MW#								
Depth	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result
0-2’								
2-4’								
4-6’								
6-8’								
8-10’								
10-12’								
12-14’								
14-16’								
16-18’								
18-20’								
20-22’								
22-24’								
24-26’								
26-28’								
28-30’								
30-32’								
32-34’								
34-36’								

36-38’								
38-40’								
40-42’								
42-44’								
44-46’								
46-48’								
48-50’								
GW Depth								

The soil samples that were submitted for analysis should be in **BOLD** or marked with *

SOIL CLASSIFICATION

SOIL CLASSIFICATION:	SOIL CLASS 1	SOIL CLASS 2	SOIL CLASS 3
SOIL SYMBOL:	GW, GP, GM, GC, SW, SP, SM,	SC, ML, CL, OL, MH	CH, OH, PT

MARK THE CORRECT CHOICE: SOIL CLASS 1 ☐ SOIL CLASS 2 ☐ SOIL CLASS 3 ☐

LABORATORY DATA

LABORATORY NAME: _____

ADDRESS: _____

PHONE #: _____

CHEMICAL OF CONCERN / TEST METHOD: _____

DATE SAMPLES RECEIVED BY LAB: _____

DATE SAMPLES ANALYZED BY LAB: _____

TEMPERATURE OF COOLER/SAMPLES: _____

IMMEDIATE CORRECTIVE ACTIONS

FREE PRODUCT PRESENT: YES ☐ NO ☐

AMOUNT OF FREE PRODCT RECOVERED TO DATE: _____

LOCATION OF FREE PRODUCT: _____

OFF-SITE ACCESS

IS OFF-SITE ACCESS REQUIRED TO DELINEATE COCs: YES ☐ NO ☐

IF YES, DESCRIBE: _____

GROUNDWATER DETERMINATION

MARK THE CORRECT CHOICE

THE SATURATED ZONE IS ASSUMED TO BE GROUND WATER**:** YES ☐ NO ☐

THE SATURATED ZONE IS NOT CONSIDERED GROUND WATER: YES ☐ NO ☐ N/A ☐

DEPTH TO THE SATURATED ZONE: <15' ☐ 15'-30' ☐ 31-50' ☐ > 50' ☐

IF THE SATURATED ZONE IS NOT CONSIDERED GROUND WATER, DOCUMENTATION MUST BE PROVIDED:

GROUND WATER FLOW DIRECTION: _____

DRINKING WATER DETERMINATION

IF ANY OF THE FOLLOWING FOUR ITEMS APPLY, GROUND WATER IS CONSIDERED DRINKING WATER:

1.) The UST site or surrounding area is located in a Drinking Water Source Protection Area as defined by paragraph (C)(5) of OAC 1301:7-9-13**:** YES ☐ NO ☐

DESCRIBE: _____

2.) The UST site is in a Sensitive Area as defined by OAC 1301:7-9-09**:** YES ☐ NO ☐

DESCRIBE: _____

3.) A drinking water source in the ground water is identified within the surrounding area, even if the source is completed into a lower saturated zone than the saturated zone to be evaluated on an UST site. This identification shall include the information required in paragraph (I)(1)(b) of OAC 1301:7-9-13**:** YES ☐ NO ☐

DESCRIBE: _____

4.) A surface water body is located within three hundred feet of the UST site**:** YES ☐ NO ☐

DESCRIBE: _____

If the UST site does not meet the drinking water requirements of the four items listed above, then ground water underlying THE UST site shall be considered non-drinking water if any one of the BELOW six items apply:

1.) Ground water in the upper saturated zone yields less than three gallons per minute;
YES ☐ NO ☐ Not Evaluated ☐

DESCRIBE: _____

2.) Ground water in the upper saturated zone has a background level of total dissolved solids of three thousand milligrams per liter or greater; YES ☐ NO ☐ Not Evaluated ☐

DESCRIBE: _____

3.) An UST site is located in an area where an urban setting designation pursuant to Chapter 3746 of the Revised Code and rules adopted there under has been approved by the director of Ohio Environmental Protection Agency and the owner and operator verifies that the urban setting designation remains protective of the potable use pathway in accordance with OAC 3745-300-10(D)(3)(b); YES ☐ NO ☐ Not Evaluated ☐

DESCRIBE: _____

4.) No potable wells are located within 300 feet of an UST site based on a physical survey and an ordinance requires a mandatory tie-in to a municipal water system for all properties in the surrounding area; YES ☐ NO ☐ Not Evaluated ☐

DESCRIBE: _____

5.) No potable wells are located within 300 feet of an UST site based on a physical survey and an ordinance prohibits the installation of potable water wells at all properties within the surrounding area; or YES ☐ NO ☐ Not Evaluated ☐

DESCRIBE: _____

6.) No potable wells are located within 300 feet of an UST site based on a physical survey and 100 % of the properties within 300 feet of an UST site area are connected to a municipal water source or a municipal source is readily available. YES ☐ NO ☐ Not Evaluated ☐

DESCRIBE: _____

Drinking Water Determination Conclusions

Groundwater is considered drinking water: ☐
Groundwater is not considered drinking water: ☐

SITE MAXIMUM CONCENTRATIONS

	SOIL				GROUND WATER		
	SB	Depth	Conc. mg/kg	Action Level	MW	Conc. mg/L	Action Level
BENZENE							
TOLUENE							
ETHYLBENZENE							
TOTAL XYLENES							
MTBE							
BENZO (a) ANTHRACENE							
BENZO (a) PYRENE							
BENZO (b) FLUORANTHENE							
BENZO (k) FLUORANTHENE							
CHRYSENE							
DIBENZ (a,h) ANTHRACENE							
INDENO (1,2,3-cd) PYRENE							
NAPHTHALENE							
TPH (C6-C12)					N/A	N/A	N/A
TPH (C10-C20)					N/A	N/A	N/A
TPH (C20-C34)					N/A	N/A	N/A
OTHER:							

TIER 1 DECISIONS

Select one of the following:

☐ The concentrations of all chemical(s) of concern are at or below action levels determined in accordance with paragraph (I)(2)(f) of OAC 1301:7-9-13 for all applicable pathways, and no further action is requested.

or

☐ The concentrations of chemical(s) of concern are above applicable action level(s) determined in accordance with paragraph (I)(2)(f) of OAC 1301:7-9-13, and the following chemicals of concern and pathways require further evaluation:

If applicable, please list the COCs and the pathways that failed:

COC	Soil Pathways	COC	GW Pathways

Upon approval of the completeness of the Tier 1 Investigation Report, the owners and operators are planning on conducting one or a combination of the following:

A.) An Interim Response Action: Yes ☐

B) A Tier 2 Evaluation: Yes ☐

C.) A Remedial Action Plan: Yes ☐

MISCELLANEOUS DATA

THE FOLLOWING ITEMS MUST BE ATTACHED:

ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-13 OR ADDITIONAL INFORMATION WHICH CLARIFIES THE INVESTIGATION ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

TABLES:
TABLE 1 - SOIL CONCENTRATIONS COMPARED TO ACTION & DELINEATION LEVELS
TABLE 2 - GROUND WATER CONCENTRATIONS COMPARED TO ACTION & DELINEATION LEVELS
TABLE 3 - MONITORING WELL GAUGING DATA

FIGURES:
FIGURE 1 - TOPOGRAPHIC MAP
FIGURE 2 - SITE MAP
FIGURE 3 – SITE MAP WITH SOIL BORING LOCATIONS, SOIL CONCENTRATIONS AND SAMPLE DEPTH
FIGURE 4 - SITE MAP WITH MONITORING WELLS AND GROUND WATER CONCENTRATIONS
FIGURE 5 - GROUND WATER CONTOUR MAP

APPENDIX:
APPENDIX A – SOIL BORING LOGS
APPENDIX B – MONITORING WELL CONSTRUCTION DIAGRAMS
APPENDIX C – MONITORING WELL DEVELOPMENT & SAMPLING FORMS
APPENDIX D - SOIL CLASSIFICATION FORM
APPENDIX E – LABORATORY ANALYTICAL REPORT
APPENDIX F – CHAIN OF CUSTODY
APPENDIX G – DRINKING WATER EVALUATION SUPPORTING DOCUMENTATION

The Tier 1 Investigation Report Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the form is legible and complete.

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:
NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

CHEMICALS OF CONCERN AND RECOMMENDED LABORATORY METHODS

Analytical Group 1 - light distillate products - including unleaded gasoline, leaded gasoline and aviation gasoline;
Analytical Group 2 - middle distillate products - including diesel, light fuel oils, stoddard solvents, mineral spirits, kerosene, and jet fuels;
Analytical Group 3 - heavy petroleum distillate products - including, but not limited to, lubricating and hydraulic oils;
Analytical Group 4 - used oil
Analytical Group 5 - unknown petroleum products or petroleum products other than those listed in analytical groups 1, 2, 3 and 4. Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

	Analytical Group Number	**1**	**2**	**3**	**4**	**5**	**Analytical Methods**
		Light Distillates	Middle Distillates	Heavy Distillates	Used Oil	Unknowns & Others	
	Chemical						
Aromatics	Benzene	x	x		x		8021/8260
	Toluene	x	x		x		
	Ethylbenzene	x	x		x		
	o, m and p-Xylenes	x	x		x		
Additives	Methyl tertiary-butyl ether (MTBE)	x			x		
Polynuclear Aromatics	Benzo(a)anthracene		x	x	x		8270/8310
	Benzo(a)pyrene		x	x	x		
	Benzo(b)fluoranthene		x	x	x		
	Benzo(k)fluoranthene		x	x	x		
	Chrysene		x	x	x		
	Dibenz(a,h)anthracene		x	x	x		
	Indeno(1,2,3-c,d)pyrene		x	x	x		
	Naphthalene		x	x	x		
Chlorinated Hydrocarbons	Volatile Organic Hydrocarbons				x		8260
Total Petroleum Hydrocarbons *1	TPH (C6 – C12)	x			x		8015
	TPH (C10 – C20)		x		x		
	TPH (C20 – C34)			x	x		
	Varies based on UST contents			x	x	*2	

*1 TPH analysis is not required for ground water samples.
*2 Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

TIER 1 DELINEATION NOTIFICATION FORM

Due within ninety days of the occurrence of any of the following:

- Receiving analytical results, which exceed action levels, pursuant to paragraph (F)(3)(c) of OAC 1301:7-9-13;
- Electing to conduct corrective actions pursuant to paragraph (B)(2) of OAC 1301:7-9-13;
- Electing to conduct a Tier 1 Source Investigation pursuant to (F)(3)(b)(i) of OAC 1301:7-9-13;
- Receiving analytical results, which exceed action levels, from a closure assessment conducted pursuant to paragraph (F) of OAC 1301:7-9-12; or
- Conducting corrective action activities pursuant to paragraph (B)(3) and (B)(4) of OAC 1301:7-9-13.

OWNER/OPERATOR AND FACILITY DATA

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

UST OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____

UST OPERATOR INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

PROPERTY OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

UNDERGROUND STORAGE TANK (UST) SYSTEM DATA

Tank #	Date Installed	Capacity	Const. Material	Tank Status	Date Removed

STATUS= OOS<90 *– Out of Service < 90 days* ***OOS>90*** *– Out of Service > 90 days* ***RE*** *- Replace* ***R*** *- Removed*
CIU *- Currently In Use* ***NA*** *- Not Applicable* ***CIS -*** *Change in Service* ***CIP*** *- Closed in Place*

SITE HISTORY AND VISUAL SITE EVALUATION

(Include a description of the property, surrounding area, the date the release occurred, etc.)

TIER 1 SOURCE INVESTIGATION

POTENTIAL SOURCE(S):

POTENTIAL SOURCE AREA(S):

CHEMICALS OF CONCERN:

SUBSURFACE INVESTIGATION:

SOIL BORINGS INSTALLED DURING THIS INVESTIGATION / DATE:

PREVIOUSLY INSTALLED SOIL BORINGS / DATE:

MONITORING WELLS INSTALLED DURING THIS INVESTIGATION / DATE:

PREVIOUSLY INSTALLED MONITORING WELLS / DATE:

SB/MW	Install Date	Location	Installed With*	Total Depth	Depth to GW	Static GW	Depth to Bedrock	Screened Interval	MW Diameter

*HSA/SS – hollow stem auger/split spoon, DP – direct push, HA – hand auger

FIELD SCREENING

INSTRUMENT USED: _____

METHODOLOGY USED: _____

CALIBRATION PROCEDURES: _____

SB/MW#								
Depth	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result
0-2’								
2-4’								
4-6’								
6-8’								
8-10’								
10-12’								
12-14’								
14-16’								
16-18’								
18-20’								
20-22’								
22-24’								
24-26’								
26-28’								
28-30’								
30-32’								
32-34’								
34-36’								
36-38’								
38-40’								
40-42’								
42-44’								
44-46’								
46-48’								
48-50’								
GW Depth								

The soil samples that were submitted for analysis should be in **BOLD** or marked with *****

SITE MAXIMUM CONCENTRATIONS

	SOIL				GROUND WATER		
	SB	Depth	Conc. mg/kg	Action Level	MW	Conc. mg/L	Action Level
BENZENE							
TOLUENE							
ETHYLBENZENE							
TOTAL XYLENES							
MTBE							
BENZO (a) ANTHRACENE							
BENZO (a) PYRENE							
BENZO (b) FLUORANTHENE							
BENZO (k) FLUORANTHENE							
CHRYSENE							
DIBENZ (a,h) ANTHRACENE							
INDENO (1,2,3-cd) PYRENE							
NAPHTHALENE							
TPH (C6-C12)					N/A	N/A	N/A
TPH (C10-C20)					N/A	N/A	N/A
TPH (C20-C34)					N/A	N/A	N/A
OTHER:							

MISCELLANEOUS DATA

THE FOLLOWING ITEMS MUST BE ATTACHED:
ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-13 OR ADDITIONAL INFORMATION WHICH CLARIFIES THE INVESTIGATION ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

TABLES:
TABLE 1 - SOIL CONCENTRATIONS COMPARED TO ACTION LEVELS FOR EACH PATHWAY
TABLE 2 - GROUND WATER CONCENTRATIONS COMPARED TO ACTION LEVELS FOR EACH PATHWAY

FIGURES:
FIGURE 1 - TOPOGRAPHIC MAP
FIGURE 2 - SITE MAP
FIGURE 3 – SITE MAP WITH SOIL BORING LOCATIONS, SOIL CONCENTRATIONS AND SAMPLE DEPTH
FIGURE 4 - SITE MAP WITH MONITORING WELLS AND GROUND WATER CONCENTRATIONS
FIGURE 5 - GROUND WATER CONTOUR MAP

APPENDIX:
APPENDIX A – SOIL BORING LOGS
APPENDIX B – MONITORING WELL CONSTRUCTION DIAGRAMS
APPENDIX C – MONITORING WELL DEVELOPMENT & SAMPLING FORMS
APPENDIX D – SOIL CLASSIFICATION FORM
APPENDIX E – LABORATORY ANALYTICAL REPORT
APPENDIX F – CHAIN OF CUSTODY

The Tier 1 Delineation Notification Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the form is legible and complete. This notification is documentation that the O/O is electing to proceed to Delineation pursuant to OAC 1301:7-9-13(I).

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:
NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

CHEMICALS OF CONCERN AND RECOMMENDED LABORATORY METHODS

Analytical Group 1 - light distillate products - including unleaded gasoline, leaded gasoline and aviation gasoline;
Analytical Group 2 - middle distillate products - including diesel, light fuel oils, stoddard solvents, mineral spirits, kerosene, and jet fuels;
Analytical Group 3 - heavy petroleum distillate products - including, but not limited to, lubricating and hydraulic oils;
Analytical Group 4 - used oil
Analytical Group 5 - unknown petroleum products or petroleum products other than those listed in analytical groups 1, 2, 3 and 4. Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

	Analytical Group Number	**1**	**2**	**3**	**4**	**5**	**Analytical Methods**
		Light Distillates	Middle Distillates	Heavy Distillates	Used Oil	Unknowns & Others	
	Chemical						
Aromatics	Benzene	x	x		x		8021/8260
	Toluene	x	x		x		
	Ethylbenzene	x	x		x		
	o, m and p-Xylenes	x	x		x		
Additives	Methyl tertiary-butyl ether (MTBE)	x			x		
Polynuclear Aromatics	Benzo(a)anthracene		x	x	x		8270/8310
	Benzo(a)pyrene		x	x	x		
	Benzo(b)fluoranthene		x	x	x		
	Benzo(k)fluoranthene		x	x	x		
	Chrysene		x	x	x		
	Dibenz(a,h)anthracene		x	x	x		
	Indeno(1,2,3-c,d)pyrene		x	x	x		
	Naphthalene		x	x	x		
Chlorinated Hydrocarbons	Volatile Organic Hydrocarbons				x		8260
Total Petroleum Hydrocarbons *1	TPH (C6 – C12)	x			x		8015
	TPH (C10 – C20)		x		x		
	TPH (C20 – C34)			x	x		
	Varies based on UST contents			x	x	*2	

*1 TPH analysis is not required for ground water samples.
*2 Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

BUSTR SOIL CLASSIFICATION FORM

Major Divisions			Letter Symbol	Typical Description	Soil Class
Coarse Grained Soils More than 50% of material is retained on #200 Sieve	Gravel and Gravelly Soils More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravels (Little or No Fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines	Class 1
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines	
		Gravels with Fines (Appreciable Amount of Fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures	
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures	
	Sand and Sandy Soils More than 50% of Coarse Fraction Passes thru No. 4 Sieve	Clean Sand (Little or No Fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines	
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines	
		Sands with Fines (Appreciable Amount of Fines)	SM	Silty-Sands, Sand-Silt Mixtures	
			SC	Clayey Sands, Sand-Clay Mixtures	Class 2
Fine Grained Soils More than 50% of material passes thru #200 Sieve	Silts and Clays Liquid Limit<50		ML	Inorganic Silt and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sand or Clayey Silts with Slight Plasticity	
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays	
			OL	Organic Silts and Organic Silty Clays of Low Plasticity	
	Silts and Clays Liquid Limit>50		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soil	
			CH	Inorganic Clays of High Plasticity, Fat Clays	Class 3
			OH	Organic Clays of Medium to Plasticity, Organic Silts	
Highly Organic Soils			PT	Peat, Humus, Swamp Soil with High Organic Contents	

Pathway	Symbol	Pathway	Symbol
Soil to DW Leaching		**GW to Indoor Air**	
Soil to Indoor Air		**Soil to Non-DW Leaching**	

I have inspected the soil at:_____ Ohio.
(address) (city)

Name (Printed):_____ Date: _____
(Name of Classifier, Title, Firm Name)

Signature:_____

300 FT DOOR-TO-DOOR SURVEY FORM

DATE

COMPANY
CONTACT
ADDRESS
CITY/STATE/ZIP

RE: Water Use Survey of Properties Located Within 300 Feet of the following UST site:
UST SITE NAME
SITE ADDRESS
CITY, STATE
FACILITY ID #

Dear PROPERTY OWNER/TENANT:

CONSULTANT is conducting an environmental investigation on behalf of OWNER/OPERATOR NAME for the above referenced site to maintain compliance with the State Fire Marshal, Bureau of Underground Storage Tank Regulations (BUSTR). BUSTR requires that a survey be conducted on every property within 300 feet of the UST site referenced above to determine if drinking water wells are or have been present. This investigation is being performed in an effort to try to protect drinking water resources.

This letter was sent to you because your property is located within 300 feet of the UST site referenced above. Please answer the four questions below and return the form within 10 days to assist us in evaluating drinking water usage within the surrounding area of the UST site. By returning this survey, you are helping us make a well-informed, environmentally responsible decision in your community. If you have any questions, please contact me by telephone at PHONE NUMBER..

Sincerely,
PREPARED BY
PERSON'S TITLE

Please answer the following questions by circling "Y" (YES) OR "N" (NO).

