# Investigation of Underground Storage Tank Releases

*Office of Land Quality*
*Remediation Services, Compliance and Response Branches*

# Quality Assurance Program Plan

B-001-OLQ-R-XX-09-Q-R0

MARCH 24, 2009

**Office:** Office of Land Quality (OLQ)

**Branch:** Remediation Services Branch and Compliance and Response Branch

**Sections:** Underground Storage Tank Section, Leaking Underground Storage Tank Section, Excess Liability Program Technical Section

**Effective date:** Upon Environmental Protection Agency (EPA) Approval

**Date revised:** N/A

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**Review cycle:** Five Years

**QAPP Summary:**

This Quality Assurance Program Plan (QAPP) outlines the requirements for administering the leaking underground storage tank (UST) program through the OLQ Remediation Services and Compliance and Response Branches. Specifically, this QAPP provides guidance for the collection of data used to support investigation, monitoring, and corrective action activities associated with the release of petroleum and hazardous substances from regulated USTs. The program activities are supported by U.S. Environmental Protection Agency (EPA) Region 5 through a Cooperative Agreement with the Indiana Department of Environmental Management (IDEM).

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# Introduction

The following Quality Assurance Program Plan (QAPP) has been prepared by the Office of Land Quality (OLQ) in an effort to facilitate the Underground Storage Tank (UST) Program conducted by OLQ, based on the Indiana Department of Environmental Management (IDEM) and U.S. Environmental Protection Agency (EPA) Region 5 requirements.

This document provides instruction for the preparation, review, approval and implementation of technical and quality aspects of leaking UST environmental investigations prepared for IDEM by external contractors and IDEM staff, primarily by referencing existing program documentation. This document in no manner addresses all required information for all types of investigative activities.

The U.S. EPA, through CIO 2105.0 May 5, 2000 reaffirms and establishes requirements for the Agency's mandatory Quality System. Because UST Program activities include environmentally related measurements or data generation, the IDEM is required by EPA regulations (40 CFR Part 31.45) to develop and implement a quality assurance system. This resulting QAPP for the IDEM's UST Program has been developed pursuant to:

- *EPA Requirements for Quality Assurance Project Plans (QAPPs)* (QA/R-5), EPA/240/B-01/003, March 2001 (Reissued May 2006);
- *Guidance for QAPPs,* (G-5), EPA/240/R-02/009, December 2002;
- *IDEM Agency-Wide Quality Management Plan*, IDEM, 2007*;*
- *Office of Land Quality Remediation Services Branch Quality Management Plan*, IDEM 2007;
- *Policy, Standard Operating Procedure (SOP), and Quality Assurance Project Plan (QAPP) Documentation Policy,* IDEM A-050-OEA-07-P-R0, Feb. 2007;
- *QAPP Development and Approval SOP*, IDEM A-006-OEA-06-S-R0, June 2006

# A. Project Management

## A.1. Title and Approval Sheet

See cover page.

## A.2. Table of Contents

See table of contents.

## A.3. Distribution List

Each role listed below will either receive a copy of the approved QAPP, or be notified of how to obtain an electronic copy. The approved document will be made available via IDEM's Extranet, and also be available via a link on IDEM's Leaking Underground Storage Tank web site.

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The approved document will be posted on IDEM's OLQ web site.

## A.4. Project/Task Organization

### A.4.1. UST Program Structure

IDEM is the State agency authorized to manage environmental issues and conditions in the State of Indiana. The State of Indiana applied for approval of the underground storage tank (UST) program under Subtitle I of the Resource Conservation and Recovery Act (RCRA); this approval was granted by the EPA effective August 11, 2006 authorizing IDEM to operate the UST Program in the State in lieu of the Federal UST program.

Within IDEM's Office of Land Quality (OLQ), there are three sections that are involved with the regulation of UST systems. These sections are:

- The Underground Storage Tank Section
- The Leaking Underground Storage Tank (LUST) Section
- The Excess Liability Trust Fund (ELTF) Technical Section

This *Investigation of UST Releases QAPP* only covers the activities that involve the collection and analysis of environmental data for the UST Program in support of suspected and confirmed releases of petroleum and hazardous substances from regulated USTs. Therefore, although the UST Section is also responsible for compliance inspections of UST facilities, and the OLQ Operations and Finance section is responsible for review and payment of ELTF-eligible financial claims, these activities are not described within this document.