1. Is a water well installed on your property for drinking, irrigation or other purposes?	Y	N	Unsure
2. If **YES** to #1: Is the water well still in use (if no, please explain)?	Y	N	
3. Are you obtaining your drinking water from a municipal or private source (i.e. from the city or village)?	Y	N	
4. Are you aware of any water wells in the area (if yes, please explain)?	Y	N	

Comments: _____

_____

_____

Signature of property owner/manager:_____Date:_____

Enclosure: Self-Addressed Stamped Envelope

TIER 1 EVALUATION REPORT FORM

This report form is to be submitted if all COCs are below action levels for all pathways after completing a Tier 1 Source Investigation. This report form is due within ninety days of any of the following items:

- Receiving analytical results, which exceed action levels, pursuant to paragraph (F)(3)(c) of OAC 1301:7-9-13;
- Electing to conduct corrective actions pursuant to paragraph (B)(2) of OAC 1301:7-9-13;
- Electing to conduct a Tier 1 Source Investigation pursuant to (F)(3)(b)(i) of OAC 1301:7-9-13;
- Receiving analytical results, which exceed action levels, from a closure assessment conducted pursuant to paragraph (F) of OAC 1301:7-9-12; or
- Conducting corrective action activities pursuant to paragraph (B)(3) and (B)(4) of OAC 1301:7- 9-13

OWNER/OPERATOR AND FACILITY DATA

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

UST OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____

UST OPERATOR INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

PROPERTY OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP: _____
CONTACT PERSON: _____
PHONE: _____

UNDERGROUND STORAGE TANK (UST) SYSTEM DATA

Tank #	Date Installed	Capacity	Const. Material	Tank Status	Date Removed

STATUS= OOS<90 *– Out of Service < 90 days* ***OOS>90*** *– Out of Service > 90 days* ***RE*** *- Replace* ***R*** *- Removed*
CIU *- Currently In Use* ***NA*** *- Not Applicable* ***CIS -*** *Change in Service* ***CIP*** *- Closed in Place*

SITE HISTORY AND VISUAL SITE EVALUATION

(Include a description of the property, surrounding area, the date the release occurred, etc.)

TIER 1 SOURCE INVESTIGATION

POTENTIAL SOURCE(S):

POTENTIAL SOURCE AREA(S):

CHEMICALS OF CONCERN:

SUBSURFACE INVESTIGATION:

SOIL BORINGS INSTALLED DURING THIS INVESTIGATION / DATE:

PREVIOUSLY INSTALLED SOIL BORINGS / DATE:

MONITORING WELLS INSTALLED DURING THIS INVESTIGATION / DATE:

PREVIOUSLY INSTALLED MONITORING WELLS / DATE:

SB/MW	Install Date	Location	Installed With*	Total Depth	Depth to GW	Static GW	Depth to Bedrock	Screened Interval	MW Diameter

*HSA/SS – hollow stem auger/split spoon, DP – direct push, HA – hand auger

FIELD SCREENING

INSTRUMENT USED: _____

METHODOLOGY USED: _____

_____

_____

_____

CALIBRATION PROCEDURES: _____

_____

_____

_____

SB/MW#								
Depth	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result
0-2’								
2-4’								
4-6’								
6-8’								
8-10’								
10-12’								
12-14’								
14-16’								
16-18’								
18-20’								
20-22’								

22-24’								
24-26’								
26-28’								
28-30’								
30-32’								
32-34’								
34-36’								
36-38’								
38-40’								
40-42’								
42-44’								
44-46’								
46-48’								
48-50’								
GW Depth								

The soil samples that were submitted for analysis should be in **BOLD** or marked with *

SOIL CLASSIFICATION

SOIL CLASSIFICATION:	SOIL CLASS 1	SOIL CLASS 2	SOIL CLASS 3
SOIL SYMBOL:	GW, GP, GM, GC, SW, SP, SM,	SC, ML, CL, OL, MH	CH, OH, PT

MARK THE CORRECT CHOICE: SOIL CLASS 1 ☐ SOIL CLASS 2 ☐ SOIL CLASS 3 ☐

LABORATORY DATA

LABORATORY NAME: _____

ADDRESS: _____

PHONE #: _____

CHEMICAL OF CONCERN / TEST METHOD: _____

DATE SAMPLES RECEIVED BY LAB: _____

DATE SAMPLES ANALYZED BY LAB: _____

TEMPERATURE OF COOLER/SAMPLES: _____

GROUNDWATER DETERMINATION

MARK THE CORRECT CHOICE

THE SATURATED ZONE IS ASSUMED TO BE GROUND WATER**:** YES ☐ NO ☐

THE SATURATED ZONE IS NOT CONSIDERED GROUND WATER: YES ☐ NO ☐ N/A ☐

DEPTH TO THE SATURATED ZONE: <15’ ☐ 15’-30’ ☐ 31-50’ ☐ > 50’ ☐

IF THE SATURATED ZONE IS NOT CONSIDERED GROUND WATER, DOCUMENTATION MUST BE PROVIDED:

GROUND WATER FLOW DIRECTION: _____

IMMEDIATE CORRECTIVE ACTIONS

CURRENT FREE PRODUCT PRESENT: YES ☐ NO ☐ HISTORICAL: YES ☐ NO ☐

LOCATION OF FREE PRODUCT: _____

AMOUNT OF FREE PRODCT RECOVERED TO DATE: _____

OTHER IMMEDIATE CORRECTIVE ACTIONS: _____

SITE MAXIMUM CONCENTRATIONS

	SOIL				GROUND WATER		
	SB	Depth	Conc. mg/kg	Action Level	MW	Conc. mg/L	Action Level
BENZENE							
TOLUENE							
ETHYLBENZENE							
TOTAL XYLENES							
MTBE							
BENZO (a) ANTHRACENE							
BENZO (a) PYRENE							
BENZO (b) FLUORANTHENE							
BENZO (k) FLUORANTHENE							
CHRYSENE							
DIBENZ (a,h) ANTHRACENE							
INDENO (1,2,3-cd) PYRENE							
NAPHTHALENE							
TPH (C6-C12)					N/A	N/A	N/A
TPH (C10-C20)					N/A	N/A	N/A
TPH (C20-C34)					N/A	N/A	N/A
OTHER:							

MISCELLANEOUS DATA

THE FOLLOWING ITEMS MUST BE ATTACHED:
ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-13 OR ADDITIONAL INFORMATION WHICH CLARIFIES THE INVESTIGATION ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

TABLES:
TABLE 1 - SOIL CONCENTRATIONS COMPARED TO ACTION LEVELS FOR EACH PATHWAY
TABLE 2 - GROUND WATER CONCENTRATIONS COMPARED TO ACTION LEVELS FOR EACH PATHWAY
TABLE 3 - MONITORING WELL GAUGING DATA

FIGURES:
FIGURE 1 - TOPOGRAPHIC MAP
FIGURE 2 - SITE MAP
FIGURE 3 – SITE MAP WITH SOIL BORING LOCATIONS, SOIL CONCENTRATIONS AND SAMPLE DEPTH
FIGURE 4 - SITE MAP WITH MONITORING WELLS AND GROUND WATER CONCENTRATIONS
FIGURE 5 - GROUND WATER CONTOUR MAP

APPENDIX:
APPENDIX A – SOIL BORING LOGS
APPENDIX B – MONITORING WELL CONSTRUCTION DIAGRAMS
APPENDIX C – MONITORING WELL DEVELOPMENT & SAMPLING FORMS
APPENDIX D – SOIL CLASSIFICATION FORM
APPENDIX E – LABORATORY ANALYTICAL REPORT
APPENDIX F – CHAIN OF CUSTODY

The Tier 1 Evaluation Report Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the form is legible and complete.

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:
NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

CHEMICALS OF CONCERN AND RECOMMENDED LABORATORY METHODS

Analytical Group 1 - light distillate products - including unleaded gasoline, leaded gasoline and aviation gasoline;
Analytical Group 2 - middle distillate products - including diesel, light fuel oils, stoddard solvents, mineral spirits, kerosene, and jet fuels;
Analytical Group 3 - heavy petroleum distillate products - including, but not limited to, lubricating and hydraulic oils;
Analytical Group 4 - used oil
Analytical Group 5 - unknown petroleum products or petroleum products other than those listed in analytical groups 1, 2, 3 and 4. Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

	Analytical Group Number	**1**	**2**	**3**	**4**	**5**	**Analytical Methods**
		Light Distillates	Middle Distillates	Heavy Distillates	Used Oil	Unknowns & Others	
	Chemical						
Aromatics	Benzene	x	x		x		8021/8260
	Toluene	x	x		x		
	Ethylbenzene	x	x		x		
	o, m and p-Xylenes	x	x		x		
Additives	Methyl tertiary-butyl ether (MTBE)	x			x		
Polynuclear Aromatics	Benzo(a)anthracene		x	x	x		8270/8310
	Benzo(a)pyrene		x	x	x		
	Benzo(b)fluoranthene		x	x	x		
	Benzo(k)fluoranthene		x	x	x		
	Chrysene		x	x	x		
	Dibenz(a,h)anthracene		x	x	x		
	Indeno(1,2,3-c,d)pyrene		x	x	x		
	Naphthalene		x	x	x		
Chlorinated Hydrocarbons	Volatile Organic Hydrocarbons				x		8260
Total Petroleum Hydrocarbons *1	TPH (C6 – C12)	x			x		8015
	TPH (C10 – C20)		x		x		
	TPH (C20 – C34)			x	x		
	Varies based on UST contents			x	x	*2	

*1 TPH analysis is not required for ground water samples.
*2 Additional chemical(s) of concern and analytical methods must be selected, as appropriate, based on reasonably available information related to the product stored, including additives, impurities and degradation products. In addition, chemical(s) of concern should be selected based on their toxicity, mobility, and persistence in the environment. The owners and operators shall consult with the fire marshal for the appropriate chemical(s) of concern for products not in analytical group 1, 2, 3 and 4.

INTERIM RESPONSE ACTION (IRA) NOTIFICATION FORM

(Due ten days prior to beginning the IRA)

OWNER/OPERATOR AND FACILITY DATA

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

OWNER/OPERATOR INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____
OWNER ☐ OPERATOR ☐

Description of IRA: _____

Anticipated volume of soil to be removed: _____

Estimated volume of free product and/or ground water to be recovered: _____

The anticipated length of time of the IRA: _____

ATTACHMENTS:

- A Site Map indicating the limits of excavation and location of free product is to be attached.
- A proposed Sampling and Analysis Plan is to be attached.

PRIOR APPROVAL MUST BE OBTAINED IF ANY OF THE FOLLOWING APPLY:

- The combined total volume of soil to be excavated for all tier evaluations will be greater than eight hundred cubic yards;
- The anticipated time to initiate and complete the interim response action is greater than three months; or
- More than one interim response action is to be conducted.

Yes ☐ No ☐ Prior approval from BUSTR is required

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:

NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

INTERIM RESPONSE ACTION (IRA)REPORT FORM

(Due within sixty days of completing the activities)

OWNER/OPERATOR AND FACILITY DATA

FACILITY INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

OWNER/OPERATOR INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____

IRA ACTIVITIES

Description of IRA: _____

Actual volume of soil and/or ground water remediated: _____

Soil and/or ground water disposal documentation: _____

SAMPLE COLLECTION PROCEDURES:

SAMPLE PRESERVATION: _____

SAMPLING EQUIPMENT: _____

SAMPLING METHOD: _____

FIELD SCREENING:

INSTRUMENT USED: _____
METHODOLOGY USED: _____

SAMPLING RESULTS

	PRE-IRA RESULTS			POST IRA RESULTS			
	SB	Depth	Conc. mg/kg	SB	Depth	Conc. mg/kg	Action Level
BENZENE							
TOLUENE							
ETHYLBENZENE							
TOTAL XYLENES							
MTBE							
BENZO (a) ANTHRACENE							
BENZO (a) PYRENE							
BENZO (b) FLUORANTHENE							
BENZO (k) FLUORANTHENE							
CHRYSENE							
DIBENZ (a,h) ANTHRACENE							
INDENO (1,2,3-cd) PYRENE							
NAPHTHALENE							
TPH (C6-C12)							
TPH (C10-C20)							
TPH (C20-C34)							
OTHER:							

MISCELLANEOUS DATA

THE FOLLOWING ITEMS MUST BE ATTACHED:

ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-13 OR ADDITIONAL INFORMATION WHICH CLARIFIES THE INVESTIGATION ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

TABLES:
TABLE 1 - SOIL CONCENTRATIONS COMPARED TO ACTION & DELINEATION LEVELS
TABLE 2 - GROUND WATER CONCENTRATIONS COMPARED TO ACTION & DELINEATION LEVELS

FIGURES:
FIGURE 1 - TOPOGRAPHIC MAP
FIGURE 2 - SITE MAP SHOWING THE LIMITS OF THE EXCAVATION AND SAMPLE LOCATIONS

APPENDIX:
APPENDIX A – LABORATORY ANALYTICAL REPORT
APPENDIX B – CHAIN OF CUSTODY
APPENDIX C – PCS FORM
APPENDIX D – DISPOSAL DOCUMENTATION

The Interim Response Action Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the form is legible and complete.

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:

NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

STATE FIRE MARSHAL/BUSTR

PETROLEUM CONTAMINATED SOIL (PCS) FORM

This form should be completed and submitted within 120 days of generating a stockpile, within 180 days of placing the soil in portable containers, within 10 days of commencing off-site storage or prior to treatment, whichever comes first.
A separate PCS form shall be completed for each stockpile generated.

OWNER/OPERATOR INFORMATION		
OWNER/OPERATOR NAME	CONTACT PERSON	AREA CODE-PHONE
CITY	STATE	ZIP CODE

UST FACILITY INFORMATION	STORAGE FACILITY INFORMATION	FACILITY WHERE SOILS WILL BE DISPOSED OF OR TREATED
FACILITY ID#	FACILITY ID#	
FACILITY NAME	FACILITY NAME	FACILITY NAME
ADDRESS	ADDRESS	ADDRESS
CITY STATE ZIP CODE	CITY STATE ZIP CODE	CITY STATE
TELEPHONE COUNTY	TELEPHONE COUNTY DATE TRANSFERRED	STOCKPILE DESIGNATION (e.g., pile #1, pile from waste oil cavity, etc.)

DATE STOCKPILE WAS GENERATED _____

Cubic Yards

_____ On-site treatment (requires a treatment plan)

_____ Off-site treatment (requires a treatment plan)

_____ Soil analysis falls below Rule 16 re-use levels (RUL)

_____ Returned to excavation (below site specific action levels) (RTE BAL)

_____ Returned to excavation (above site specific action levels) (RTE AAL)

_____ Disposal at a landfill (LFL)

_____ Disposal at a treatment facility (COM)

_____ Stockpile remains on-site (provide written explanation) (SOS)

TIER 2 EVALUATION REPORT FORM

(Due within eighteen months from the approval of the Tier 1 Investigation report)

FACILITY / UST OWNER DATA

FACILITY INFORMATION:

NAME: _____
ADDRESS: _____
CITY: _____
COUNTY: _____
ZIP CODE: _____
LAT/LONG: _____
FACILITY ID #: _____

UST OWNER INFORMATION:

COMPANY: _____
ADDRESS: _____
CITY, STATE: _____
ZIP CODE: _____
CONTACT PERSON: _____
PHONE: _____

TIER 1 CONCLUSIONS

During the Tier 2 Evaluation, the following chemicals of concern and pathways will be evaluated:

Chemicals of Concern	Soil Pathways	Chemicals of Concern	GW Pathways

SOURCE INVESTIGATION

SUBSURFACE INVESTIGATION:

SOIL BORINGS INSTALLED DURING THIS INVESTIGATION / DATE: _____

PREVIOUSLY INSTALLED SOIL BORINGS / DATE: _____

MONITORING WELLS INSTALLED DURING THIS INVESTIGATION / DATE: _____

PREVIOUSLY INSTALLED MONITORING WELLS / DATE: _____

SB/MW	Install Date	Location	Installed With*	Total Depth	Depth to GW	Static GW	Depth to Bedrock	Screened Interval	MW Diameter

*HSA/SS – hollow stem auger/split spoon, DP – direct push, HA – hand auger

FIELD SCREENING

INSTRUMENT USED: _____

METHODOLOGY USED: _____

_____

_____

_____

CALIBRATION PROCEDURES: _____

_____

_____

SB/MW#								
Depth	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result	PID/FID Result
0-2’								
2-4’								
4-6’								
6-8’								
8-10’								
10-12’								
12-14’								
14-16’								
16-18’								
18-20’								
20-22’								
22-24’								
24-26’								
26-28’								
28-30’								
30-32’								
32-34’								
34-36’								

36-38’								
38-40’								
40-42’								
42-44’								
44-46’								
46-48’								
48-50’								
GW Depth								

The soil samples that were submitted for analysis should be in **BOLD** or marked with *

SITE MAXIMUM CONCENTRATIONS

	SOIL				GROUND WATER		
	SB	Depth	Conc. mg/kg	Action Level	MW	Conc. mg/L	Action Level
BENZENE							
TOLUENE							
ETHYLBENZENE							
TOTAL XYLENES							
MTBE							
BENZO (a) ANTHRACENE							
BENZO (a) PYRENE							
BENZO (b) FLUORANTHENE							
BENZO (k) FLUORANTHENE							
CHRYSENE							
DIBENZ (a,h) ANTHRACENE							
INDENO (1,2,3-cd) PYRENE							
NAPHTHALENE							
TPH (C6-C12)					N/A	N/A	N/A
TPH (C10-C20)					N/A	N/A	N/A
TPH (C20-C34)					N/A	N/A	N/A
OTHER:							

LAND USE DETERMINATION

LAND USE FOR AN UST SITE SHALL BE RESIDENTIAL UNLESS:

1.) The current land use at an UST site is not residential and seventy-five % of the area within three hundred feet of the property boundaries of an UST site is non-residential land use;
YES ☐ NO ☐

DESCRIBE: _____

_____

2.) A land use restriction as approved by the fire marshal for an UST site in accordance with paragraph (L)(4)(a)(ii)(*c*) of OAC 1301:7-9-13 has been implemented and recorded in the county where the UST site is located or the owners and operators enter into an environmental covenant with the fire marshal in accordance with Sections 5301.80 through 5301.92 of the Revised Code:
YES ☐ NO ☐

_____

DESCRIBE: _____

Land Use Determination should be described in detail in Appendix G.

SITE CONCEPTUAL EXPOSURE MODEL

The site conceptual exposure model shall be developed to clearly describe the conditions under which an exposure to chemical(s) of concern may occur by identifying exposure pathways and points of exposure. The Pathway evaluation includes a review of the following:

(a) Receptor identification
(b) Media identification.
(c) Transport mechanisms identification.
(d) Routes of exposure identification.

FOLLOWING THE PATHWAY COMPLETENESS EVALUATION, AN EXPOSURE PATHWAY IS INCOMPLETE WHEN ANY ONE OF THE FOLLOWING CRITERIA EXISTS:

1. There is no point(s) of exposure identified pursuant to paragraph (L)(4)(b) of OAC 1301:7-9-13, for a chemical of concern in an identified environmental media; YES ☐ NO ☐

DESCRIBE: _____

2. Site-specific data demonstrates that there is no transport mechanism in the identified environmental media to move the chemical(s) of concern from the source area(s) to the point(s) of exposure; YES ☐ NO ☐

DESCRIBE: _____

3. Site-specific data demonstrates that there are no route(s) of exposure in the identified environmental media to move the chemical(s) of concern from the source area(s) to the point(s) of exposure; YES ☐ NO ☐

DESCRIBE: _____

4. Points of exposure are eliminated by ground water use restrictions enforceable by a local government and/or regulatory agency, a deed restriction, or an environmental covenant with the fire marshal; YES ☐ NO ☐

DESCRIBE: _____

5. Points of exposure are eliminated by land use restrictions enforceable by local government, regulatory agencies, or deed restrictions.

YES ☐ NO ☐

DESCRIBE: _____

Pathway Evaluation Conclusions:

DESCRIBE: _____

The Site Conceptual Exposure Model should be described in detail in Appendix L.