There is some overlap in section duties as they pertain to the suspected and confirmed releases from USTs – particularly between the LUST and ELTF Technical Sections. Each of these sections includes a Section Chief (SC), one or more senior environmental manager(s) (SEMs), and project managers (PMs). The assignment of individual sites to PMs in either section is dependent upon factors such as eligibility for reimbursement under ELTF, site priority, and workload. The LUST Program is managed by the LUST and ELTF Technical Sections.

In Indiana, environmental data collection in support of the investigation of UST releases is usually documented by and submitted to the IDEM by consulting firms hired by the owner/operators of the site. Data collection requirements are laid out in the applicable UST/LUST program guidance and this *Investigation of UST Releases QAPP*. The principal data users are the LUST and ELTF Section Chiefs (SC); Project Managers (PM); site consultants; technical evaluation staff (chemist, geologist, risk assessor, data manager, and/or engineer); and the EPA.

An organizational chart for the UST Program is provided in Figure 1, and the roles and responsibilities as they pertain to this QAPP and releases from USTs are described in the narrative below.

### A.4.2. UST Program Roles and Responsibilities

*IDEM OLQ Compliance Branch Roles and Responsibilities*

- **OLQ Compliance Branch Chief:**
  - Assigns staff to review the *Investigation of UST Releases QAPP;*
  - Ensures staff compliance with this QAPP, SOPs, and policies.
- **UST Section Chief (SC):**
  - Responsible for approving and implementing the *Investigation of UST Releases QAPP*;

- Assigns UST Program inspector caseload;
- Coordinates UST Program requirements with LUST and ELTF SCs, and the EPA.

- **UST Inspectors:**
  - Inspect UST closure activities;
  - Evaluate *UST Closure Reports;*
  - Notify the LUST Section when confirmed UST releases have been noted during inspection duties;
  - Evaluate owner/operator compliance with UST Program rules and regulations.

- **Emergency Response:**
  - Receives notification of suspected and confirmed releases with emergency conditions as well as release reports after hours and on weekends*;*
  - Mitigates emergency conditions due to spills and overfills, when they are present;
  - Completes Incident Response Report in ULCERS database.

*IDEM OLQ Remediation Service Branch Roles and Responsibilities*

- **OLQ Remediation Service Branch (RSB) Chief:**
  - Assigns staff to develop and review the *Investigation of UST Releases QAPP;*
  - Ensures staff compliance with this QAPP, SOPs, and policies;
  - Approves the *Investigation of UST Releases QAPP*.

- **LUST and ELTF Technical Section Chiefs (SC):**
  - Responsible for approving, maintaining, and implementing the *Investigation of UST Releases QAPP*;
  - Serves as the primary interface with the EPA for program reporting (LUST SC);
  - Assign PM caseload (ELTF Technical Section);
  - Approve site closure documentation, typically in the form of 'No Further Action' letters.

- **Senior Environmental Managers**
  - Assigns PM caseload (LUST Section).

- **Project Managers (PM):**
  - Responsible for compliance with the *Investigation of UST Releases QAPP*;
  - Performs project management duties for all assigned sites;
  - Evaluates owner/operator compliance with UST Program rules and regulations;
  - Coordinates the OLQ technical evaluation team;
  - Approves UST Program site documentation;
  - Writes IDEM site correspondence;
  - Conducts or arranges for field work oversight;
  - Collects and/or splits samples with owner/operator consultants;
  - Manages contracts at sites where the owner/operator or other responsible party is unable or unwilling to comply with regulations;
  - Receives notification of suspected and confirmed releases during office hours;
  - Along with administrative assistants, maintains site-specific records and updates IDEM's UST/LUST/ELTF databases.

*IDEM OLQ Science Service Branch Roles and Responsibilities*

The following roles provide independent technical evaluation services for the UST Program:

- **OLQ Science Service Branch (SSB) Chief:**
  - Assigns staff to review the *Investigation of UST Releases QAPP;*
  - Ensures staff compliance with QAPPs, SOPs, and policies.

- **Chemistry, Geological Services, Engineering, and Risk Services SCs**:

- Assign technical reviewer caseload*;*
- Approve technical reviewer memorandums and reports.

- **Chemists:**
  - Provide an independent review, verification, and validation of data generated for the UST Program*;*
  - Evaluate project goals, analytical methods, data reviews and data acceptability on the basis of analytical data results, laboratory Quality Assurance/Quality Control (QA/QC), sampling reports, audits, and procedures;
  - Review Quality Assurance Project/Program Plans (QAPPs);
  - Provide support as required for sampling plan development and oversight of field sample collection.

- **Geologists and Engineers:**
  - Provide technical support as required including report review, evaluation of proposed remedial activities, and appropriateness of land use controls*;*
  - Provide support as required for sampling plan development and oversight of field sample collection.

- **Risk Evaluators:**
  - Provide technical support and expertise for LUST sites seeking closure through IDEM's Risk Integrated System of Closure (RISC).

- **Geographic Information System (GIS)/Data Support Personnel:**
  - Provide technical support as required including geographic positioning system (GPS) data, GIS mapping, and electronic data submission and storage.

*IDEM Quality Assurance Roles and Responsibilities*

- **IDEM Agency Quality Assurance (QA) Manager(s);**
  - Review and evaluate the *Investigation of UST Releases QAPP* for conformance with the *QAPP Development and Approval SOP*, EPA and IDEM QAPP Checklists, and other quality management system requirements;
  - Responsible for the implementation and maintenance of the IDEM quality management system, as described in the EPA approved *IDEM Agency-Wide Quality Management Plan.*

- **SSB Quality Assurance (QA) Coordinator:**
  - Provides the independent reviewer role for program and project QAPPs, including the *Investigation of UST Releases QAPP;*
  - Performs contract laboratory performance and system audits;
  - Participates in QA efforts at the agency, division, and branch level.

- **RSB Quality Assurance (QA) Coordinator**:
  - Facilitates the *Investigation of UST Releases QAPP* development process;
  - Participates in QA efforts at the agency, division, and branch level.

*Consultant Roles and Responsibilities*

- **Owner/Operator Consultant:**
  - Prepares release notifications and reports, and implements corrective action as needed;
  - Supervises and schedules consultant or subcontractor field staff for sample collection and site characterization activities, in accordance with IDEM and UST Program guidance documents;
  - Ensures staff are qualified and trained, including knowledge of IDEM and UST Program requirements;

- Develops environmental standard operating procedures for use by consultant staff;
- Reviews, approves, and submits consultant generated reports;
- Complies with UST Program guidance, including but not limited to the *RISC User's Guide Chapter 3* (Appendix C), the *RISC Technical Resource Guidance Document* (Appendix D), and QA/QC guidance (see Section B.5.1).
- Performs IDEM-approved remedial activities at sites.

- **Consultant Laboratory:**
  - Performs requested test methods on samples submitted by the consultant;
  - Provides QA/QC documentation (see Section B.5.1);
  - Allows IDEM SSB laboratory audit staff to review laboratory quality system documentation;
  - Ensures that appropriate analytical methods, QA/QC procedures, and equipment calibration are performed;
  - Ensures that laboratory staff is adequately trained;
  - Prepares laboratory analytical data packages.