POINTS OF EXPOSURE

Where ground water has been determined to be a drinking water source in accordance with paragraph (I)(2)(c) or (I)(2)(e) of OAC 1301:7-9-13, the point of exposure shall be one of the following, whichever is closest to the source area(s):

1. Any potable well located on an UST site; YES ☐ NO ☐

DESCRIBE: _____

2. The property line when an UST site is located in a Drinking Water Source Protection Area; YES ☐ NO ☐

DESCRIBE: _____

3. The Drinking Water Source Protection Area boundary if a Drinking Water Source Protection Area is within 300 feet of an UST site; YES ☐ NO ☐

DESCRIBE: _____

The point of exposure is the property line, unless one of the following can be demonstrated:

1. No potable wells are located within 300 feet of an UST site based on a physical survey and an ordinance requires a mandatory tie-in to a municipal water system for all properties in the surrounding area; YES ☐ NO ☐

DESCRIBE: _____

2. No potable wells are located within 300 feet of an UST site based on a physical survey and an ordinance prohibits the installation of potable water wells at all properties within the surrounding area; YES ☐ NO ☐

DESCRIBE: _____

3. No potable wells are located within 300 feet of an UST site based on a physical survey and 100 % of the properties within 300 feet of an UST site are connected to a municipal water source or a municipal source is readily available; YES ☐ NO ☐

DESCRIBE: _____

4. A roadway or railroad separates the source from the down gradient property where a well could be installed, in which case the point of exposure shall be the property line of that property. YES ☐ NO ☐

DESCRIBE: _____

5. If a point of exposure has not been identified in paragraph (L)(4)(b)(i)(*a*)(*i*) through (L)(4)(b)(i)(*a*)(*iv*) of OAC 1301:7-9-13, the point of exposure shall be 300 feet from the source area(s) or an alternate point of exposure approved by the fire marshal. YES ☐ NO ☐

DESCRIBE: _____

Points of Exposure should be described in detail in Appendix H.

SITE SPECIFIC TARGET LEVEL DEVELOPMENT

Fate and transport of chemical(s) of concern above action levels that have potentially complete exposure pathways shall be evaluated by using BUSTR's Tier 2 Spreadsheets. Site specific target levels can be developed by replacing default values specified by the fire marshal for the geological, hydrogeological, and physical parameters in the algorithms used to develop action levels with site-specific values. The following table includes site-specific data utilized to generate Tier 2 SSTLs.

Default Parameter	Default Value	Site Specific Value	Applicable Pathway	Reference

The following table depicts the calculated SSTL:

Chemical	SSTL	Applicable Pathway

BUSTR-Screen is utilized to predict the fate and transport of chemicals of concern is ground water. The following table indicates site-specific data utilized in the model:

Default Parameter	Default Value	Site-Specific Value	Reference

The following table indicates the predictions of the fate and transport model:

Chemical of Concern	POD	Date & Predicted POD Concentration	Date & Actual POD Concentration	Predicted POE Concentration

Site Specific Target Level Development should be described in detail in Appendix M.
BUSTR-Screen should be described in detail in Appendix I.

IMMEDIATE CORRECTIVE ACTIONS

CURRENT FREE PRODUCT PRESENT: YES ☐ NO ☐ HISTORICAL: YES ☐ NO ☐

LOCATION OF FREE PRODUCT: _____

_____

_____

AMOUNT OF FREE PRODCT RECOVERED TO DATE: _____

_____

OTHER IMMEDIATE CORRECTIVE ACTIONS: _____

_____

TIER 2 DECISIONS

Select one of the following:

☐ The concentrations of all chemical(s) of concern are at or below Tier 2 site-specific target levels for all pathways and no monitoring is required pursuant to paragraph (O) of OAC 1301:7-9-13, then no further action is required.

☐ The concentrations of all chemical(s) of concern are at or below Tier 2 site-specific target levels for all pathways and a monitoring plan is required to validate BUSTR-Screen. The monitoring plan that is prepared in accordance with paragraph (L)(7) of OAC 1301:7-9-13 is included in Appendix P of this report.

☐ The concentration of a specific chemical of concern is at or below the Tier 2 site-specific target levels, then no further evaluation is necessary for that chemical of concern and for the corresponding complete exposure pathway:

☐ The concentrations of chemical(s) of concern are above the Tier 2 site-specific target levels for one or more exposure pathways, and the following chemicals of concern and pathways require further evaluation:

If applicable, please list the COCs and the pathways that failed:

COCs	Soil Pathways	COCs	GW Pathways

The owners and operators are planning on conducting one or a combination of the following:

A.) An Interim Response Action: ☐
B.) A Remedial Action Plan: ☐
C.) A Tier 3 Evaluation: ☐
D.) A plan for approval by the fire marshal to calibrate or disprove the fate and transport model using additional site-specific data: ☐

MISCELLANEOUS DATA

THE FOLLOWING ITEMS MUST BE ATTACHED:

ADDITIONAL INFORMATION WHICH IS REQUIRED BY OAC 1301:7-9-13 OR ADDITIONAL INFORMATION WHICH CLARIFIES THE INVESTIGATION ACTIVITIES SHALL BE SUBMITTED AS APPENDICIES TO THIS REPORT.

TABLES:
TABLE 1 - SOIL CONCENTRATIONS COMPARED TO ACTION & DELINEATION LEVELS
TABLE 2 - GROUND WATER CONCENTRATIONS COMPARED TO ACTION & DELINEATION LEVELS
TABLE 3 - MONITORING WELL GAUGING DATA
TABLE 4 – SITE SPECIFIC GEOTECHNICAL DATA

FIGURES:
FIGURE 1 - TOPOGRAPHIC MAP
FIGURE 2 - SITE MAP
FIGURE 3 – SITE MAP WITH SOIL BORING LOCATIONS, SOIL CONCENTRATIONS AND SAMPLE DEPTH
FIGURE 4 - SITE MAP WITH MONITORING WELLS AND GROUND WATER CONCENTRATIONS
FIGURE 5 - GROUND WATER CONTOUR MAP
FIGURE 6 – CROSS SECTIONS

APPENDIX:
APPENDIX A – SOIL BORING LOGS
APPENDIX B – MONITORING WELL CONSTRUCTION DIAGRAMS
APPENDIX C – SOIL CLASSIFICATION FORM
APPENDIX D – LABORATORY ANALYTICAL REPORT
APPENDIX E – CHAIN OF CUSTODY
APPENDIX F – DRINKING WATER EVALUATION SUPPORTING DOCUMENTATION
APPENDIX G – LAND USE DETERMINATION (including a map depicting the land use within 300' of the site)
APPENDIX H – POINTS OF EXPOSURE DOCUMENTATION
APPENDIX I – BUSTR-SCREEN DOCUMENTATION
APPENDIX J – GEOTECHNICAL LABORATORY REPORT
APPENDIX K – LAND & GROUND WATER USE RESTRICTIONS / COVENANTS
APPENDIX L – SITE CONCEPTUAL EXPOSURE MODEL
APPENDIX M – SITE SPECIFIC TARGET LEVEL DEVELOPMENT
APPENDIX N - MONITORING PLAN
APPENDIX O – SLUG TEST / PUMP TEST RESULTS

The Tier 2 Evaluation Report Form **must** be signed by the UST owner/operator. The owner/operator is responsible for ensuring all data is accurate, and the form is legible and complete.

OWNER / OPERATOR SIGNATURE: _____

PRINT NAME: _____ **DATE:** _____

FORM PREPARED BY:
NAME: _____
COMPANY: _____
ADDRESS: _____
PHONE #: _____
EMAIL: _____

DATE

LAND-USE SURVEY FORM

COMPANY
CONTACT
ADDRESS
CITY/STATE/ZIP

RE: Land-use Survey Within 300 Feet of the following UST site:
UST SITE NAME
SITE ADDRESS
CITY, STATE
FACILITY ID #

Dear PROPERTY OWNER/TENANT:

CONSULTANT is conducting an environmental investigation on behalf of OWNER/OPERATOR NAME for the above referenced site to maintain compliance with the State Fire Marshal, Bureau of Underground Storage Tank Regulations (BUSTR). BUSTR requires that a survey be conducted on every property within 300 feet of the UST site referenced above to determine the current and potential future land use.

This letter was sent to you because your property is located within 300 feet of the UST site referenced above. Please answer the six questions below and return the form within 10 days to assist us in evaluating the area of the UST site. By returning this survey, you are helping us make a well-informed, environmentally responsible decision in your community. If you have any questions, please contact me by telephone at PHONE NUMBER.

Sincerely,

PREPARED BY
PERSON'S TITLE

1. What is the property currently used as (Residential or Business)?: _____

(if business, provide name & type of business) _____

2. How long has the property been used for the purpose described in item #1?: _____

3. What is the property currently zoned as?: _____

4. Has anybody ever lived on the property?: Yes ☐ No ☐

5. Does anybody currently live on the property?: Yes ☐ No ☐

6. Are there plans to allow anybody to live on the property?: Yes ☐ No ☐

Comments: _____

Signature of property owner/manager: _____ Date: _____

Enclosure: Self-Addressed Stamped Envelope

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Appendix F: Action Level Development

Table of Contents **Page**

Figures and Tables **Page**

Acronyms

AL	action levels
ASTDR	Agency for Toxic Substances and Disease Registry
ASTM	American Society for Testing and Materials
BP	Beyond Petroleum (formerly British Petroleum)
BUSTR	Bureau of Underground Storage Tank Regulations
CA	corrective action
CIDARS	Chemical Information Database and Applicable Regulatory Standards
CFR	Code of Federal Regulations
COC(s)	chemical(s) of concern
DTW	depth to the top of ground water
ER	exchange rate
GUPUS	Generic Unrestricted Potable Use Standard
H	Henry's Law Constant
HEAST	Health Effects Assessment Summary Tables
HSDB	Hazardous Substance Data Bank
IRIS	Integrated Risk Information System
MCL	maximum constant level
NCEA	National Center for Environmental Assessment
OAC	Ohio Administrative Code
O/O	owner/operator
Ohio EPA	Ohio Environmental Protection Agency
PAH	polynuclear aromatic hydrocarbon
POD	point of demonstration
POE	point of exposure
RBCA	risk-based corrective action
RISC	Risk-Integrated Software for Cleanups
SSTL	site-specific target level
TPH	total petroleum hydrocarbon
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VAP	Voluntary Action Program
VF	volatilization factor

F.1 Tier 1 Action Levels

The action levels (ALs) published in the Ohio Administrative Code (OAC) 1301:7-9-13 were developed using the assumptions, parameters, and algorithms provided in this Appendix. In general, ALs developed for common chemical(s) of concern (COCs) use the most conservative assumptions for the exposure pathways typically encountered at an underground storage tank (UST) site. Specifically, ALs assume that the receptors will be children and adults living at the site and that all exposures will occur at the source of the highest COC concentrations.

F.2 Tier 2 Site-Specific Target Levels

The Bureau of Underground Storage Tank Regulations (BUSTR) Spreadsheets must be used to evaluate COC fate and transport when the COC concentrations exceed ALs for complete exposure pathways. The fate and transport of COCs may be evaluated by conducting *one or a combination* of the following three options:

1. Develop site-specific target levels (SSTLs) by replacing default values with site-specific data in the BUSTR Spreadsheets;
2. Utilize analytical fate and transport modeling (i.e., BUSTR-Screen) to predict COC concentrations in ground water at each point of exposure (POE); and/or
3. Back-calculate SSTLs by utilizing a combination of BUSTR-Screen and BUSTR Spreadsheets.

BUSTR Spreadsheets are located on the website at www.com.state.oh.us/sfm/bust or by contacting BUSTR at (614) 752-7938 for an electronic version available on a compact disc.

F.2.1 SSTL Development in BUSTR Spreadsheets (Option 1)

SSTLs can be calculated by replacing the default values used in AL calculations with site-specific values for certain geological and hydrogeological parameters. Site-specific values may *only* be substituted for the following parameters:

- Total porosity in vadose zone;
- Volumetric water content in vadose zone;
- Volumetric air content in vadose zone;
- Volumetric air content in capillary fringe soil;
- Volumetric water content in capillary fringe soil;
- Total organic carbon;
- Dry bulk density;
- Saturated hydraulic conductivity; and
- Ground water Darcy velocity.

Other values that were determined during the Tier 1 and Tier 2 investigations, such as depth to ground water, soil type, building type, depth from source to ground water, and land-use classification, may be changed with supporting documentation. Exposure parameters can only be changed from residential to non-residential based upon the land-use determination.

When using SSTLs calculated this way, assume that the exposure pathways identified in the Tier 1 Evaluation apply and compare the SSTL to the highest concentration for each COC for each

exposure pathway. As in the Tier 1 Evaluation, assume that the SSTLs are located at the POE. This approach is also appropriate for calculating SSTLs for chemicals that have no calculated Tier 1 ALs.

BUSTR Spreadsheets include soil to indoor air, soil to outdoor air, ground water to indoor air, ground water to outdoor air, and soil leaching to ground water (or drinking water). Direct contact and total petroleum hydrocarbon (TPH) values are listed in OAC Rule 1301:7-9-13(J)(2)(d) and (J)(2)(e), therefore these values cannot be recalculated using site-specific data. For chemicals not listed in the direct contact table, reference the Ohio Environmental Protection Agency (Ohio EPA) DERR VAP generic direct contact standards and supplemental generic direct contact standards. (See OAC 3745-300-08.)

F.2.2 Fate and Transport Modeling Using BUSTR-Screen (Option 2)

BUSTR-Screen may be used to predict COC concentrations at each point of demonstration (POD) or POE for ground water ingestion and ground water to indoor air pathways.

BUSTR-Screen is a ground water fate and transport model combining a user interface with Bioscreen, a Microsoft® Excel-based modeling program created by the United States Environmental Protection Agency (USEPA). The purpose of the BUSTR-Screen interface to the Bioscreen Model is to simplify presentation of input parameters and output results for BUSTR CA sites.

Bioscreen and BUSTR-Screen are Microsoft® Excel based modeling programs based on Domenico fate and transport equations. The equations and calculations used in the BUSTR-Screen Model are identical to those used in the Bioscreen Model, version 1.4. Both models predict the amount of natural attenuation of dissolved hydrocarbons in confined or unconfined aquifers. The models are designed to predict only horizontal flow with a constant seepage velocity.

BUSTR requires that BUSTR-Screen be used if ground water fate and transport modeling is performed during the Tier 2 Evaluation process (OAC 1301:7-9-13, effective March 1, 2005.)

BUSTR-Screen can be downloaded from the BUSTR website at www.com.state.oh.us/sfm/bust. (For additional information, see Appendix G, BUSTR-Screen.)

F.2.3 Back Calculation Using BUSTR Spreadsheets and BUSTR-Screen (Option 3)

Another option for calculating SSTLs is using BUSTR Spreadsheets and BUSTR-Screen to evaluate the fate and transport of COCs in the environmental media for the soil leaching, ground water transport, and/or volatilization pathways. For example, the owner/operator O/O may use a combination of the soil to ground water leaching and BUSTR-Screen spreadsheets to predict acceptable soil and ground water SSTLs that are protective of the POE in the source area.

F.3 Default Parameters

Tables F.1 – F.4 below provide the default input and exposure parameters used in developing the Tier 1 action levels and the recommended parameters for developing Tier 2 SSTLs. Less conservative, site-specific values may be substituted for many of these default parameters. **Whenever a site-specific input parameter is substituted for a default parameter, provide supporting documentation to BUSTR**. Do not modify the residential default exposure parameters, such as the parameters listed in Table F.1, Default Exposure Parameters.

Table F.1- Default Exposure Parameters

Parameter	Symbol	Units	Residents				Workers			
			Child		Adult		Non-residential		Excavation	
Target Risk	TR	unitless	1.00E-05	a	1.00E-05	a	1.00E-05	a	1.00E-05	a
Target Hazard Quotient	THQ	unitless	1	a	1	a	1	a	1	a
Averaging Time (carcinogens)	AT_c	years	70	a	70	a	70	a	70	a
Averaging Time (non-carcinogens)	AT_n	years	6	a	17	a	25	b	1	c
Body Weight	BW	kg	15	a	70	a	70	b	70	c
Exposure Duration	ED	years	6	a	17	a	25	b	1	c
Exposure Frequency	EF	days	350	a	350	a	250	b	120	c
Skin surface area	SA	cm^2	NA	f	NA	f	NA	f	3300	c
Soil to skin adherence factor	M	unitless	NA	f	NA	f	NA	f	1	d
Ingestion Rate	IR_{soil}	mg/day	NA	f	NA	f	NA	f	200	c
Inhalation Rate (indoor)	IR_{air}	m^3/hr	0.625	a	0.625	a	0.833	b	NA	f
Inhalation Rate (outdoor)	IR_{air}	m^3/hr	0.833	b	0.833	b	0.833	b	1.00	c
Exposure time (indoor)	ET	hours	16	a	16	a	8	e	NA	f
Exposure time (outdoor)	ET	hours	2	e	2	e	8	e	8	c,e

Notes for Table F.1, Default Exposure Parameters:
a. Values used in development of Tier 1 action levels.
b. ASTM RBCA standard default exposure.
c. VAP Voluntary Action Program (construction worker guidance).
d. U.S. EPA Supplemental Risk Assessment Guidance for Superfund.
e. U.S. EPA Exposure Factors Handbook.
f. Not applicable.

Table F.2- Default Soil Parameters

Parameter	Symbol	Units	Class 1 Soil	Class 2 Soil	Class 3 Soil
Total Porosity in vadose zone	Θ_T	cm^3/cm^3	0.43	0.43	0.43
Volumetric water content in vadose zone	Θ_{ws}	cm^3/cm^3	0.12	0.15	0.25
Volumetric air content in vadose zone	Θ_{as}	cm^3/cm^3	0.31	0.28	0.18
Volumetric air content in capillary fringe soil	Θ_{acap}	cm^3/cm^3	0.043	0.043	0.043
Volumetric water content in capillary fringe soil	Θ_{wcap}	cm^3/cm^3	0.387	0.387	0.387
Thickness of capillary fringe	h_{cap}	Cm	5	5	5
Fraction organic carbon	F_{oc}	g oc/ g soil	0.002	0.0025	0.003
Bulk density	ρ_s	g/cm^3	1.4	1.6	1.8
Saturated hydraulic conductivity	K_s	cm/sec	5.83E-03	4.17E-05	1.67E-05
Wetting front suction head	Ψ	Cm	-4.95	-21.85	-31.63
Infiltration rate	I	cm/year	31.75	20.32	6.35
Ponding depth	h	Cm	0	0	0

Table F.3- Default Building Parameters

Parameter	Symbol	Units	Residential	Non-Residential
Enclosed space air exchange rate	ER	1/sec	1.39E-04	2.30E-04
Enclosed space volume/infiltration area ratio	L_B	Cm	487.68	487.68
Enclosed space foundation or wall thickness	Lcrack	Cm	15	15
Areal fraction of cracks in foundation/walls	η	cm^2/cm^2	0.001	0.001
Volumetric air content in foundation/wall cracks	Θ_{acrack}	cm^3/cm^3	0.25	0.25
Volumetric water content in foundation/wall cracks	Θ_{wcrack}	cm^3/cm^3	0.19	0.19

Table F.4- Default Ground Water and Atmospheric Parameters

Parameter	Symbol	Units	Value
Ground water darcy velocity	U_{gw}	cm/yr	2500
Ground water mixing zone thickness	δ_{gw}	cm	200
Ambient air mixing zone height	δ_{air}	cm	200
Wind speed above ground surface in ambient mixing zone	U_{air}	cm/sec	225
Width of source area parallel to wind direction	W	cm	1500

F.3.1 Default Physical, Chemical, and Toxicological Properties for COCs

The tables below, Table F.5, Reference Table of Physical and Chemical Properties and Table F.6, Reference Table of Toxicological Properties, provide COC specific input parameter values for deriving ALs; additional COCs also are provided below. If a COC specific input parameter value is not provided on these tables or in these references, then use another publicly available reference.

Table F.5- Reference Table of Physical and Chemical Properties

Chemical of Concern	Molecular Weight		Solubility 20º-25º		Vapor Pressure 20º-25º		Henry's Law Constant		Soil-Water Partition Coe	
	g/mol	Reference	mg/L	Reference	mmHg(sat)	Reference	Dimensionless	Reference	K_{oc} (L/kg)	Reference
Aromatic Hydrocarbons										
benzene	78.1	a	1.75E+03	b	9.52E+01	h	2.28E-01	b	6.17E+01	q
toluene	92.1	a	5.26E+02	b	2.84E+01	h	2.72E-01	b	1.40E+02	q
ethyl benzene	106.2	a	1.69E+02	b	9.60E+00	h	3.23E-01	b	2.04E+02	q
xylenes, total	106.2	e	1.75E+02	q	8.84E+00	h	2.90E-01	e	1.29E+02	q
1,2,4 trimethyl benzene	120.2	s	5.70E+01	s	2.03E+00	a	6.16E-03	s	7.20E+02	s
Additives										
1,2 dibromoethane, EDB	187.9	a	4.30E+03	a	1.12E+01	h	2.89E-02	f	4.37E+01	j
1,2 dichloroethane, EDC	99	a	8.52E+03	q	7.89E+01	h	4.01E-02	b	3.80E+01	q
methyl tert butyl ether, MTBE	88.2	g	5.10E+04	q	2.49E+02	h	2.04E-02	g	6.00E+00	q
Polynuclear Aromatic Hydrocarbons										
acenaphthene	154.2	a	4.24E+00	b	2.30E-03	a	6.36E-03	b	4.90E+03	q
anthracene	178.2	a	4.34E-02	b	2.67E-06	h	2.67E-03	b	2.34E+04	q
benzo(a)anthracene	228.3	a	9.40E-03	b	3.05E-08	h	1.37E-04	b	3.58E+05	q
benzo(b)fluoranthene	252.3	a	1.50E-03	b	5.00E-07	h	4.55E-03	b	1.23E+06	b
benzo(k)fluoranthene	252.3	a	8.00E-04	b	9.65E-10	h	3.40E-05	b	1.23E+06	b
benzo(g,h,i)perylene	276.34	s	2.60E-04	s	1.01E+00	a	1.60E-06	s	2.50E+05	s
benzo(a)pyrene	252.3	a	1.62E-03	b	5.49E-09	a	4.63E-05	b	9.69E+05	q
chrysene	228.3	a	1.60E-03	b	6.23E-09	h	3.88E-03	b	3.98E+05	b
dibenz(a,h)anthracene	278.4	a	2.49E-03	b	1.00E -10	h	6.03E-07	b	1.79E+06	q
fluoranthene	202.3	a	2.06E-01	b	1.23E-08	h	6.60E-04	b	4.91E+04	q
fluorine	166.2	a	1.98E+00	b	8.42E-03	h	2.61E-03	b	7.71E+03	q

Table F.5- Reference Table of Physical and Chemical Properties (continued)

indeno(1,2,3-cd)pyrene	276.3	a	2.20E-05	b	1.00E-10	h	6.56E-05	b	3.47E+06	b
naphthalene	128.2	a	3.10E+01	b	8.50E-02	h	1.98E-02	b	1.19E+03	q
pyrene	202.3	a	1.35E-01	b	2.45E-06	h	4.51E-04	b	6.80E+04	q
Volatile Organics										
carbon tetrachloride	153.2	a	7.93E+02	b	1.15E+02	a	1.25E+00	b	1.52E+02	q
chlorobenzene	112.6	a	4.72E+02	b	1.20E+01	h	1.52E-01	b	2.24E+02	q
chloroform	119.4	a	7.92E+03	b	1.97E+02	h	1.50E-01	b	5.25E+01	q
1,1 dichloroethane	99	a	5.06E+03	b	2.27E+02	a	2.30E-01	b	5.34E+01	q
1,1 dichloroethylene	96.9	a	2.25E+03	b	6.00E+02	h	1.07E+00	b	6.50E+01	q
cis 1,2 dichloroethylene	96.9	c	3.50E+03	b	2.01E+02	h	1.67E-01	b	3.55E+01	b
trans 1,2 dichloroethylene	96.9	a	6.30E+03	b	3.31E+02	h	3.85E-01	b	3.80E+01	q
methylene chloride	84.9	a	1.30E+04	b	4.35E+02	h	8.98E-02	b	1.00E+01	q
styrene	104.2	a	3.10E+02	b	6.40E+00	h	1.13E-01	b	9.12E+02	q
1,1,2,2 tetrachloroethane	167.9	a	2.97E+03	b	4.62E+00	h	1.41E-02	b	7.90E+01	q
tetrachloroethylene (PCE)	165.8	a	2.00E+02	b	1.86E+01	a	7.54E-01	b	2.65E+02	q
1,1,1 trichloroethane	133.4	a	1.33E+03	b	1.24E+02	a	7.05E-01	b	1.35E+02	q
1,1,2 trichloroethane	133.4	a	4.42E+03	b	2.30E+01	h	3.74E-02	b	7.50E+01	q
trichloroethylene (TCE)	131.4	a	1.10E+03	b	6.90E+01	a	4.22E-01	b	9.40E+01	q
vinyl chloride	62.5	a	2.76E+03	b	2.98E+03	h	1.11E+00	b	1.88E+01	q

Table F.5- Reference Table of Physical and Chemical Properties (continued)

Chemical of Concern	Octanol/Water		Degradation Rate (Half-Life)		Air Diffusivity		Water Diffusivity	
	Partition Coe		high end to low end range		$D_{i,a}$ (25°C)		$D_{i,w}$ (25°C)	
	log K_{ow} (L/kg)	Reference	day^{-1},(days)	Reference	cm^2/s	Reference	cm^2/s	Reference
Aromatic Hydrocarbons								
benzene	2.13E+00	b	7.00E-02(10) to 9.60E-04(720)	d	8.80E-02	b	9.80E-06	b
toluene	2.75E+00	b	.1(7)-.025(28)	d	8.70E-02	b	8.60E-06	b
ethyl benzene	3.14E+00	b	.1(6)-.00304(228)	d	7.50E-02	b	7.80E-06	b
xylenes, total	3.16E+00	s	.050(14)-.0019(360)	d	7.67E-02	q	8.46E-06	q
1,2,4 trimethyl benzene	3.78E+00	s	4.50E-02(15) to 1.23E-02(56)	d	6.44E-02	q	7.92E-06	q
Additives								
1,2 dibromoethane, EDB	1.76E+00	a	.0354(19.6)-.0058(120)	d	5.00E-02	g	9.60E-06	a
1,2 dichloroethane, EDC	1.47E+00	b	.007(100)-.0019(360)	d	1.04E-01	b	9.90E-06	b
methyl tert butyl ether, MTBE	9.40E-01	s	.012(56)-.0019(360)	d	1.03E-01	q	1.05E-05	q
Polynuclear Aromatic Hydrocarbons								
acenaphthene	3.92E+00	b	.0282(24.6)-.00340(204)	d	4.21E-02	b	7.69E-06	b
anthracene	4.55E+00	b	.007(100)-.00075(920)	d	3.24E-02	b	7.74E-06	b
benzo(a)anthracene	5.70E+00	b	.00340(204)-.000510(1360)	d	5.10E-02	b	9.00E-06	b
benzo(b)fluoranthene	6.20E+00	b	.00096(720)-.000568(1220)	d	2.26E-02	b	5.56E-06	b
benzo(k)fluoranthene	6.20E+00	b	.0003898(1778)-.000162(4280)	d	2.26E-02	b	5.56E-06	b
benzo(g,h,i)perylene	6.63E+00	s	0.0005873(1180)-0.0005331(1300)	d	2.03E-02	q	5.20E-06	q
benzo(a)pyrene	6.11E+00	b	.00608(114)-.000654(1060)	d	4.30E-02	b	9.00E-06	b
chrysene	5.70E+00	b	.000934(742)-.0003(2000)	d	2.48E-02	b	6.21E-06	b
dibenz(a,h)anthracene	6.69E+00	b	.000960(722)-.000369(1880)	d	2.02E-02	b	5.18E-06	b
fluoranthene	5.12E+00	b	.0025(280)-.00079(880)	d	3.02E-02	b	6.35E-06	b
fluorine	4.21E+00	b	.011(64)-.0058(120)	d	3.63E-02	b	7.88E-06	b

Table F.5- Reference Table of Physical and Chemical Properties (continued)

indeno(1,2,3-cd)pyrene	6.65E+00	b	.00058(1200)-.000475(1460)	d	1.90E-02	b	5.66E-06	b
naphthalene	3.36E+00	b	.7(1)-.00269(258)	d	5.90E-02	b	7.50E-06	b
pyrene	5.11E+00	b	.0017(420)-.00018(3800)	d	2.72E-02	b	7.24E-06	b
Volatile Organics								
carbon tetrachloride	2.73E+00	a	.1(7)-.0019(360)	d	7.80E-02	b	8.80E-06	b
chlorobenzene	2.86E+00	b	.0051(136)-.002(300)	d	7.30E-02	b	8.70E-06	a
chloroform	1.92E+00	b	.012(56)-.0004(1800)	d	1.04E-01	b	1.00E-05	b
1,1 dichloroethane	1.79E+00	a	.011(64)-.0019(360)	d	7.42E-02	b	1.05E-05	b
1,1 dichloroethylene	2.13E+00	a	.012(56)-.005(132)	d	9.00E-02	b	1.04E-05	b
cis 1,2 dichloroethylene	1.86E+00	b	no data		7.36E-02	b	1.13E-05	b
trans 1,2 dichloroethylene	2.07E+00	b	no data		7.07E-02	b	1.19E-05	b
methylene chloride	1.25E+00	a	.050(14)-.012(56)	d	1.01E-01	b	1.17E-05	b
styrene	2.94E+00	b	.025(28)-.003(210)	d	7.10E-02	b	8.00E-06	b
1,1,2,2 tetrachloroethane	2.39E+00	a	1.550(.446)-.015(45)	d	7.10E-02	b	7.90E-06	b
tetrachloroethylene (PCE)	2.67E+00	b	.0019(360)-.00096(720)	d	7.20E-02	b	8.20E-06	b
1,1,1 trichloroethane	2.48E+00	a	.005(140)-.0013(546)	d	7.80E-02	b	8.80E-06	b
1,1,2 trichloroethane	2.05E+00	b	.0051(136)-.00095(730)	d	7.80E-02	b	8.80E-06	b
trichloroethylene (TCE)	2.71E+00	b	.0022(321)-.0004(1653)	d	7.90E-02	b	9.10E-06	b
vinyl chloride	1.50E+00	b	.012(56)-2.41E-04(2875)	d	1.06E-01	b	1.23E-06	b

References for Table F.5, Reference Table for Physical and Chemical Properties:

a. Montgomery, J. H., 1996. Ground water Chemicals Desk Reference, 2nd. Edition. CRC Press, Inc. Boca Raton, FL.
b. US EPA, 1996. *Soil Screening Guidance*, EPA540/R-96/018.
c. Windholz, M. (ed.), 1976. *The Merck Index, 9th Edition*, Merck and Co., Inc. Rahway, N.J.
d. Howard,P.,et al., 1991. *Handbook of Environmental Degradation Rates*, Lewis Publishers Inc., Chelsea, MI. Half-life values are given in days for ground water and include a high-end range and low-end range.
e. American Society for Testing & Materials, *Standard Guide for Risk-Based Corrective Action Applied at* Petroleum Release Sites, E 1739-95
f. Henry's Law Constant (HLC) (atm-m^3/mol) is calculated from HCL (dimensionless) by dividing by 41. HLC (dimensionless) is calculated from HLC (atm-m3/mol) by multiplying by 41(Soil Screening Guidance).
g. BP Oil and Spence, L.R., October, 1996. *Risk-Integrated Software for Cleanups* (RISC), , Version 3.0.
h. Howard and Meylan, 1997. *Handbook of Physical Properties of Organic Chemicals*.
j. K_{oc} value is converted from log K_{oc} given in Reference a.
q. Ohio EPA - Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) - Revised 7-14-03
s. Hazardous Substance Data Bank (HSDB)

Table F.6- Reference Table of Toxicological Properties

Chemical of Concern								
	Slope Factor Ingestion		Slope Factor Inhalation (p)		Reference Dose Ingestion		Reference Dose Inhalation (p)	
	1/(mg/kg-d)	Reference	1/(mg/kg-d)	Reference	mg/kg-d	Reference	mg/kg-d*	Reference
Aromatic Hydrocarbons								
benzene	5.50E-02	k	2.70E-02	k	4.00E-03	k	8.58E-03	k
toluene	no data		no data		2.00E-01	k	1.14E-01	k
ethyl benzene	no data		no data		1.00E-01	k	2.86E-01	k
xylenes, total	no data		no data		2.00E-01	k	2.86E-02	k
1,2,4 trimethyl benzene	no data		no data		5.00E-02	n	1.72E-03	n
Additives								
1,2 dibromoethane, EDB	8.50E+01	k	7.70E-01	k	no data		5.71E-05	l
1,2 dichloroethane, EDC	9.10E-02	k	9.10E-02	k	3.00E-02	n	1.43E-03	r
methyl tert butyl ether, MTBE	no data		no data		no data		8.58E-01	k
Polynuclear Aromatic Hydrocarbons								
acenaphthene	no data		no data		6.00E-02	k	no data	
anthracene	no data		no data		3.00E-01	k	no data	
benzo(a)anthracene	7.30E-01	k	3.08E-01	n	no data		no data	
benzo(b)fluoranthene	7.30E-01	k	3.08E-01	n	no data		no data	
benzo(k)fluoranthene	7.30E-02	k	3.08E-02	n	no data		no data	
benzo(g,h,i)perylene	no data		no data		3.00E-02	q	no data	
benzo(a)pyrene	7.30E+00	k	3.08E+00	k	no data		no data	
chrysene	7.30E-03	k	3.08E-03	n	no data		no data	
dibenz(a,h)anthracene	7.30E+00	k	3.08E+00	n	no data		no data	
fluoranthene	no data		no data		4.00E-02	k	no data	
fluorine	no data		no data		4.00E-02	k	no data	

Table F.6- Reference Table of Toxicological Properties (continued)

indeno(1,2,3-cd)pyrene	7.30E-01	k	3.08E-01	n	no data		no data	
naphthalene	no data		no data		2.00E-02	k	8.58E-04	k
pyrene	no data		no data		3.00E-02	k	no data	
Volatile Organics								
carbon tetrachloride	1.30E-01	k	5.25E-02	k	7.00E-04	k	5.72E-04	n
chlorobenzene	no data		no data		2.00E-02	k	1.72E-02	n
chloroform	6.10E-03	k	8.05E-02	k	1.00E-02	k	2.84E-02	r
1,1 dichloroethane	no data		no data		1.00E-01	l	1.43E-01	l
1,1 dichloroethylene	no data		no data		5.00E-02	k	5.72E-02	k
cis 1,2 dichloroethylene	no data		no data		1.00E-02	l	1.00E-02	m
trans 1,2 dichloroethylene	no data		no data		2.00E-02	k	2.00E-02	m
methylene chloride	7.50E-03	k	1.60E-03	k	6.00E-02	k	8.60E-01	l
styrene	no data		no data		2.00E-01	k	2.86E-01	k
1,1,2,2 tetrachloroethane	2.00E-01	k	2.03E-01	k	6.00E-02	n	no data	
tetrachloroethylene (PCE)	5.20E-02	n	2.03E-03	n	1.00E-02	k	7.72E-02	r
1,1,1 trichloroethane	no data		no data		2.80E-01	n	2.86E-01	n
1,1,2 trichloroethane	5.70E-02	k	5.60E-02	k	4.00E-03	k	4.00E-03	m
trichloroethylene (TCE)	1.10E-02	n	5.95E-03	n	6.00E-03	n	6.00E-03	m
vinyl chloride	1.40E+00	k	3.08E-02	k	3.00E-03	k	2.86E-02	k

References for Table F.6, Reference Table of Toxicological Properties:
k . Integrated Risk Information System (IRIS).
l. Health Effects Assessment Summary Tables (HEAST).
m. route extrapolation.
n. National Center for Environmental Assessment (NCEA).
q. Ohio EPA - Voluntary Action Program Chemical Information Database and Applicable Regulatory Standards (CIDARS) - Revised 7-14-03.
r. ATSDR.

F.4 Ground Water Ingestion Pathway

F.4.1 Tier 1

The ground water ingestion AL for each COC was derived from the maximum contaminant level (MCL) established by the USEPA under the National Primary Drinking Water Regulations (40 [Code of Federal Regulations] CFR Part 141) and the National Secondary Drinking Water Regulations (40 CFR Part 143). Find the MCL values at http://www.epa.gov/safewater/mcl.html.

Several of the polynuclear aromatic hydrocarbon (PAH) action levels are based on a Generic Unrestricted Potable Use Standard (GUPUS) calculated by Ohio EPA DERR VAP. These action levels are listed in OAC 3745-300-08(C)(3)(b)&(c) or VAPs Supplemental Generic Numerical Values. (Information on calculating a GUPUS can be found in the *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures* prepared by the Ohio EPA, DERR VAP, February 2002.)

F.4.2 Tier 2

Regardless of the land use, assume that a residential adult or child receptor can ingest COCs that are dissolved in ground water (or surface water) used as drinking water.

Therefore, SSTLs cannot be calculated for the ground water ingestion pathway during further tier evaluations. Instead, apply the AL for ground water ingestion at the site-specific point of exposure.

If a MCL is not available for a COC and a Generic Unrestricted Potable Use Standard (GUPUS) has been calculated by the Ohio EPA DERR VAP, then use the Ohio EPA Generic Potable Unrestricted Use Standard.

If a MCL or an Ohio EPA GUPUS is not available for a COC, then provide sufficient justification to eliminate it from the list of COCs being evaluated.

F.5 Direct Contact with Soil Pathway

F.5.1 Tier 1

Within this exposure pathway, consider these four exposure routes for adult or child receptor in a residential setting: 1) incidental ingestion, 2) dermal contact, 3) inhalation of volatile organic compounds, and 4) inhalation of particulates.

Each direct contact COC AL for each COC derives from the Ohio EPA DERR VAP rule OAC 3745-300-08 (B)(3)(b) Table II: *Generic Direct Contact Soil Standards for Carcinogenic and Noncarcinogenic Chemicals of Concern – Residential Land Use Category*.

The *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures* prepared by the Ohio EPA, DERR VAP, February 2002, provides details on how the direct contact ALs were derived.

F.5.2 Tier 2

Residential

No site-specific default exposure factors may be substituted during Tier 2.

Non-Residential

Consistent with the approach used for the Tier 1 ALs, the Tier 2 SSTLs for direct contact also follow the VAP rule. Specifically, the Tier 2 SSTLs may be taken from OAC 3745-300-08 (B)(3)(c) Table III: *Generic Direct Contact Soil Standards for Carcinogenic and Noncarcinogenic Chemicals of Concern – Commercial and Industrial Land Use Categories*. Tier 2 SSTLs may also be taken from the Supplemental Generic Numerical Values developed by the Ohio EPA.

Additionally, Tier 2 SSTLs may be developed according to the *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures,* Ohio EPA, DERR VAP, February 2002.

Construction and Excavation Worker

The direct contact with soil by construction and excavation workers must be evaluated whenever all soil pathways required in Tier 1 have been eliminated. Consistent with the approach used for the Tier 1 action levels, the Tier 2 SSTLs for direct contact also follow the VAP rule. Specifically, the Tier 2 SSTLs may be taken from OAC 3745-300-08 (B)(3)(d) Table IV: *Generic Direct Contact Soil Standards for Carcinogenic and Noncarcinogenic Chemicals of Concern – Construction and Excavation Activities Categories*. Tier 2 SSTLs may also be taken from any of the Supplemental Generic Numerical Values developed by the Ohio EPA.

Additionally, Tier 2 SSTLs may be developed according to the *Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures*, Ohio EPA, DERR VAP, February 2002.

F.6 Indoor Air Inhalation Pathway

This indoor air concentration is the acceptable concentration of a COC that a receptor may be exposed to within a home or other building. This concentration may be used as the point of exposure concentration to calculate the soil to indoor air and the ground water to indoor air SSTLs.

F.6.1 Assumptions

Calculate the residential indoor air concentrations for carcinogenic COCs with a combined adult and child exposure that averages life spans. This assumption suggests that a resident spends some of that time as a child and the remainder as an adult. The combined approach results in more conservative ALs/SSTLs (as opposed to evaluating adults or children individually).

Calculate the residential indoor air concentrations for non-carcinogenic COCs with only the child's exposure. These assumptions were made for the non-carcinogen case because during the

child's exposure, the body weight values are low and the inhalation rates are equal to the adult values, resulting in more conservative action levels/SSTLs.

Calculate the non-residential indoor air concentrations for both carcinogenic and non-carcinogenic COCs for the adult worker. Although residents may be exposed at non-residential properties, their exposures are assumed to be infrequent and of short duration. Adult workers are the maximally exposed receptor group, resulting in more conservative SSTLs.

F.6.2 Algorithms

Calculate the SSTLs for vapor to indoor air using Equations F.1, F.2, and F.3, below, which are found in the *Risk Assessment Guidance for Superfund*.