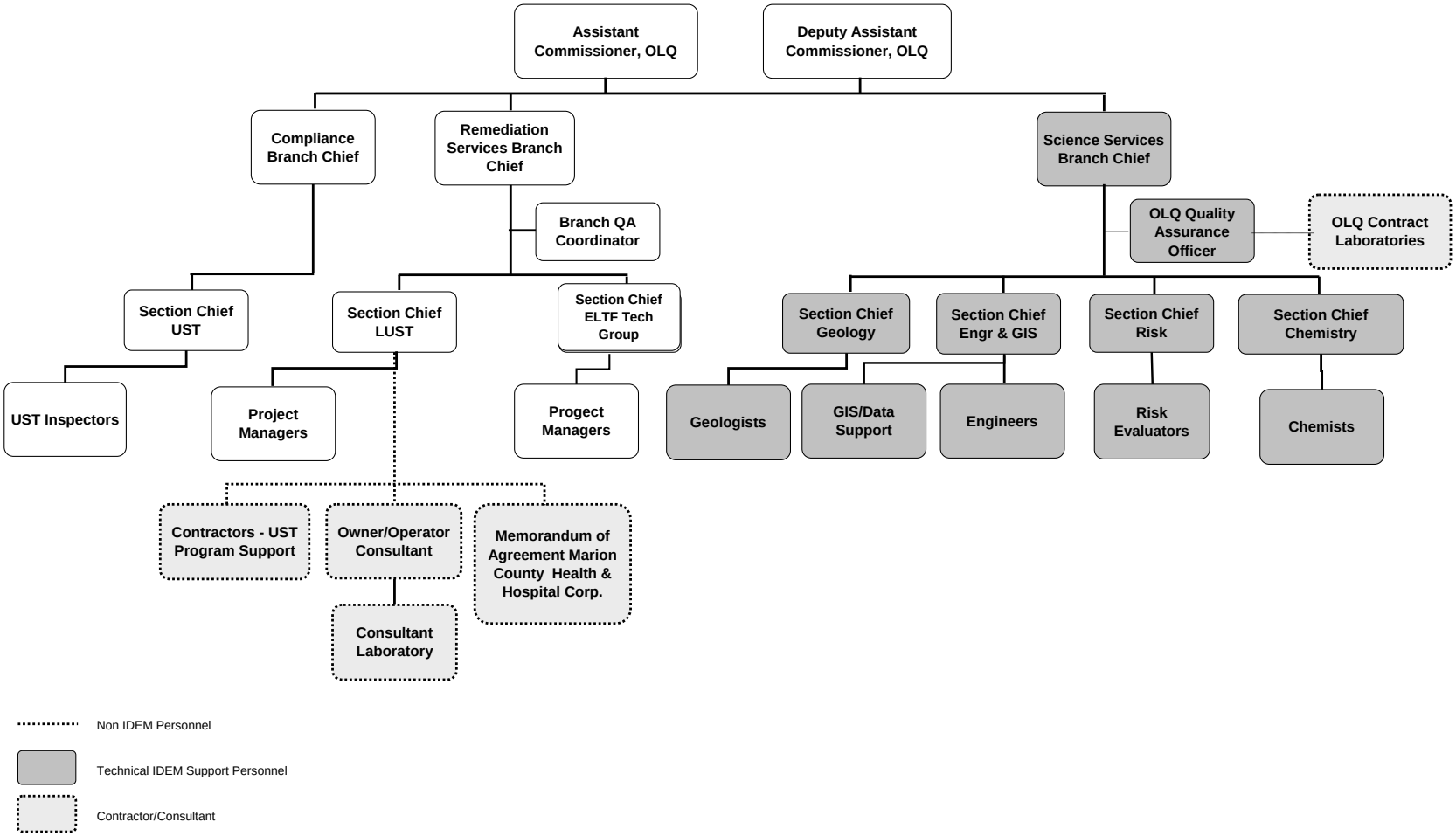
*EPA Roles and Responsibilities (not shown on organizational chart)*

- **EPA Region 5 UST Section, Enforcement Officer:**
  - Responsible for directing and overseeing UST Program activities;
  - Serves as part of final approval authority of IDEM *Investigation of UST Releases QAPP*;
  - Conducts annual and semi-annual programmatic reviews.
- **EPA QA Reviewer:**
  - Reviews *Investigation of UST Releases QAPP* and other quality documentation as assigned.
  - Serves as part of final approval authority of IDEM *Investigation of UST Releases QAPP*.

*Other Organizations - Roles and Responsibilities*

- **OLQ Support Contractors**:
  - Perform PM duties for low and medium priority LUST sites, or;
  - Process ELTF Claims.
- **OLQ Contract Laboratory Staff:**
  - Perform requested test methods on samples submitted by IDEM staff;
  - Ensure that appropriate analytical methods, QA/QC procedures, documentation, equipment calibration are performed;
  - Ensure that laboratory staff is adequately trained;
  - Prepare laboratory analytical data packages per Appendix 2 of the *RISC Technical Resource Guide* (Appendix D) as required by the OLQ Laboratory Contract 5-102.

**Figure 1 UST Releases QA Organizational Chart**



## A.5. Problem Definition/Background

The U.S. EPA estimates that there are approximately 640,000 USTs nationwide that store petroleum and other hazardous substances. Releases from USTs impact soil, groundwater, and surface water; and can cause harm to human health and the environment. In 1984, Congress added Subtitle I of the Resource Conservation and Recovery Act (RCRA) requiring the EPA to develop a regulatory program for USTs. The federal Leaking Underground Storage Tank Program was supplemented in 1986 with creation of the Leaking Underground Storage Tank Trust Fund, financed by a 0.1 cent tax on each gallon of motor fuel sold nationwide. These funds are allocated through the states, including Indiana and IDEM's UST Program, to oversee cleanups of sites where releases from UST have occurred and to pay for cleanups at sites where financially responsible parties cannot be identified or are not responsive.