Equation F.1- Carcinogenic Chemicals of Concern (non-residential only)

$$SSTL_{air\text{-}c} = \frac{TR \times BW \times AT_c \times 365\frac{days}{year} \times 10^3 \frac{ug}{mg}}{SF_i \times IR_{air} \times ET \times EF \times ED}$$

Equation F.2- Non-carcinogenic Chemicals of Concern

$$SSTL_{air\text{-}h} = \frac{THQ \times RfD \times BW \times AT_c \times 365\frac{days}{year} \times 10^3 \frac{ug}{mg}}{IR_{air} \times ET \times EF \times ED}$$

Equation F.3- Carcinogenic Chemicals of Concern (Residential Only)

Input Parameters

$$SSTL_{air\text{-}c} = \frac{TR \times AT_c \times 365\frac{days}{year} \times 10^3 \frac{ug}{mg}}{SF_i \times ET \times EF \times \left[\frac{ED_{child} \times IR_{child}}{BW_{child}} + \frac{ED_{adult} \times IR_{adult}}{BW_{adult}}\right]}$$

See the Default Parameters Section of this Appendix for the input parameters for Equations F.1, F.2, and F.3 above. There are no input parameters unique to these algorithms.

F.7 Soil to Indoor Air Pathway

Where a soil source area exists below a building, COCs adsorbed to soil can volatilize into the soil pore spaces; travel through the soil, and into the cracks in a foundation of a building, ultimately mixing with the air inside of the building.

F.7.1 Algorithms

Calculate the SSTLs for vapor to indoor air from soil sources using Equation F.4, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation F.4- SSTL Soil to Indoor Air

$$SSTL_{soil\text{-}air} = \frac{SSTL_{air}}{VF} \times 10^{-3} \frac{mg}{ug}$$

F.7.2 Input Parameters

$SSTL_{air}$ is the SSTL for indoor air inhalation for a COC used in Equations 1, 2, and 3 above.

VF (also referenced as VF_{sesp}) is the volatilization factor for a COC in subsurface soil migrating to indoor air that is used in Equation 5.

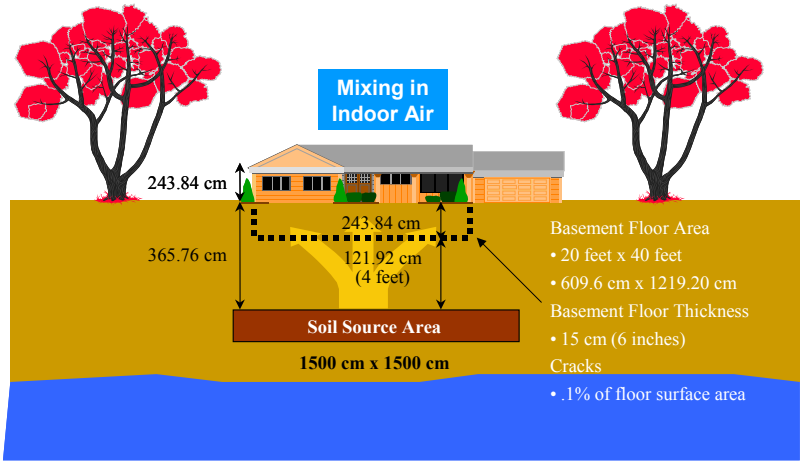
F.7.3 Volatilization Factor for a COC in Subsurface Soil to Indoor Air (VF_{sesp})

The VF for COCs in subsurface soil to indoor air relates the concentration of a COC in soil vapor to its concentration in soil. It describes the diffusion for COCs through the soil and cracks in a building's foundation.

Assumptions

For the action levels calculated during Tier 1, assume that the house is a one-story structure with a full basement. Locate the house directly over the soil source area. Assume that vapors will infiltrate through the basement floor only. Assume that the house dimensions are 40 ft. (1219.20 cm) by 20 ft. (609.6 cm) by 16 ft. (487.68 cm) in height (i.e., the combined height of the basement and the first floor). (See Figure F.1- Soil to Indoor Air Assumptions.)

Figure F.1- Soil to Indoor Air Assumptions



Algorithms

Calculate the volatilization factor (VF_{sesp}) for COCs in subsurface soil to indoor air using Equation F.5, below, which is from the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a heuristic model presented by Johnson and Ettinger.

Equation F.5- Volatilization Factor for Subsurface Soil to Indoor Air

$$VF_{sesp} = \frac{\dfrac{H\rho_s}{\theta_{WS} + k_s\rho_s + H\theta_{as}}\left[\dfrac{\dfrac{D_s^{eff}}{L_s}}{ER \bullet L_B}\right]}{1 + \left[\dfrac{\dfrac{D_s^{eff}}{L_s}}{ER \bullet L_B}\right] + \left[\dfrac{\dfrac{D_s^{eff}}{L_s}}{\left(\dfrac{D_{crack}^{eff}}{L_{crack}}\right)n}\right]} \text{ x } 1000\frac{cm^3 - kg}{m^3 - g}$$

Calculating the VF requires the calculation of an effective diffusion coefficient for the vapor phase chemical in soil (D_s^{eff}) and an effective diffusion coefficient for the vapor phase chemical through foundation cracks (D_{crack}^{eff}). The diffusion coefficients are functions of the vadose zone soil porosity (Θ_T), the water-filled porosity of the vadose zone soil (Θ_{ws}) and the air-filled porosity (Θ_{as}). During Tier 2, based on the site data, the identification of the properties of more than one soil layer in the vadose zone might be required. If this is the case, then the effective diffusion coefficient in soil would include contributions from each of the soil layers.

Calculate the effective diffusion coefficient in soil (D_s^{eff}) using Equation F.6, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on the semi-empirical model presented by Millington and Quirk.

Equation F.6- Effective Diffusion Coefficient in Soil Based on Vapor-Phase Concentrations

$$D_s^{eff} = D^{air} \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Calculate the effective diffusion coefficient through foundation cracks (D_{crack}^{eff}) using Equation F.7, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on the semi-empirical model presented by Millington and Quirk.

Equation F.7- Effective Diffusion Coefficient through Foundation Cracks

$$D_{crack}^{eff} = D^{air} \frac{\theta_{acrack}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$$

Input Parameters

See the Default Parameters Section of this Appendix for default input parameter values for calculating VF_{sesp}, D_s^{eff} , and D_{crack}^{eff} . Two parameters unique to these algorithms are L_s and L_B, which derive from Equations F.8 and F.9, below, respectively.

Equation 8- Depth to Top of Subsurface Source from Bottom of Basement or Foundation

L_s = (depth of subsurface source) - (depth to bottom of basement)

Equation F.9- Enclosed Space Volume/Infiltration Ratio

$$L_B = \frac{\text{Length of basement x Width of basement x (Height of basement + Height of house)}}{\text{Length of basement x Width of basement}}$$

When calculating the VF_{sesp}, the following default input parameter values must be used and should only be modified with prior approval from BUSTR:

- Aerial fraction of cracks in foundation/walls (η);
- COC-specific input parameter values (H, K_{oc}, D^{air}, D^{wat});
- Volumetric air content in foundation/wall cracks (Θ_{acrack}); and
- Volumetric water content in foundation/wall cracks (Θ_{wcrack}).

Many common COC-specific input parameters can be found in Section F.3- Default Parameters of this Appendix. First, consult these tabulated values and the references used to define the default COCs for any additional COCs. If a COC-specific input parameter value is not there, then use another publicly available reference.

Input Parameters That Might Be Site-Specific

There are four groups of site-specific input parameters that may be modified when calculating the VF_{sesp} during Tier 2:

1. Physical Dimensions of the Building

The length, width, and height of the building must be accurately estimated because the model used to calculate indoor air concentration assumes that concentrations of COCs are evenly mixed throughout the building. Never assume that the height of the building is more than one story or 8 ft. (243.84 cm). If there is no basement for the building, then assume that the basement height is zero. Additionally, the enclosed space foundation/wall thickness (L_{crack}) may also be modified based on the actual thickness of the basement floor or building slab (if no basement exists). Modifications to the physical dimensions of the building may require a re-calculation of the volume/infiltration area ratio (L_B) **and/or** institutional controls (i.e., deed restriction) to ensure that the building configuration is maintained and protective of future land use.

2. Physical Dimensions of the Subsurface Source Area

The soil thickness between the bottom of the basement and top of the source (L_s) may be changed. If the depth to the bottom of the basement is below the top of the subsurface soil source, then use a value of 1 cm for L_s. This assumes that the subsurface foundation of the building could be placed directly onto the source of COCs.

3. Characteristics of the Subsurface Soil

Site-specific characteristics of the subsurface soil in the vadose zone between the top of the source area and the bottom of the basement may be used if sufficient data is collected to demonstrate that these values represent soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon (f_{oc});
- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as}); and
- Total soil porosity in the vadose zone (Θ_t).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T, any changes to one of these values must be reflected by changes in the other two values.

4. Enclosed Space Air Exchange Rate

A site-specific enclosed space air exchange rate (ER) may be substituted for the recommended default parameters. However, the source/assumptions used to derive the ER value must be documented.

F.8 Ground Water to Indoor Air Pathway

Where a ground water source area exists below a building, COCs dissolved in ground water can volatilize into the soil pore spaces, travel through the soil, and into the cracks in a foundation of a building, and mix with the air inside the building. An adult or child receptor can inhale COCs that have volatilized into the air.

F.8.1 Algorithms

Calculate the SSTLs for vapor to indoor air from a ground water source using Equation F.10, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Site*.

Equation F.10- COCs in Ground Water Vapor to Indoor Air

$$SSTL_{water\text{-}air} = \frac{SSTL_{air}}{VF} \times 10^{-3} \frac{mg}{ug}$$

F.8.2 Input Parameters

$SSTL_{air}$ is the SSTL for indoor air inhalation for the COCs shown in Equations F.1, F.2, and F.3 above.

VF (also referred to as VF_{wesp}) is the volatilization factor for a COC in ground water migrating to indoor air as presented below in Equation F.11.

F.8.3 Volatilization Factor for a COC in Ground Water to Indoor Air - (VF_{wesp})

The VF for COCs in ground water to indoor air relates the COC concentration in indoor air to its concentration in ground water and accounts for diffusion through the soil and cracks in the foundation of a building.

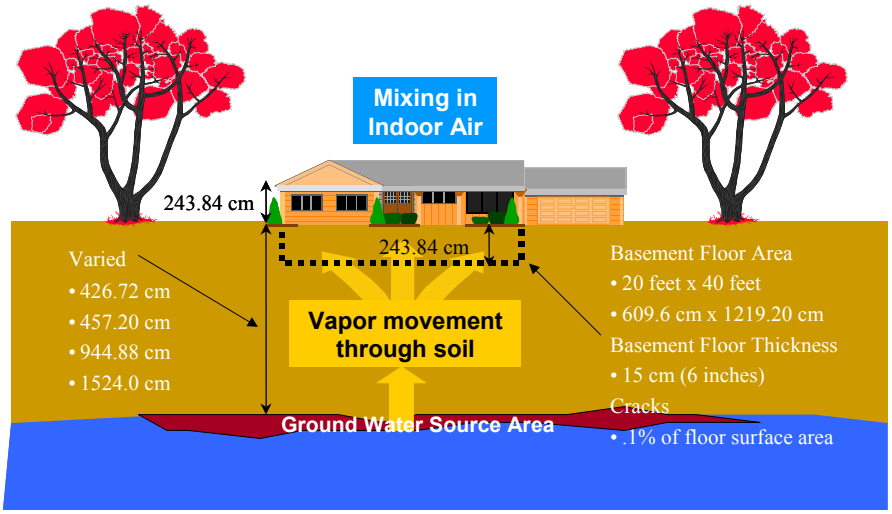
Assumptions

For the action levels calculated during Tier 1, assume that the house is a one-story structure with a full basement directly over the ground water source area. Vapors are assumed to infiltrate through the basement floor only. The house is assumed to be 40 ft. (1219.20 cm) in length by 20 ft. (609.6 cm) in width by 16 ft. (487.68 cm) in height (i.e., the combined height of the basement and the first floor). (See Figure F.2 Ground Water to Indoor Air Assumptions.)

In Tier 1, the variable depth to ground water would fall into one of these categories:

- Less than 15 ft. uses 14 ft. (426.72 cm);
- 15 to 30 ft. uses 15 ft. (457.20 cm);
- 31 ft. to 50 ft. uses 31 ft. (944.88 cm); or
- Greater than 50 ft. uses 50 ft. (1524.0 cm).

Figure F.2- Ground Water to Indoor Air Assumptions



Algorithms

Calculate the volatilization factor (VF_{wesp}) for COCs in ground water migrating to indoor air using Equation F.11, below, which is from the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a model developed by Johnson and Ettinger.

Equation F.11- Volatilization Factor for Ground Water to Indoor Air

$$VF_{WESP} = \frac{H\left[\dfrac{\dfrac{D_{ws}^{eff}}{L_{GW}}}{ER \times L_B}\right]}{1+\left[\dfrac{\dfrac{D_{ws}^{eff}}{L_{GW}}}{ER \times L_B}\right]+\left[\dfrac{\dfrac{D_{ws}^{eff}}{L_{GW}}}{\left(\dfrac{D_{crack}^{eff}}{L_{crack}}\right)\eta}\right]} \times 10^3 \frac{L}{m^3}$$

Calculating the VF factor requires the calculation of an effective diffusion coefficient (D_{ws}^{eff}) for the vapor phase chemical from the ground water surface through the capillary fringe (h_{cap}) and through the vadose zone (h_v) soil, and an effective diffusion coefficient (D_{crack}^{eff}) for the vapor phase chemical through foundation cracks. The diffusion coefficients are functions of the vadose zone soil porosity (Θ_T), the water-filled porosity of the vadose zone soil (Θ_{ws}), the air-filled porosity (Θ_{as}), the water-filled porosity of the capillary fringe (Θ_{wcap}), and the air-filled porosity of the capillary fringe (Θ_{acap}). Assume that the total soil porosity in the capillary fringe is the same as the vadose zone, but with different assumptions for the air-filled fractions and water-filled fractions. In the capillary fringe, the water content is higher than in the remainder of the vadose zone. The capillary fringe is thicker in finer grained soil, with smaller pore sizes than in coarser grained soil. This provides a greater resistance to vapor phase movement.

Calculate the effective diffusion coefficient for the vapor phase chemical from the ground water surface through the capillary fringe and through the vadose zone soil (D_{ws}^{eff}) using Equation F.12, below, which is found in *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equivalent diffusion coefficient (D_{ws}^{eff}) for the resistances in series is given by the harmonic average of the effective diffusion coefficients for the individual layers weighted by their thicknesses.

Equation F.12- Effective Diffusion Coefficient between Ground Water and Bottom of the Basement or Foundation

$$D_{ws}^{eff} = \left(h_{cap} + h_v\right)\left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}}\right]^{-1}$$

D_s^{eff} is the effective diffusion coefficient in the vadose zone soil based on vapor-phase concentration. (See Equation F.6 above.) For the site-specific case, based on the site data, identification of properties of more than one soil layer in the vadose zone may be required. If this is the case, then include the separate contributions from each of the soil layers.

D_{cap}^{eff} is the effective diffusion coefficient through the capillary fringe; calculate it using Equation F.13, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on the semi-empirical model presented by Millington and Quirk.

Equation F.13- Effective Diffusion Coefficient in the Capillary Fringe

$$D_{cap}^{eff} = D^{air} \frac{\Theta_{acap}^{3.33}}{\Theta_T^2} + D^{wat} \frac{1}{H} \frac{\Theta_{wcap}^{3.33}}{\Theta_T^2}$$

Calculate the effective diffusion coefficient through foundation cracks (D_{crack}^{eff}) using Equation F.13 above

Input Parameters

See the Default Parameters Section of this Appendix for the input parameter values used in Equations F.11, F.12, and F.13, above. The parameters L_{GW} and h_v are unique to these equations and can be found below in Equations F.14 and F.15, respectively.

Equation F.14- Depth to Top of Ground Water from the Bottom of Basement or Foundation

$$L_{GW} = \text{(Depth to top of groundwater) - (Depth to bottom of basement)}$$

Equation F.15- Thickness of Vadose Zone below Basement or Foundation

$$h_v = L_{GW} - h_{cap}$$

When calculating the VF_{wesp}, use the following default input parameter values and modify them only with prior approval from BUSTR:

- Aerial fraction of cracks in foundation/walls (η);
- COC-specific input parameter values (H, D^{air}, D^{wat}); and
- Volumetric air content in foundation/wall cracks (Θ_{acrack}) and the volumetric water content in foundation/wall cracks (Θ_{wcrack}).

See Section F.3- Default Parameters of this Appendix for input parameter values for some common COCs. Use any publicly available reference for any COC-specific input parameter value not in this Appendix.

Input Parameters That Might Be Site-Specific

There are four groups of site-specific input parameters that may be modified when calculating the VF_{wesp} during Tier 2:

1. Physical Dimensions of the Building

The length, width, and height of the building must be accurately estimated because the model used to calculate indoor air concentration assumes that concentrations of the COCs are evenly mixed throughout the building. Never assume the height of the building to be more than one story or 8 ft. (243.84 cm). If there is no basement for the building, then assume that the basement height is zero. Additionally, the enclosed space foundation/wall thickness (L_{crack}) may also be modified based on the actual thickness of the basement floor or building slab (if no basement exists). Modifications to the physical dimensions of the building may require a re-calculation of the volume/infiltration area ratio (L_B) and/or **institutional controls (i.e., Environmental Covenant) to ensure that this building configuration is maintained and protective of future land use.**

2. Depth to Ground Water

The depth to the top of the ground water (DTW) and the thickness of the capillary fringe (h_{cap}) are the only physical dimensions required for this volatilization factor. Calculate the depth to top of ground water from bottom of basement (L_{GW}) based on the DTW from the ground surface. Calculate the thickness of the vadose zone (h_v) based on the thickness of the capillary fringe (h_{cap}). If the depth of the bottom of the basement is below the DTW, then use a value of 30.48 cm for L.

3. Characteristics of the Subsurface Soil

Use site-specific characteristics of the subsurface soil in the vadose zone between the top of the source area and the bottom of the basement if sufficient data is collected to demonstrate that these values represent the soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon (F_{oc});
- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as});
- Total soil porosity in the vadose zone (Θ_T);
- Volumetric water content in the capillary fringe (Θ_{wcap}); and
- Volumetric air content in the capillary fringe (Θ_{acap}).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T, any changes to one of these values must be reflected by changes in the other two values.

4. Enclosed Space Air Exchange Rate

A site-specific enclosed space air ER may be substituted for the recommended default parameters. However, the source/assumptions used to derive the ER value must be documented.

F.9 Soil to Ground Water Leaching Pathway

Where a soil source exists above ground water, COCs adsorbed to soil can dissolve in infiltrating water, migrate to ground water, and mix with ground water. There are two potential endpoints for this pathway.

1. The first is based on soil leaching to drinking water, which is calculated using the drinking water action levels (MCLs) as the target concentrations for the COCs in ground water. The GUPUS, or USEPA Region 9 preliminary remediation goals (PRGs), may be used if no drinking water AL exists.

2. The second is based on the action levels or SSTLs calculated for the ground water to indoor air pathway as the target concentration for COCs in ground water.

Tier 1 ALs assume a horizontal dilution factor of 10 for a well located 30 ft. from the center of the source area. The Tier 2 model, however, does not include this dilution factor and assumes the well is located directly in the center of the source area. Therefore, COC concentrations must be modeled to a site-specific point of exposure. If the Tier 2 concentration is less than the Tier 1 concentration, the Tier 1 concentration can be used.

F.9.1 Assumptions

Assume that the thickness of the soil source area varies according to the soil type:

- 6 ft. (182.88 cm) for Class 1 Soil;
- 4 ft. (121.92 cm) for Class 2 Soil; or
- 2 ft. (60.96 cm) for Class 3 Soil.

The depth to ground water is categorized to one of these:

- Less than 15 ft. uses 14 ft. (426.72 cm);
- 15 to 30 ft. uses 15 ft. (457.20 cm);
- 31 to 50 ft. uses 31 ft. (944.88 cm); or
- Greater than 50 ft. uses 50 ft. (1524.0 cm).

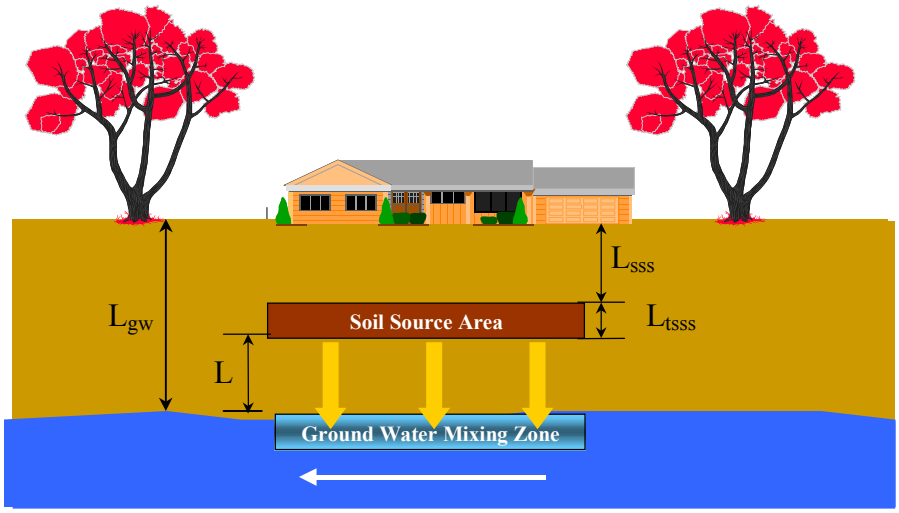
The distance between the bottom of the source area and the top of the ground water is calculated using Equation F.16 below.

Equation F.16- The Distance between the Bottom of the Soil Source and the Top of the Ground Water

$$L = L_{gw} - L_{sss} - L_{tsss}$$

L_{gw} is the depth to ground water, L_{sss} is the depth to the top of the soil source area, and L_{tsss} is the thickness of the soil source area. Where L is less than 1 ft. (30.48 cm), L is set equal to 1 ft. (30.48 cm.) (See Figure F.3- Soil Leaching to Ground Water Assumptions.)

Figure F.3- Soil Leaching to Ground Water Assumptions



F.9.2 Algorithms

The first step in calculating the SSTL for soil leaching COCs to ground water is to calculate the soil leaching to ground water SSTL without degradation. As demonstrated in Equation F.17, below, do this by dividing the applicable action level (MCL for drinking water) or SSTL (ground water to indoor air) by a soil to ground water leaching factor.

Equation F.17- Soil to Ground Water SSTL without Degradation

$$SSTL_{no\ deg} = \frac{AL_W}{LF_{SW}}$$

AL_w is the action level/SSTL for a COC in water, and LF_{sw} is the soil to ground water leaching factor. Specifically, this leaching factor includes both partitioning and mixing; calculate it using Equation F.18, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation F.18- Soil to Ground Water Leaching Factor

$$LF_{SW} = \frac{\rho_s}{\left(\Theta_{ws} + K_d\rho_s + \Theta_{as}H\right)\left(1 + \frac{U_{gw} \times \delta_{gw}}{I \times W}\right)} \times 10^0 \ \frac{cm^3 - kg}{L - g}$$

Determine the degradation of COCs by calculating the time for water to infiltrate through soil from the bottom of the soil source area to the top of the ground water. Then apply that travel time to a first order degradation rate. This process, based on the Green-Ampt model, assumes that infiltration is responsible for the mobilization of hydrocarbons in the vadose zone.

Determine the time needed for the infiltrating water to move from the location of the highest concentration of a COC to the ground water with Equation F.19, which follows below.

Equation F.19- Time for Infiltrating Water to Move from the Source to the Water Table

$$t = \left(\frac{\Theta_{as}}{K_u}\right) \times \left[L - (h - \Psi) \times \left(\ln\left(\frac{h + L - \Psi}{(h - \Psi)}\right)\right)\right] \times \frac{1 \text{ day}}{86400 \text{ seconds}}$$

Calculate the seepage velocity of the ground water using Equation F.20, below.

Equation F.20- Vertical Seepage Velocity of Water

$$V_w = L/t$$

Use Equation F.21, below, to calculate the travel velocity of the COCs in the soil.

Equation F.21- COCs Velocity

$$V_c = \frac{V_w}{\left[1 + \left(\frac{\rho_s \times K_d}{\Theta_t}\right)\right]}$$

Calculate the partitioning coefficient between soil pore water and the soil using Equation F.22, below.

Equation F.22- Partitioning Coefficient between Soil Pore Water and Soil

$$K_d = K_{OC} \times F_{OC}$$

For determining the time required for the COCs to reach the ground water, use Equation F.23, below.

Equation F.23- Travel Time for COCs to Reach Water Table

$$t_c = L/V_c$$

Calculate the ratio of the final COC concentration in the soil pore relative to the original concentration using Equation F.24, below.

Equation F.24- Ratio of Final COCs Concentration in Soil Pore to Original Concentration

$$\frac{C_f}{C_w} = e^{(-kt_c)}$$

Then calculate the SSTL for soil leaching to ground water using Equation F.25, below.

Equation F.25- SSTL for Soil Leaching to Ground Water

$$SSTL = \frac{SSTL_{no\ deg}}{C_f / C_w}$$

F.9.3 Input Parameters

L is the depth to ground water from the bottom of the source. Section F.3, Default Parameters, contains the remaining input parameters for Equations F.17 – F.25, above.

The following default input parameters must be used and may be modified only with prior approval from BUSTR:

- The COC-specific input parameter values (H, K_{oc}); and
- Ground water mixing zone thickness (δ_{gw}).

Input Parameters That Might Be Site-Specific

The following two groups of site-specific input parameters in equations used for developing SSTLs may be modified:

1. Physical Dimensions of the Subsurface Source Area

These parameters include the width of the source area parallel to the ground water flow direction (W) and the depth to ground water from the bottom of the source area (L).

2. Site-specific Characteristics of the Subsurface Soil

Consider site-specific characteristics of the subsurface soil in the vadose zone if sufficient data is collected to show that site-specific values represent the soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon; (Foc),
- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as});
- Total soil porosity in the vadose zone (Θ_T);
- Ground water Darcy velocity (U_{gw});
- Infiltration rate (I);
- Saturated hydraulic conductivity of vadose zone (K_s);

- Unsaturated hydraulic conductivity of vadose zone (K_u); and
- Wetting front suction (Ψ).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T, any changes to one of these values must be reflected by changes in the other two values.

F.10 TPH Action Levels

The action levels for TPH were obtained from Ohio EPA VAP rule OAC 3745-300-08 (B)(3)(a)(ii)(*e*) Table I: *Total Petroleum Hydrocarbon Soil Saturation Concentration*. As stated in the Ohio EPA rule, the TPH concentrations contained in the table "are based on residual soil saturation with additional consideration for the toxicity of the uncharacterized portion of the total petroleum hydrocarbon".

NOTE: The Ohio EPA, DERR VAP TPH values were determined for VAP's industrial land use category. Also, the amount of risk associated with the TPH has not been quantified.

At BUSTR sites, the O/O must determine the proper soil classification and petroleum distillate fraction in order to identify the applicable TPH action level for the release.

The TPH action levels apply to all BUSTR sites during the Tier 1 and Tier 2 Evaluations. The TPH action levels are applicable to both the residential and non-residential land use scenarios, and cannot be re-calculated based on land use, receptor, site-specific data, or other factors during the Tier 1 and Tier 2 Evaluations. Additional evaluation of TPH may be conducted in Tier 3. (See Section 3.12, Tier 3 Evaluation.)

F.11 Outdoor Air Inhalation Pathway

In situations where the indoor air exposure pathway has been eliminated, the outdoor air exposure from subsurface soil or ground water must be evaluated. The direct contact with soil pathway addresses outdoor inhalation of volatiles and particulates from surface soil. Surface soil is considered 0 to 10 ft. for the residential scenario and 0 to 2 ft. for the non-residential scenario. Assume that excavation workers are exposed to the area of highest soil contamination to a default depth of 10 ft.

Calculate an outdoor air concentration that is protective of the receptor for each COC. This outdoor air concentration is the acceptable COC concentration that impacts a receptor that monitors exposure outside of a home or other building. Use this concentration to back-calculate the soil to outdoor air and the ground water to outdoor air SSTLs.

Evaluate this pathway for adult and child residential receptors, adult non-residential receptors, and adult excavation worker receptors.

F.11.1 Assumptions

For the residential receptor, calculate the SSTL for a carcinogenic COC using a combination of adult and child exposures. For the SSTLs for non-carcinogenic COCs, calculate only the child exposure. Assume the non-carcinogen case because the child's body weight value is low and the inhalation rate is equal to the adult value, resulting in more conservative SSTLs. For the

carcinogens, the averaging time spans a lifetime, so assume the receptor spends some of that time as a child and the remainder as an adult, resulting in more conservative SSTLs (when compared to the adult-only calculation).

For the non-residential and excavation worker receptor, calculate the SSTL for carcinogenic and non-carcinogenic COCs by using only the adult non-residential or excavation worker exposure.

F.11.2 Algorithms

Calculate the SSTLs for vapor to outdoor air with Equations F.1, F.2, and F.3, above. (See the Indoor Air Inhalation Section.)

F.11.3 Input Parameters

See the input parameters found Section F.3, Default Parameters.

F.12 Subsurface Soil to Outdoor Air Pathway

Where a contaminant source area exists below an outdoor area, COCs adsorbed to soil can volatilize into the soil pore spaces, travel through the soil, and mix with the ambient air. Evaluate this pathway for adult and child residential receptors, adult non-residential receptors, and adult excavation worker receptors.

F.12.1 Algorithms

Calculate the $SSTL_{soil\text{-}air}$ values for vapor to outdoor air from soil sources by using Equation F.26, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation F.26- Vapor to Outdoor Air from a Soil Source

$$SSTL_{soil\text{-}air} = \frac{SSTL_{air}}{VF} \times 10^{-3} \frac{mg}{ug}$$

F.12.2 Input Parameters

$SSTL_{air}$ is the SSTL for outdoor air inhalation for a COC. (See Equations F.1, F.2, and F.3, above.)

VF (also referenced as $VF_{samb)}$ is the volatilization factor for a COC in subsurface soil migrating to outdoor air. (See Equation F.27, below.)

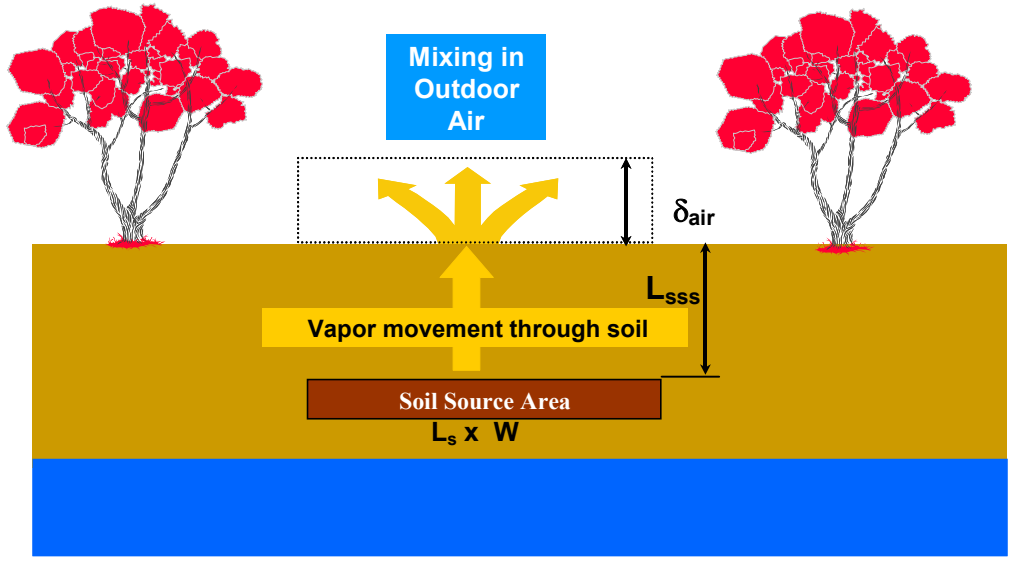
F.12.3 Volatilization Factor for a COC in Subsurface Soil to Outdoor Air (VF_{samb})

The VF for COCs in subsurface soil to outdoor air relates the COC concentration in soil vapor to its concentration in soil, and accounts for diffusion through the soil and mixing with ambient air.

Assumptions

Assume that the receptor is located directly over the soil source area. Vapors are assumed to migrate through the soil and mix with ambient air. Mixing in ambient air occurs in a box with dimensions defined as the length of the source L_{Source} (L_s) area perpendicular to wind direction by the width of source W_{Source} (W) area parallel to wind direction by the height of the mixing zone Delta Air (δ_{air}). (See Figure F.4- Soil to Outdoor Air Dimensions.)

Figure F.4- Soil to Outdoor Air Dimensions



Algorithms

Calculate the volatilization factor (VF_{samb}) for COCs in subsurface soil to outdoor air using Equation F.27, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a model presented by Johnson, Hertz, and Byers.

Equation F.27- Volatilization Factor for COCs in Subsurface Soil to Outdoor Air

$$VF_{samb} = \frac{H\rho_s}{\left[\Theta_{ws} + k_s\rho_s + H\Theta_{as}\right]\left(1 + \frac{U_{air}\delta_{air}L_s}{D_s^{eff}W}\right)} \times 10^3 \frac{cm^3 - kg}{m^3 - g}$$

Input Parameters

Calculating the volatilization factor requires the calculation of an effective diffusion coefficient for the vapor phase chemical in soil (D_s^{eff}). To do this, use Equation F.6, above.

When calculating the VF_{samb}, use the following default input parameters and modify the values for these parameters with prior approval from BUSTR:

- The COC-specific input parameter values (H, K_{oc},etc.); and
- The ambient air mixing zone height (δ_{air}).

See Section F.3, Default Parameters, for specific input parameter values for COCs. If COC-specific input parameter value is not provided, then use another publicly available reference.

Input Parameters That Might Be Site-Specific

The following three groups of site-specific input parameters when calculating the VF_{samb} for purposes of developing the $SSTL_{soil\text{-}air}$ may be modified:

1. Physical Dimensions for the Subsurface Source Area

Two physical dimensions are required for this VF_{samb}: the depth to the top of the subsurface source area (Lsss) and the width of the source area parallel to the wind direction (W_{Source}). If site-specific input parameter values are not determined for these dimensions, use the values in Section F.3, Default Parameters. The required dimensions are shown in Figure F.4- Soil to Outdoor Air Dimensions.

2. Characteristics of the Subsurface Soil

Use site-specific characteristics of the subsurface soil in the vadose zone between the top of the source area and the ground surface if sufficient data is collected to demonstrate that these values represent the soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon (F_{oc});

- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as}); and
- Total soil porosity in the vadose zone (Θ_t).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_t , any changes to one of these values must be reflected by changes in the other two values. If site-specific characteristics for subsurface soil for the site are not determined use the values presented in Section F.3, Default Parameters.

3. Wind Speed above Ground Surface in Ambient Mixing Zone

Use the wind speed (U_{air}) above the ground surface (i.e., in the ambient mixing zone) to determine site-specific information for the site and the surrounding area. If a site-specific U_{air} is not determined, then use a wind speed of 225 cm/sec.

F.13 Ground Water to Outdoor Air Pathway

Where a ground water source area exists below an open area, COCs can volatilize into the soil pore spaces, travel through the soil, and mix with the ambient air. Evaluate this pathway when the ground water to indoor air pathway has been eliminated.

F.13.1 Algorithms

Calculate the $SSTL_{water\text{-}air}$ for vapor to outdoor air from a ground water source using Equation F.28, below, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation F.28- Ground Water Vapors to Outdoor Air

$$SSTL_{water\text{-}air} = \frac{SSTL_{air}}{VF} \text{ x } 10^{-3} \frac{mg}{ug}$$

F.13.2 Input Parameters

$SSTL_{air}$ is the SSTL for outdoor air inhalation for a COC. See Figures F.1, F.2, and F.3, above.

VF (also referenced as VF_{wamb}) is the volatilization factor for a COC in ground water migrating to outdoor air. (See Equation F.29, below.)

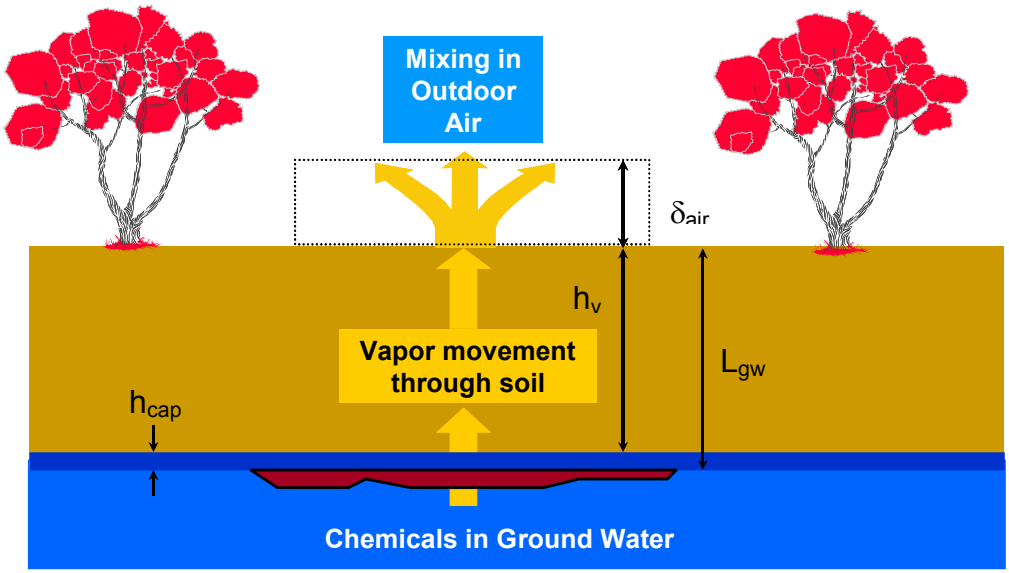
F.13.3 Volatilization Factor for a COC in Ground Water to Outdoor Air

The VF_{wamb} for COCs in ground water to outdoor air relates the COC concentration in ground water to its concentration in soil vapor; this VF describes diffusion through the soil and mixing with ambient air.

Assumptions

Assume that the receptor is located directly over the ground water source area. Also assume that vapors migrate through the soil and mix with ambient air. Mixing in ambient air occurs in a box with dimensions defined as the length of the source area perpendicular to wind direction (L_s) by the width of source (W) area parallel to ground water flow direction by the height of the mixing zone (δ_{air}). (See Figure F.5- Ground Water to Outdoor Air Dimensions.)

Figure F.5- Ground Water to Outdoor Air Dimensions



Algorithms

Calculate the VF_{wamb} for COCs in ground water to outdoor air using Equation F.29, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a model presented in the *Superfund Exposure Assessment Manual*.

Equation F.29- Volatilization Factor for COCs in Ground Water to Outdoor Air

$$VF_{wamb} = \frac{H}{1 + \left[\frac{U_{air}\delta_{air}L_{GW}}{WD_{ws}^{eff}}\right]} \text{ x } 10^3 \frac{L}{m^3}$$

Input Parameters

Calculating the VF_{wamb} requires the calculation of an effective diffusion coefficient for the vapor phase chemical from the ground water surface through the capillary fringe and through the vadose zone soil (D_{ws}^{eff}). This calculation requires an effective diffusion coefficient for the vapor phase

chemical in soil (D_s^{eff}) and the effective diffusion coefficient through the capillary fringe (D_{cap}^{eff}), which is derived as follows:

- The effective diffusion coefficient in soil (D_s^{eff}) uses Equation 6, above;
- The effective diffusion coefficient through the capillary fringe (D_{cap}^{eff}) uses Equation F.13, above; and
- The effective diffusion coefficient for the vapor phase chemicals from the ground water surface through the capillary fringe and through the vadose zone soil (D_{ws}^{eff}) uses Equation F.12, above, with the exception that the term h_v is the thickness of the vadose zone from ground surface, instead of from the bottom of the basement.

Use the following default input parameters when calculating the VF_{wamb}:

- The COC-specific input parameter values (H, D^{air}, D^{wat}); and
- The ambient air mixing zone height (δ_{air}).

See Section F.3, Default Parameters, for COC-specific input parameter values. If a COC-specific input parameter value is not provided, then use another publicly available reference.

Input Parameters That Might Be Site-Specific

The following three groups of site-specific input parameters when calculating the VF_{wamb} may be modified:

1. Physical Dimensions of the Subsurface Source Area

Use only the depth to the top of the ground water source area (L_{gw}), the thickness of the capillary fringe (h_{cap}), and the width of the source area (W) parallel to the ground water flow direction to calculate VF_{wamb}. Calculate the thickness of the vadose zone below the ground surface (h_v) by subtracting the thickness of the capillary fringe. If site-specific input parameter values are not determined, then use the values in Section F.3, Default Parameters.