UST Program responsibilities have been delegated to the State/IDEM through a Cooperative Agreement with the U.S. EPA. In addition to federal funds in the form of grants, the UST Program is also financed by State dedicated funds (the Petroleum UST Trust Fund and the Excess Liability Trust Fund (ELTF)). Rules regarding the implementation and payment for corrective action through the ELTF are provided in 328 IAC 1, as adopted by the Underground Storage Tank Financial Assurance Board (FAB). The overall design of the UST Program follows 329 IAC 9 and IC 13-23.

IDEM's UST Program utilizes a risk-based approach to assess and remediate UST releases. The *Risk Integrated System of Closure (RISC) Technical Guide* (Appendix D) describes how to achieve consistent closure of contaminated soil and groundwater by documenting:

- How to assess contamination present at a site;
- How to evaluate potential exposure pathways to contamination;
- What the options are for determining land use based site closure levels;
- What options are available for achieving a closure (No Further Action) status;
- How to use exposure prevention of residual contamination as a closure option (to prevent people from coming in contact with contaminants), and;
- What to do if contamination threatens drinking water or environmentally sensitive areas.

The RISC process provides a default approach to site closure and a framework for non-default options if the default approach is not used. This QAPP document provides an outline of the basic requirements for the default RISC approach. Further information on the use of RISC within each of IDEM's existing remediation programs, including the UST Program, may be referenced in the *RISC User's Guide*. The User's Guide is divided into five chapters. Chapter 3 (Appendix C), provides details on processes and the applicability of RISC to the UST Program.

## A.6. Project/Task Description

Within the UST Program, the number and type of tasks required may vary based upon site characteristics. Each completed task may lead to a request for additional investigation, for free-product abatement actions, or may result in a consideration of a 'No Further Action' (NFA) status from IDEM. In general the project tasks for the UST Program may be broken into 3 major categories: 1) Notification and response tasks for suspected or confirmed releases, 2) Investigation tasks for potential or confirmed releases, and 3) Remediation, risk assessment, and closure tasks.

Tasks within these groups are summarized in Table I, and include references to sources where additional information may be found as well as project schedule dates.

**Table 1 UST Program - Releases Project Task Summary**

| Task | Description/Report Contents | Category | Schedule | References for More Detail |
|---|---|---|---|---|
| Suspected Release/Confirmed Release | Documentation to include owner/operator details; UST system description; description of suspected release. | Notification and Response | Notify IDEM within 24 hours; 7 days to confirm release or no release | *RISC User's Guide Chapter 3* Section 3.3. 329 IAC 9-4-3 |
| Mitigation and Free Product (FP) Abatement | Documentation of vacuum events; vapor mitigation; occupant evacuation; alternate water supply provision; interceptor trench; booms in surface water; product recovery efforts; etc. | Notification and Response | Reports due 20-days (mitigation) OR 45 days (FP Recovery) from date of notification to IDEM | *RISC User's Guide Chapter 3* Section 3.3.4; *329 IAC 9-4-1*; 329 IAC 9-5-3.2 |
| UST Closure Report | Report provides the details of UST closure, including sampling results that may or may not indicate a release from the UST system. Required for removal, closure in-place, and change of service. | Investigation | Within 30 days of UST decommissioning or closure | *RISC User's Guide Chapter 3* Section 3.1.3; *329 IAC 9*; 329 IAC 2-6.1; 675 IAC 22; 40 CFR 280. |
| Initial Site Characterization (ISC) | Initiate investigation to define nature and extent of contamination and evaluate exposure pathways and receptors, evaluate remediation alternatives. | Investigation | Within 60 days of release confirmation | *RISC User's Guide Chapter 3* Section 3.5;329 IAC 9-5-5.1 |
| Further Site Characterization (FSI) | Further investigation if ISC fails to define nature and extent of contamination; evaluation of remedial alternatives. | Investigation | Generally within 60 days of IDEM request for FSI; extensions possible upon request | *RISC User's Guide Chapter 3* Section 3.5; 3299-5-6 |
| Corrective Action Plan (CAP) | Plan describing remedial strategy for site: *RISC User's Guide* Ch. 3, Para. 3.7. | Remediation, risk assessment, and closure | CAP due to IDEM by 60 days from request for CAP; date may vary; CAP must include progress milestone timetable. | *RISC User's Guide Chapter 3* Section 3.7; 329 IAC 9-5-7. |
| Corrective Action Implementation Report | Documents remedial system installation, construction activities, etc. | Remediation, risk assessment, and closure | Generally 60 days from CAP implementation; extensions possible upon request | *RISC User's Guide Chapter 3* Section 3.7; 329 IAC 9.5.7 |
| Corrective Action Plan Progress Report | Required for: 1) When requested by IDEM prior to corrective action; 2) Corrective action monitoring; 3) Monitored natural attenuation or other closure monitoring such as plume stability demonstration. | Remediation, risk assessment, and closure | Quarterly, or as documented in CAP | *RISC User's Guide Chapter 3* Section 3.7.3; 329 IAC 9.5.7 |
| Request for No Further Action | Documents justification for closure decision, including risk assessment. | Remediation, risk assessment, and closure | After successful implementation of CAP (if required) | *RISC User's Guide Chapter 3* Section 3.6 |