2. Characteristics of the Subsurface Soil

Use the site-specific characteristics of the subsurface soil in the vadose zone, between the top of the source area and the ground surface, if sufficient data is collected to demonstrate that these values present the soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as});
- Total soil porosity in the vadose zone (Θ_t);
- Volumetric water content in the capillary fringe (Θ_{wcap}); and
- Volumetric air content in the capillary fringe (Θ_{acap}).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T and the sum of the Θ_{wcap} and the Θ_{acap} must equal the Θ_T. Any changes to one of these values must be reflected by changes in the other two values.

3. Wind Speed above Ground Surface in Ambient Mixing Zone

Determine the wind speed (U_{air}) above the ground surface (i.e., in the ambient mixing zone) based on the surrounding area and site-specific information. If a site-specific U_{air} is not determined, then use a wind speed of 225 cm/sec.

F.14 Fate and Transport in Ground water

When considering a migration of COCs in the ground water, use fate and transport modeling to calculate COC concentrations at various distances from the source. During a Tier 2 Evaluation, the O/O must use the BUSTR-Screen model (based on the transport equation developed by P. A. Domenico).

F.14.1 Assumptions

The BUSTR-Screen model is based on the following assumptions:

- One-dimensional ground water flow along the centerline of the plume;
- Steady state source concentration;
- Finite or infinite mass of source;
- First-order decay;
- Uniform and constant aquifer properties; and
- Three-dimensional dispersion within the plume.

F.14.2 Algorithms

Equations F.30 and F.31, below, define the maximum COC concentration allowable in the ground water at the source area ($SSTL_{source\_area}$) for meeting the AL or SSTL at the point of exposure.

Equation F.30- Maximum Concentration at Source Area to Meet SSTL or Action Level at the Point of Exposure

$$SSTL_{source\_area} = \frac{ALpoe}{DAFgw}$$

The *ALpoe* is the action level or SSTL applied at the point of exposure.

The *DAFgw* is the dilution attenuation factor calculated by the Domenico solution.

Equation F.31- Dilution Attenuation Factor

$$DAFgw = EXP\left\{\frac{sPod}{2\times Ldisp}\left[1-\sqrt{1+\left(\frac{4\times \deg rade\_lo\times Ldisp\times Rf}{Vseep}\right)}\right]\right\}\times ERF\left[\frac{GWSource}{4\times\sqrt{Tdisp\times sPod}}\right]\times ERF\left[\frac{GDSource}{2\times\sqrt{Vdisp\times sPod}}\right]$$

Calculate the retardation factor (Rf) with Equation F.32, below.

Equation F.32- Retardation Factor

$$\mathrm{Rf} = 1+\frac{\mathrm{Rhobsat}\times\mathrm{FOCgw}\times\mathrm{Koc}}{\mathrm{PorSat}}$$

Use the Equation F.33, below, to derive the seepage velocity (V_{seep}).

Equation F.33- Seepage Velocity

$$\mathrm{VSeep} = \frac{\mathrm{Kssat}\times\mathrm{Igrad}}{\mathrm{PorSat}}$$

F.14.3 Input Parameters

Table F.7, below, includes the input parameters for equations F.30 through F.33:

Table F.7- Input Parameters

Variable	Description	Units	Value
Koc	Organic carbon partitioning factor	L/kg	Chemical of concern specific
Rhobsat	Soil bulk density in saturated zone	kg/L	Site-specific
Porsat	Total soil porosity in the saturated zone	cm^3/cm^3	Site-specific
F_{oc}sat	Fraction organic carbon in saturated zone	g-oc/g soil	Site-specific
GWSource	Width of source area parallel to ground water flow direction	ft	Site-specific
GDSource	Depth of source area parallel to ground water flow direction	ft	Site-specific
Ldisp	Longitudinal dispersivity	ft	$\mathrm{Ldisp} = 0.1\times\mathrm{sPod}$
Tdisp	Transverse dispersivity	ft	$\mathrm{Tdisp} = 0.33\times\mathrm{Ldisp}$
Vdisp	Vertical dispersivity	ft	$\mathrm{Vdisp} = 0.05\times\mathrm{Ldisp}$
SPod	Saturated zone distance from source area to point of exposure	ft	Site-specific
Vseep	Seepage velocity (See Equation 33)	ft/yr	Site-specific
Degrade_lo	Degradation rate at low end of range	1/yr	Chemical of concern specific
Igrad	Ground water gradient	ft/ft	Site-specific
Kssat	Saturated hydraulic conductivity of saturated zone	ft/yr	Site-specific

NOTE: Some variable names, symbols and units of measurement listed above are not consistent with Appendix G - BUSTR-Screen Ground Water Model, however, the equations produce identical results. Appendix G describes the procedures for conducting ground water fate and transport modeling during Tier 2 Evaluations.

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Appendix G: BUSTR-Screen Ground Water Model

Table of Contents		Page
G.1	Introduction	G-1
G.2	Approach	G-2
G.3	Data Input Worksheets	G-3
G.4	Model Validation	G-7
G.5	Data Presentation & Information Submitted to BUSTR	G-8
G.6	Model Calibration During the Second Phase of Modeling	G-9
G.7	References	G-15

Figures, Tables and Examples		Page
Figure G.1	"BUSTR" Worksheet from BUSTR-Screen	G-13
Figure G.2	"Variable" Worksheet from BUSTR-Screen	G-14
Table G.1	Saturated Zone Soil Types and Default Values	G-12
Table G.2	Chemical-Specific Default Values	G-12
Example G.1	Hydraulic Conductivity Evaluation	G-10
Example G.2	Solute Degradation Rate Evaluation	G-11

G.1 Introduction

BUSTR-Screen is a ground water fate and transport model combining a user interface with Bioscreen, a Microsoft® Excel based modeling program created by the United States Environmental Protection Agency (USEPA) (Newell, McLeod and Gonzales, 1996 and 1997). The purpose of the BUSTR-Screen interface to the Bioscreen model is to simplify the presentation of input parameters and output results for BUSTR corrective action sites.

Bioscreen and BUSTR-Screen are Microsoft® Excel based modeling programs based on Domenico fate and transport equations. The equations and calculations used in the BUSTR-Screen model are identical to those used in the Bioscreen model, version 1.4. Both models predict the amount of natural attenuation of dissolved hydrocarbons in confined or unconfined aquifers. The models are designed to predict only horizontal flow with a constant seepage velocity.

BUSTR requires that BUSTR-Screen be used if ground water fate and transport modeling is performed during the Tier 2 Evaluation process (Ohio Administrative Code (OAC) 1301:7-9-13, effective March 1, 2005). Other ground water models are not allowed during the Tier 2 process.

The information that follows outlines how to use the BUSTR-Screen model for BUSTR corrective action sites. BUSTR-Screen can be downloaded through the BUSTR website at www.com.state.oh.us/sfm/bust.

G.2 Approach

BUSTR Tier 2 corrective actions described in OAC 1301:7-9-13, effective March 1, 2005, allows for the use of fate and transport modeling to predict chemical of concern (COC) concentrations at an assumed point of exposure (POE). Ground water fate and transport modeling may be necessary to predict whether future concentrations of COCs meet action levels or site specific target levels (SSTLs) at a POE. The point(s) of demonstration (POD) located between the source area and POE is then used as a monitoring point to validate the model predictions.

The BUSTR-Screen model is used in a two-phased approach during Tier 2 evaluations, as follows:

- In the first phase, either BUSTR default values or site-specific data are used to predict chemical concentrations at the POD and POE. Field data are then compared to the predicted values. Do not adjust the BUSTR-Screen model to fit the observed field data curve in this first phase of a Tier 2 Evaluation. If the field data exceeds the predicted values, a Remedial Action Plan (RAP), Interim Response Action (IRA), or second phase of Tier 2 modeling may be conducted.
- In the second phase of Tier 2 modeling, the BUSTR-Screen model can be calibrated to fit the actual field data curve by calculating a site-specific biodegradation rate or by adjusting the hydraulic conductivity value. This second phase of modeling must first be proposed to BUSTR when the Tier 2 Evaluation Report is submitted. BUSTR must approve the plan to calibrate the model before this second phase of modeling is performed.

More complex numerical models or other analytical fate and transport models may be used in a Tier 3 Evaluation with prior BUSTR approval. The Tier 3 Evaluation Plan, must include a demonstration of why the proposed model is appropriate for the site conditions.

G.2.1 Limitations

There are some limitations to the use of the BUSTR-Screen Model at BUSTR-regulated sites. The limitations include, but are not limited to, the following:

- The model should not be used to model vertical flow; it is appropriate for simple horizontal flow only;
- The model should not be used with increasing or fluctuating ground water COC concentrations;
- The model is not appropriate for areas with complicated hydrology; conditions where flow boundaries exist or are near the influence of pumping wells (intermittent or constant);
- The model is not appropriate for conditions where ground water velocity changes significantly over the modeled area, where ground water flow direction is not well defined, or in geologic formations where diffusion is the prime mechanism of transport (heavy clays, etc.);
- The model is not appropriate for modeling fractured formations (consolidated or unconsolidated); or
- The model may be used to develop soil and ground water remediation SSTLs. However, after contamination is remediated to SSTL concentrations, additional ground water sampling is required to ensure that subsequent leaching will not cause COC concentrations to exceed SSTLs at the POE.

G.2.2 Default vs. Site-Specific Parameter Values

For different soil types, use the default soil parameter values provided in the BUSTR-Screen model (also see Table G.1 - Saturated Zone Soil Types and Default Values at the end of this Appendix). For different chemicals of concern, use the chemical-specific default values presented in Table G.2 - Chemical-Specific Default Values at the end of this Appendix. Do not use the default soil parameter values from the BUSTR Technical Guidance Manual (April 2005) as they are intended for vadose zone soils. The default values in Table G.1, below are intended only for the BUSTR-Screen model and may not be appropriate for other models. BUSTR recommends collecting site-specific soil and ground water data when using BUSTR-Screen to determine clean-up goals for soil and/or ground water contamination, because using the BUSTR default values may predict overly conservative clean-up goals and result in escalated expenses of remediation.

All site-specific values used in BUSTR-Screen must be from the aquifer matrix being modeled. Accurate values for the BUSTR-Screen input parameters are required. Generating accurate parameter values for modeling may require gathering data from the site in a manner not stated in the OAC or the BUSTR Technical Guidance Manual (such as from fully penetrating wells and sampling of the aquifer matrix).

G.3 Data Input Worksheets

The purpose of the BUSTR-Screen interface to the Bioscreen model is to simplify the presentation of input parameters and output results for BUSTR corrective action sites. To meet this objective, BUSTR has provided two data entry worksheets, identified as the "BUSTR" worksheet and the "Variable" worksheet tabs in Excel (see Figures G.1 and G.2, respectively at the end of this Appendix). Note that these two worksheets are substantially similar to the data input worksheets on all other BUSTR Spreadsheets used for calculating site-specific target levels (SSTLs). **All data must be entered on these two worksheets.** Please note that BUSTR-Screen does not allow data entry on the former Bioscreen worksheets labeled "Input", "Centerline Output", or "Plume Output". If data is inadvertently entered on these three sheets, the model will not run correctly; thus forcing the user to start over with a new, unaltered copy of BUSTR-Screen.

Before entering data onto the data entry worksheets, the environmental professional should review much of the Tier 1 and Tier 2 investigation information to ensure an adequate understanding of the hydrogeologic characteristics of the site and surrounding properties. This review should include soil boring logs, geologic cross-sections, location of migration pathways, potentiometric surface maps, location of hydraulic flow boundaries, seasonal fluctuations of the ground water table, etc.

Data input begins by selecting the appropriate COC from the drop down list located on the "BUSTR" worksheet of BUSTR-Screen. If the COC is not listed, select "Other", and fill in the chemical name, Koc, and half-life values to the right. Values for these parameters may be found in BUSTR's Technical Guidance Manual (Appendix F). Next, select the saturated zone soil type. Soil types correspond to USCS Soil Classifications identified in Table 3.2. After selecting the chemical and the soil classification, BUSTR-Screen automatically generates default values for the appropriate chemical and soil parameters, and inserts those default values on the "Variable" worksheet. These default values may be replaced with site-specific values, if site-specific values have been determined. When site-specific values are used, a reference must be provided listing

the appropriate report and the specific page, table or figure number. A discussion of Chemical & Physical Properties, Soil Parameters, and Site Specific Parameters is presented below in sections G.3.1, G.3.2, and G.3.3, respectively.

G.3.1 Chemical & Physical Properties

Partition Coefficient (Koc): This is the organic carbon-to-water (i.e., soil-to-water) partition coefficient. Large values indicate a high affinity for the contaminant to adhere to the organic carbon fraction of the soil. Use the default value listed in Table G.2 - Chemical-Specific Default Values.

Solute Half-life (t-half): The solute half-life is the time that it takes a petroleum chemical dissolved in the plume to biologically decay to one-half of its original concentration. During the **first phase** of BUSTR-Screen modeling, BUSTR requires use of the default values presented on Table G.2 - Chemical-Specific Default Values. Refer to Appendix F to obtain default values for other COCs not listed on Table G.2. During the **first phase** of modeling, the most conservative value (i.e., the largest t-half value) must be selected. During the **second phase** of modeling, BUSTR allows the use of site-specific solute half-lives (Section G.6 - Model Calibration provides additional information regarding site-specific half-lives).

Ground Water Action Level (AL): This is the maximum contaminant level in a drinking water ingestion exposure scenario (e.g., an unrestricted potable use standard established by the Ohio EPA).

G.3.2 Soil Parameters

Hydraulic Conductivity (K): This is the horizontal hydraulic conductivity of the saturated zone. Slug tests or pump tests are conducted at the site to determine the site-specific hydraulic conductivity. When slug tests or pump tests are performed to estimate horizontal hydraulic conductivity, BUSTR recommends performing at least three tests at different wells in the source area or near the plume's centerline. The highest hydraulic conductivity value must be used in the BUSTR-Screen model during the first phase of modeling. During the second phase of modeling, BUSTR allows the value for hydraulic conductivity to be varied in order to calibrate the model (Refer to Section G.6 - Model Calibration for additional information). When using the default values listed in Table G.1, below, the value corresponding to the most permeable type of soil in the saturated zone should be used, even if that type of soil is not the most predominant at the site.

The potentiometric surface map and geologic cross-sections should be used to select the monitoring wells used for testing. The selected wells must be located in areas that are representative of the aquifer containing the contaminant plume, and the more permeable zones of the aquifer. The selected wells should not be influenced by anomalies (e.g., former tank cavities). A significant portion of the selected wells must penetrate the aquifer being tested.

Also note the following:

- If the contaminant plume is in a bedrock aquifer, pump tests must be performed (slug test results cannot be used).
- Use at least one laboratory test (e.g., American Society for Testing and Materials (ASTM) D2487, ASTM D422) of the most permeable portion of the saturated zone when

determining the Unified Soil Classification System (USCS) Soil Classification type of the aquifer matrix.

- Results from a vertical hydraulic conductivity test (ASTM D5084) or the vertical hydraulic conductivity data presented in Appendix F may not be used with the BUSTR-Screen model.

Porosity (n): This is a ratio of the void space to the bulk volume of the aquifer matrix. Site-specific values may be determined using USEPA-approved laboratory methods for total porosity or calculations derived from geotechnical data (e.g., United States Army Corps of Engineers EM-1110-2-1906). For BUSTR modeling purposes, BUSTR will consider total porosity equal to effective porosity (no adjustment is necessary to convert total porosity to effective porosity). Samples used to obtain site-specific values must be collected from the aquifer matrix. Alternatively, the default values listed in Table G.1, below, may be used. The porosity values listed in Appendix F or values obtained from unsaturated zone soil samples may not be used.

Fraction of Organic Carbon (Foc): This value is the fraction of the aquifer soil matrix that is composed of naturally occurring organic carbon in uncontaminated areas. The Foc value is obtained through laboratory analysis of soil from within the aquifer matrix. Samples should be collected from borings located in uncontaminated areas that are downgradient of the source area and are within the migration pathway of the contaminant plume. Alternatively, the BUSTR default value of 0.001 should be used (ASTM 1995). Normally, two or three soil samples should be analyzed, and the average value should be used in BUSTR-Screen. The BUSTR default values listed in Appendix F are for vadose zone soils and may not be used in the BUSTR-Screen model. BUSTR recommends the Walkley-Black laboratory method to determine the fraction of organic carbon because most soils in the aquifer matrix contain less than 1% organic carbon. If a percentage of **organic matter** is obtained through laboratory analysis (such as ASTM-D2974), the **organic matter** value must be multiplied by a conversion factor of 0.58 to estimate a value for **organic carbon**.

Soil Bulk Density (ρ): This value is the bulk density of soil within the aquifer matrix and may be different than bulk densities obtained from above the saturated zone. Obtain soil bulk density from geotechnical analysis of soil within the aquifer matrix or by using the BUSTR default value (Table G.1 - Saturated Zone Soil Types and Default Values) based on the most permeable soil type encountered within the saturated zone. If a site-specific value is used in the model, samples from the aquifer matrix in the assumed migration pathway must be used.

G.3.3 Site-Specific Parameters

BUSTR has not determined default values for many of the site-specific parameters listed below (source thickness and soluble mass are the exceptions). Therefore, site-specific values must be developed by the BUSTR-Screen user, and the values developed must then be entered on the "Variable" worksheet.

Hydraulic Gradient (i): Hydraulic gradient is the slope of the potentiometric surface. Calculate the hydraulic gradient by constructing potentiometric surface maps using static water level data from ground water monitoring wells. Hydraulic gradients should be calculated for several sampling events (typically four quarters) due to the possibility of fluctuating ground water flow. The USEPA's hydraulic flow calculator may be used to estimate hydraulic gradients (www.epa.gov/ATHENS/learn2model/part-two/onsite/index.html).

Estimated Plume Length (Lp): The distance used for the plume length (Lp) is the downgradient distance from the source area (i.e., area of highest concentration) to the point where the ground water concentration equals the BUSTR action level for the ground water ingestion pathway (e.g., 0.005 mg/L for benzene). Estimate Lp from field data and justify the result.

Retardation Factor (R): The retardation factor is the ratio of the ground water seepage velocity to the rate that organic chemicals migrate in the ground water. BUSTR-Screen calculates the retardation factor automatically using the values provided for soil bulk density, partition coefficient and fraction of organic carbon. BUSTR allows the use of retardation factors for all COCs, including methyl tertiary-butyl ether (MTBE).

Modeled Area Length: Normally, this value is the distance from the source area to the POE. However, BUSTR may require that shorter distances be modeled if modeling to the POD. Note that BUSTR-Screen uses the value entered as the modeled area length (e.g., 300 ft.), and automatically calculates 10 evenly-spaced downgradient distances from the source area, and then inserts those 10 values in the "Field Data for Comparison" section of the BUSTR-Screen "Variable" worksheet. These calculated distances are also automatically added to "Section 7 – Field Data for Comparison" on the "Input" worksheet and the "Centerline Output" worksheet.

Modeled Area Width: This value must equal or exceed the width of the contaminant plume. Generally, allowing a modeled area width that is twice as wide as the plume width is acceptable.

Simulation Time: If the soluble mass parameter of the BUSTR-Screen model is entered as "infinite", increase the simulation time until the contaminant concentration at the point of exposure reaches steady state conditions. If the soluble mass parameter is entered as a finite value, adjust the simulation time so that the COC concentration at the POE is equal to its maximum value. Time steps may be viewed and printed from the "Centerline Output" worksheet by depressing the "Calculate Animation" button.

Source Thickness in Saturated Zone: This value is the depth of contamination in the saturated zone within the source area. Use either site-specific data or the BUSTR default value of 10 ft. Site-specific data is gathered by obtaining samples from wells within the source area that are screened at different depths (i.e., nested wells or other approved techniques) or by determining the amount of water table fluctuation (i.e., the smear zone). For most petroleum release sites, a value of 10 ft. is sufficiently accurate. If dense chemicals (e.g., chlorinated compounds) are present or if significant precipitation infiltration causes COCs to be forced downward into the aquifer, then the 10 ft. thickness may not be appropriate and site-specific data should be used.

Source Zones (width and concentration): The source zones and the associated widths are graphically presented in "Section 6 – Source Data" on the "Input" worksheet of BUSTR-Screen. The source zones are identified as "Center", "Middle", and "Outer". Enter a minimum of two source zone widths with their respective COC concentrations. Use the highest COC concentrations and their associated zone widths for the center zone and the middle zone. If the source is wide and sufficient data exists, also input a COC concentration and width for the outer zone. These concentrations and their associated width distances represent the source zone perpendicular to the centerline of the plume and ground water flow direction. Adequate characterization of the source area may require the installation of additional soil borings and monitoring wells perpendicular to the plume centerline for input into BUSTR-Screen. Additional information concerning the insertion of source zone concentrations is available in the Bioscreen User's Manual (Newell, McLeod and Gonzales, 1996 and 1997).

Source Half-life (Soluble Mass): The soluble mass is the quantity of the COC available to mix with ground water moving through the aquifer matrix. For BUSTR Tier 2 modeling purposes, an infinite soluble mass in the source area should normally be used. However, a finite soluble mass may be used under certain circumstances. For example, if a known quantity of petroleum product was released from the underground storage tank (UST) system, or if the quantity of total soluble mass can be accurately estimated, then a finite soluble mass may be used. The value calculated for finite soluble mass must include all soluble components of the petroleum product. Generally, calculating a value for finite soluble mass will require a significant number of soil samples (vadose zone and saturated zone) and ground water samples, in order to accurately characterize the distribution of petroleum hydrocarbon constituents at the site and to estimate the total mass of soluble petroleum hydrocarbon.

G.3.4 Field Data for Comparison

Site-specific data must be collected in the source area and along the plume centerline, and the concentrations must then be entered on the "Variable" worksheet.

Enter the values of concentration using site-specific data from monitoring wells in order to compare the field data to the values predicted by BUSTR-Screen. Obtain the COC concentration data from monitoring wells within the source area and from wells located near the centerline of the plume. The concentrations entered must be from the same sampling event and from sampling points that show stable to decreasing COC concentrations over time. Also, recall that the distances from the source were calculated by BUSTR-Screen based on the value entered for modeled area length. Thus, the actual locations of the monitoring wells may not exactly match the distances from the source as listed on the "Variable" worksheet.

Increasing or unstable COC concentrations are indications that the BUSTR-Screen model is not appropriate for the site. Due to the temporal variability of COC concentrations at petroleum release sites, **a graph of "concentrations vs. time" must be provided for all wells in the source area and for wells along the plume centerline**. These graphs should provide evidence that the COC concentrations are decreasing or stable, and that the values predicted by BUSTR-Screen are conservative when compared to actual site data.

During the first phase of modeling in a Tier 2 Evaluation, do not adjust the COC concentrations predicted by BUSTR-Screen to fit the observed field data curve. Calibration of the BUSTR-Screen model to actual site data is only allowed in the second phase of modeling during a Tier 2 Evaluation (See Section G.6 – Model Calibration for additional information.).

G.4 Model Validation

For BUSTR-Screen modeling performed during a Tier 2 Evaluation at BUSTR sites, model validation refers to how the predicted COC values compare to the actual field data.

Monitoring of actual contaminant concentrations at the site is required to validate the predictions made by the BUSTR-Screen model. The sampling point(s) used to validate the model is defined as the point of demonstration (POD.) The location of the POD is described in OAC 1301:7-9-13 (O)(2), effective March 1, 2005. The POD must be located on the contaminant plume centerline (i.e., the line connecting the source area with the point of exposure (POE)). The model must predict a detectable concentration of the COC at the POD (if the model predicts a value of zero, that point may not be used for the POD). Also, the monitoring well located at the POD must have

a detectable concentration of the COC in order to verify that the POD evaluation point is in the contaminant migration pathway. The POD is then monitored to evaluate the model predictions. In some cases, it may be necessary to install more than one POD monitoring well. The time required for ground water monitoring depends on the length of time that the model predicts will transpire until the concentration at the POD reaches the predicted value. If BUSTR-Screen predicts that it takes a certain number of years for contamination to move from the source area to the POD, the POD must be monitored for that number of years to validate the model assumptions. For example, if the BUSTR-Screen model predicts a benzene concentration of 20 micrograms per liter (ug/L) at the POD in 2 years, the POD must be monitored for 2 years. After 2 years of monitoring, if the benzene concentration at the POD exceeds the predicted value of 20 ug/L, the model predictions are not valid.

OAC 1301:7-9-13 (O)(1), effective March 1, 2005 requires that a monitoring plan (to verify the fate and transport model assumptions and predictions) be submitted for approval by BUSTR, and that the plan include the anticipated length and frequency of the monitoring activities (See Section 3.14 -Monitoring Plan). The length and frequency of ground water monitoring must be selected based on the COC concentrations, ground water seepage velocity, location of the POD, and other site-specific factors. BUSTR may approve quarterly, bi-annual or annual monitoring, depending on the nature and migration of the contaminant plume, and on the locations of the POD and POE. If bi-annual or annual monitoring is approved, samples must be collected at approximately the same time each year to account for fluctuations within the aquifer. All validation monitoring plans must be pre-approved by BUSTR.

In certain cases, historical data may be used to validate the BUSTR-Screen model predictions. For example, if 5 years of ground water monitoring has already been performed at the source area and POD locations, then BUSTR may allow the use of the existing data to validate the BUSTR-Screen predictions. To do this, the initial sampling events are used to predict the concentrations in subsequent years. However, historical data cannot be used to validate the model if an active remediation system was in operation during the historical period. BUSTR will consider the use of historical data to validate modeling on a case-by-case basis.

G.5 Data Presentation & Information Submitted to BUSTR

Generally, all BUSTR-Screen modeling work will be submitted with the Tier 2 Evaluation Report (or as a separate report if model calibration work has also been performed). Summarize the BUSTR-Screen modeling work with the following information:

- Printouts of all of the BUSTR-Screen worksheets used in the modeling effort. This must include the "BUSTR", "Variable", "Input", "Centerline Output" and "Plume Output" worksheets for all COCs being evaluated;
- Site maps showing the source area, plume length, plume width, ground water flow direction, monitoring well locations, potentiometric surface, centerline from the source area to the POD and to the POE, and other pertinent features. Geologic cross-sections should also be submitted;
- Summary of findings, conclusions, and recommendations;
- Discussion of final model outputs;
- Determination of the time (years) to reach "steady state";
- Sources of error and uncertainty, including a qualitative sensitivity analysis;
- Tables of all data used in verifying the model including any calculations, laboratory results, geotechnical data, etc; and

- Graphics of "concentration vs. time" for all monitoring wells in the source area and along the plume centerline

G.6 Model Calibration during the Second Phase of Modeling

BUSTR only allows the BUSTR-Screen user to calibrate the model during the second phase of the Tier 2 modeling effort. Model Calibration should only be performed if the work completed in the first phase of modeling indicates that the COC concentration at the POE will exceed the drinking water standard. This second phase of modeling must first be proposed to BUSTR as part of the Tier 2 Evaluation Report. BUSTR must approve the plan to calibrate the model before this second phase of modeling is performed. During this second phase, the BUSTR-Screen user attempts to calibrate the model by manipulating the hydraulic conductivity parameter (K) and/or the solute half-life (t-half) so that the COC concentrations predicted by the model approximate the actual field concentrations at the source and POD wells.

The Calibration Plan must include, but is not limited to the following:

- A detailed description of the proposed activity;
- Identification of monitoring wells to be used for calibration;
- Description of data sets used for half-life (t-half) and/or COC degradation rate (k) calculations;
- Description of data sets used for hydraulic conductivity (K) calculations;
- Monitoring plan activities (see Section 3.14);
- Estimated time of completion; and
- Completion report contents.

G.6.1 Calibration using Hydraulic Conductivity Estimates

During calibration, the environmental professional may manipulate the value of **hydraulic conductivity** (K) based on the slug test data collected at the site. Slug tests should be performed on at least three different wells located in the source area and along (or near) the plume centerline, and must be representative of the aquifer matrix associated with the contaminant plume. To determine the allowable values for hydraulic conductivity (K) that may be used during model calibration, two ranges must be determined.

- First, use the results from the slug tests and determine the range of (K) values bounded by the maximum and minimum values of (K).
- Second, calculate the geometric mean of (K) using the results of the slug tests, and then determine a range of (K) values bounded by the limits of the mean plus or minus one order of magnitude.

The allowable values of (K) that may be used to calibrate BUSTR-Screen are all values included in both hydraulic conductivity ranges (i.e., the values common to both ranges). Example G.1 – Hydraulic Conductivity Evaluation, provides an example of the hydraulic conductivity evaluation described above.

Example G.1 – Hydraulic Conductivity Evaluation

	Hydraulic Conductivity (K) (cm/sec)	Hydraulic Conductivity (log K)
SLUG TEST DATA		
MW-1	1.11×10^{-4}	- 3.95
MW-2	1.81×10^{-4}	- 3.74
MW-3	4.69×10^{-4}	- 3.33
MW-4	2.05×10^{-3}	- 2.69
CALCULATIONS and COMPARISON OF RANGES		
Maximum	2.05×10^{-3}	- 2.69
Minimum	1.11×10^{-4}	- 3.95
Geometric Mean	3.73×10^{-4}	Not Applicable
Arithmetic Mean	Not Applicable	- 3.43
Mean plus 1 Order of Magnitude	3.73×10^{-3}	- 2.43
Mean minus 1 Order of Magnitude	3.73×10^{-5}	- 4.43
Allowable Site-Specific Range	1.11×10^{-4} to 2.05×10^{-3}	-3.95 to -2.69

NOTE – In this example, the allowable values of hydraulic conductivity for calibrating the BUSTR-Screen model range between 1.11×10^{-4} cm/sec and 2.05×10^{-3} cm/sec (because this is the range of values intersected by the two hydraulic conductivity ranges described in Section G.6.1 – Calibration using Hydraulic Conductivity Estimates).

G.6.2 Calibration using Solute Half-life Estimates

During calibration, the environmental professional may manipulate the value of the **solute half-life** (t-half) based on site-specific data. BUSTR's approach is based on information presented in:

- "Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites (ASTM, 1998)
- "Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies (USEPA, 2002) (www.epa.gov/ada/download/issue/540S02500.pdf).

The following three steps outline the procedures for calculating a solute half-life (t-half):

Step 1:

The environmental professional must demonstrate that the contaminant plume is stable or shrinking. In order to demonstrate this, BUSTR requires that the environmental professional prepare a graphic plot of **concentration-vs.-distance** for all chemicals that exceed action level concentrations. At least three monitoring wells must be included in the concentration-vs.-distance approach, with one of the wells located in the source area and at least two wells located along the centerline of the COC plume. Several plots should be prepared, and they should include the concentration-vs.-distance data for at least three different sampling events that represent several years of plume evolution.

Step 2:

The solute half-life (t-half) must be estimated based on the **concentration-vs.-time** approach described in the two documents referenced above. The concentration-vs.-time regression analysis is based on the first-order decay equation $\{C_{(t)} = C_i\ e^{-(kt)}\}$, and is used to estimate the solute degradation rate (k). The concentration-vs.-time regression analysis must be based on the following:

- At least three monitoring wells must be evaluated;
- All monitoring wells must be located near the centerline of the COC plume, but the wells cannot be located in the source area;
- At least six sampling dates must be used, covering a span of at least three years;
- The evaluations and calculations described above should be performed with an understanding that seasonal variability, changing ground water flow directions, changing hydraulic gradients, soil heterogeneity, and other issues may impact the results of the fate and transport model;
- Although not required, the concentration-vs.-time regression calculations may include a "goodness of fit" statistical calculation using the coefficient of determination (R^2); and
- Although not required, a quantitative sensitivity analysis may be performed using the BUSTR-Screen model for the hydraulic conductivity and solute degradation rate parameters. BUSTR recommends using the two-tailed 80% confidence intervals for these two parameters.

Step 3:

Because the regression analyses described in Step 2 above will provide estimates of the solute degradation rate (k), the environmental professional must convert those values to estimates of the solute half-life (t-half) using the following equation : (t-half) = 0.693 / (k). Convert all values of (k) to (t-half), and determine the range of (t-half) values bounded by the maximum and minimum values of (t-half). The allowable values of (t-half) that may be used to calibrate BUSTR-Screen are all values within the range. Example G.2, below, provides an example of the solute degradation rate.

Example G.2 – Solute Degradation Rate Evaluation

	Benzene Degradation Rate *(k) (per year)	Benzene Half-life (t-half) (years)
SITE-SPECIFIC VALUES		
MW-1	0.257	2.7
MW-2	0.347	2.0
MW-3	0.408	1.7
MW-4	0.495	1.4
Allowable Site-Specific Ranges	0.257 to 0.495	1.4 to 2.7

*NOTE: Based on concentration-vs.-time regression analyses.

G.6.3 Reporting of Model Calibration Activities

Prepare a summary report describing the activities performed to calibrate the BUSTR-Screen model. The report should include the following items:

- All pertinent information listed in Section G.5 -Data Presentation & Information Submitted to BUSTR;
- A summary of the data and calculations performed in conjunction with Section G.6.1 - Calibration using Hydraulic Conductivity Estimates;
- A summary of the data, calculations and graphic plots developed in conjunction with Section G.6.2 -Calibration using Solute Half-life Estimates; and
- A Monitoring Plan, prepared in accordance Section 3.14 to verify the fate and transport assumptions and predictions of the calibration procedures.

Table G.1 - Saturated Zone Soil Types and Default Values

Saturated Zone Soil Type	Soil Classification Symbol	Horizontal Hydraulic Conductivity (cm/sec)	*Porosity* (cm^3/cm^3)	Fraction of Organic Carbon in Saturated Zone (g/g)	Bulk Density (kg/L)
Clay	MH, CH, OH	1 x 10e-5	0.20	0.001	1.8
Silt	ML, CL, OL	1 x 10e-3	0.30	0.001	1.7
Silty Sand	SM, SC	1 x 10e-1	0.30	0.001	1.6
Clean Sand	SW, SP	1	0.30	0.001	1.5
Gravel	GW, GP, GM, GC	10	0.35	0.001	1.4

Note - BUSTR default values shall be used when site-specific values are unknown.

Table G.2 – Chemical-Specific Default Values

Chemical of Concern	Partition Coefficient (L/kg)	Phase 1 Modeling – Default Solute Half-Life (years)
Benzene	61.7	1.97
Toluene	140	0.08
Ethyl benzene	204	0.62
Xylene	129	1.0
Methyl tertiary-butyl ether (MTBE)	6.0	1,000

Note - For chemicals of concern not listed in the above table please reference the BUSTR Technical Guidance Manual, Appendix F, Table F.5.
Note – During Phase 1 Modeling, a solute half-life of 1,000 years must be used for MTBE to simulate "no degradation". Site-specific values may be used during Phase 2 Modeling.

Figure G.1 - "BUSTR" Worksheet from BUSTR-Screen

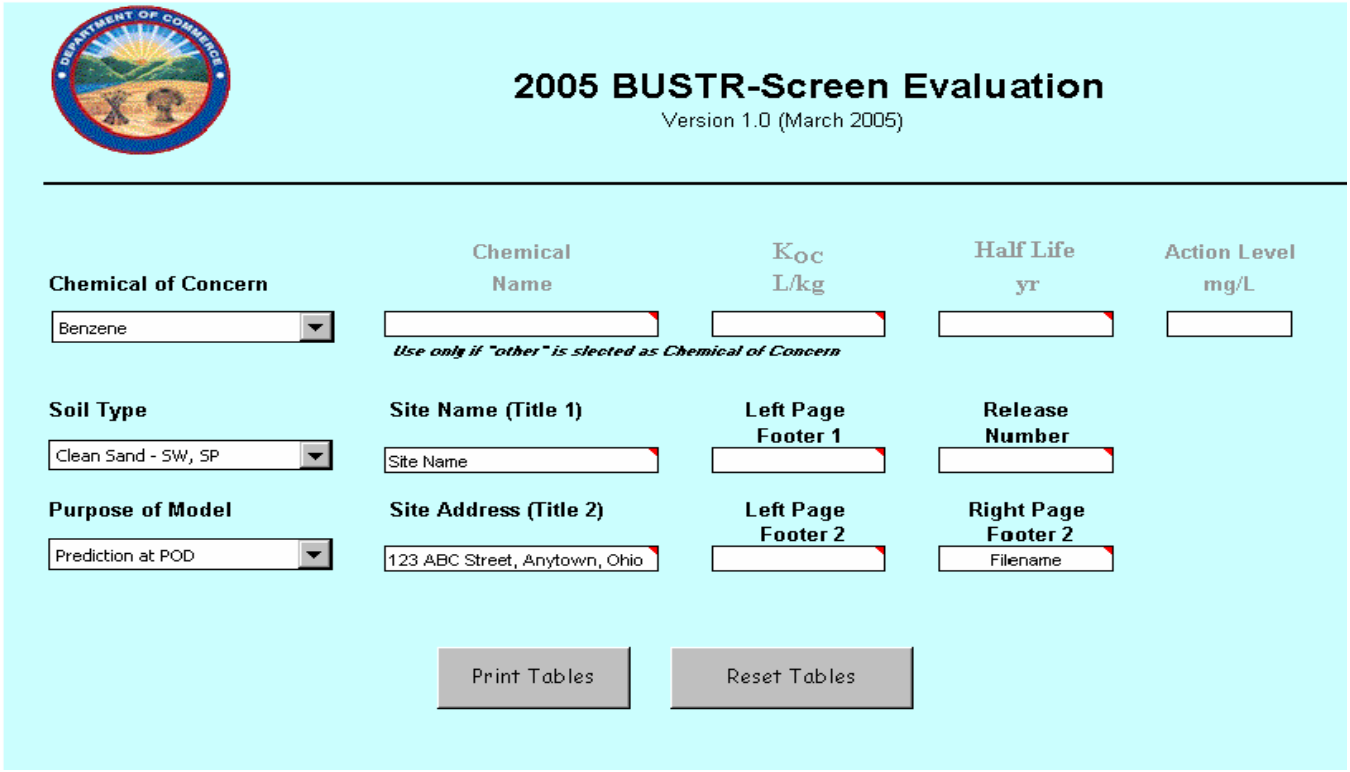

Figure G.2 - “Variable” Worksheet from BUSTR-Screen

Description	Source / Default	Symbol	Value	Units	Reference[1]
Chemical and Physical Properties for Benzene					
Partion Coefficient	Default	K_{oc}	61.7	L/kg	
Solute Half-Life	Default	t-half	1.97	year	
Groundwater Action Level	Default	AL	0.005	mg/L	
Soil Parameters for Clean Sand - SW, SP					
Hydraulic Conductivity	Default	K	1.00E+00	cm/sec	
Porosity	Default	n	0.3	unitless	
Fraction of Organic Carbon	Default	foc	0.001	unitless	
Soil Bulk Density	Default	rho	1.5	kg/L	
Site Specific Parameters					
Hydraulic Gradient	Site Specific	i		unitless	
Estimated Plume Length	Site Specific	Lp		feet	
Retardation Factor	Default	R	1.3	unitless	
Modeled Area Length	Site Specific	-		feet	
Modeled Area Width (must exceed total plume	Site Specific	-		feet	
Simulation Time	Model Specific	-		year	
Source Thickness in Saturated Zone	Default	-	10	feet	
Source Center: Width	Site Specific	-		feet	
Source Center: Concentration	Site Specific	-		mg/L	
Source Middle: Width	Site Specific	-		feet	
Source Middle: Concentration	Site Specific	-		mg/L	
Source Outer: Width	Site Specific	-		feet	
Source Outer: Concentration	Site Specific	-		mg/L	
Soluble Mass	Default	-	Infinite	kg	
Field Data for Comparison					
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	
Concentration at 0 feet from source	Site Specific	-		mg/L	

G.7 References

American Society for Testing and Materials (ASTM), 1995, *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739-95, Philadelphia, PA.

American Society for Testing and Materials (ASTM), 1998, *Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites*, ASTM E1943-98, Philadelphia, PA.

Newell, C.J., R.K. McLeod and J.R. Gonzales, 1996. *Bioscreen Natural Attenuation Decision Support System*, Users Manual Version 1.3, National Risk Management Research Laboratory, Office of Research and Development, USEPA, Cincinnati, OH.

Newell, C.J., R.K. McLeod and J.R. Gonzales, 1997. *Bioscreen Natural Attenuation Decision Support System*, Version 1.4, July 1997, Version 1.4 Revisions. National Risk Management Research Laboratory, Office of Research and Development, USEPA, Cincinnati, OH.

USEPA, 2002. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies* by Newell, C.J., H.S. Rifai, J.T. Wilson, J.A. Conner, J.A. Aziz, and M.P. Suarez. (EPA/540/S-02/500, November 2002)