## A.7. Quality Objectives and Criteria

### A.7.1. Data Quality Objectives (DQOs)

DQOs are qualitative and quantitative statements that clarify the study objective and define the appropriate type of data to collect. The DQO process results in the full set of specifications needed to support the qualitative and quantitative design of a data collection effort. DQOs are also used to assess the adequacy of data in relation to their intended use. This DQO series defines the RISC default (or generic) option.

The seven steps to the DQO Process and the approach to each step for IDEM's UST Program are described below.

**State the Problem**

A release or suspected release from a regulated UST has been identified.

**Identify the Decision**

There are five main decision statements to consider:

- Decision Statement I - *A release of petroleum or hazardous substance Contaminants of Concern (COCs) from an UST system has been confirmed.*
- Decision Statement II – *The release presents an immediate threat to human health or the environment (e.g. fire, explosion, and vapor hazards) and requires accelerated response activities*. Sites that present an immediate health or environmental threat will undergo additional accelerated response requirements.
- Decision Statement III – *The areal extent of the release above the residential closure level has been delineated.*
- Decision Statement IV - *The site contamination requires active remediation and/or the use of land use controls.*
- Decision Statement V – *The remedial actions were performed, meet remedial objectives, and eliminate exposure to COCs above the appropriate RISC default or non-default levels*

**Identify the Inputs to the Decision**

Groundwater and soil samples will be collected and analyzed to assess and document releases to the site media. Concentrations of detected contamination in soil (after calculation of exposure point concentrations) and groundwater will be compared to the default residential and industrial closure levels presented in Appendix A of *RISC Technical Resource Guide* (Appendix D). The default closure levels are risk-based numerical values for each contaminant based on chemical characteristics, media concentration, toxicity, and exposure pathway. Potential exposure pathways are evaluated, and sensitive areas (surface water, well head protection areas, etc.) are identified.

If site conditions warrant, evaluation of soil gas or indoor air samples may be necessary to evaluate the risk due to vapor intrusion. Soil gas and/or indoor air samples are compared to criteria in *IDEM's Draft Pilot Program Vapor Intrusion Guidance* (Appendix A, Reference 10).

A non-default approach may be utilized, where-by site-specific closure levels are calculated and proposed for IDEM's approval.

**Define the Study Boundaries**

The spatial and temporal boundaries of each site may vary. Samples may be collected on-site or off-site as necessary to determine the nature and extent of contamination.

Background samples may be collected on or off-site. When collected, background samples should be collected from a similar matrix (soil, ground water, or surface water). For example, background soil samples must come from the same depth and stratigraphic unit as the corresponding investigative samples and background ground water samples must come from the same depth in the same aquifer.

**Develop a Decision Rule (Develop the Analytic Approach)**

Decision Rules are "if/then" statements that determine how a project will proceed by evaluating the data. Once data have been verified and validated, all useable data are evaluated to ensure that they meet the investigative criteria. Examples of decision rules are:

- Decision Rule I – If a release of one or more COCs has occurred, then an incident number is generated and additional assessment is necessary. This decision drives the need for site characterization, risk assessments, and possible remedial activities. If not, then no incident number will be generated. The details of any suspected but not confirmed release will be documented.
- Decision Rule II – If the release causes an immediate threat to human health or the environment, then the appropriate response(s) to mitigate the threat must be initiated. If not, then the determination of nature and extent of contamination should proceed. Depending on the situation, the appropriate responses may include vapor mitigation, free product abatement, control of emergency conditions (e.g. explosion hazards) etc. Consult 329 IAC 9-5-3.2 for initial abatement measures.
- Decision Rule III – If the areal extent of contamination has not been determined, then conduct additional investigations as necessary to delineate the site and to assess receptor effects. If the extent of contamination has been determined, then the appropriate remedial action may be selected.
- Decision Rule IV - If the site contamination is significant enough to require remediation, then remedy selection and corrective action must be completed. If not, the site may receive a No Further Action (NFA) determination
- Decision Rule V – If the remedial actions were performed and there is no exposure to residual COCs above the appropriated RISC default or non-default levels, then the site may receive a No Further Action determination. If not, then further investigations and/or remedial actions will be necessary.

**Specify Limits on Decision Rules**

Data generated for the purpose of risk evaluation should be of known and documented quality. However, since the UST Program utilizes a judgmental sampling approach, the data collected does not support a statistical data quality assessment. Therefore, the specification of tolerable limits on decision errors is not applicable to this program.

**Optimize the Design for Obtaining Data**

Expected spatial, sampling, and analytical variations are key inputs to designing sampling schemes that achieve the allowable probability for judgmental sampling.

Spatial and sampling variations have been considered in the UST Program sampling design, with the result that soil sample evaluation is conducted by calculating exposure point concentrations (EPCs). For more details, consult Paragraph 3.5.1 of the *RISC User's Guide Chapter 3* (Appendix C).

### A.7.2. Measurement Quality Objectives (MQOs)

Measurement quality objectives (MQOs) are "acceptance criteria" for the quality attributes measured by project data quality indicators (DQIs). The principal DQIs are precision, accuracy (as bias), representativeness, comparability, completeness, and sensitivity (PARCC). Data Quality Indicator (DQI) criteria apply not only to the laboratory but also to the field sampling.

The overall QA objective for the UST Program is to develop and implement procedures for sampling, COC selection, laboratory analysis, and reporting. The following sections provide a brief description of each performance indicator selected for the sampling measurement systems. Tables 2 and 3 provide MQO and DQI elements for project field and analytical control standards.

**Precision**

Precision is the degree of agreement among repeated measurements of the same characteristic (analyte, parameter, etc.) under the same or similar conditions. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been. Comparing field and laboratory precision will help to identify sources of imprecision if a problem exists. Poor precision may result from field instrument variation, analytical measurement variation, poor or inappropriate sampling technique, sample transport problems, and/or heterogeneous matrices.

**Accuracy (as Bias)**

Accuracy is the extent of agreement between an observed value (sample results) and the accepted, or true, value of the parameter being measured. Analyte accuracy can be evaluated using different types of QC samples, such as a Standard Reference Material (SRM) or Laboratory Control Sample (LCS). Because environmental samples contain interferences (i.e., other compounds that may interfere with the analysis of specific analytes), the accuracy for a specific analyte should be evaluated in relation to the sample matrix. This is done by analyzing matrix spike/matrix spike duplicate (MS/MSD) samples.

Accuracy can be impacted by field sample collection and transport contamination, or by contamination introduced at the time of sample preparation and/or analysis. Sample contamination may result in either negative or positive bias. For example, metals may adsorb on plastic sampling materials. This would result in lower metals concentration being reported than are actually present in the collected sample (i.e., negative bias).

**Representativeness**

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the environmental conditions of the site. Representativeness also reflects the ability of the sample team to collect samples and laboratory personnel to analyze those samples in such manners that the data generated accurately and precisely reflects the conditions at the site. If field duplicate or co-located precision checks indicate potential spatial variability, then this may trigger additional coordination with IDEM and subsequent resampling in order to collect data that is more representative of a non-homogeneous site.

**Completeness**

Completeness is a measure of the amount of valid data collected using a measurement system. The percent of completeness is the total number of samples for which acceptable analytical data are generated divided by the total number of samples analyzed and multiplied by one hundred (100). A lack of data completeness may require additional sampling.

**Sensitivity**

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Sensitivity is determined from the value of the standard deviation at the concentration level of interest. It represents the minimum difference in concentration that can be distinguished between two samples with a high degree of confidence.

**Comparability**

Comparability is an expression of the confidence with which one set of data can be compared to another as a qualitative measurement. It is a careful identification that two data sets may be equivalent in the measurement of a parameter or set of parameters. It is dependent upon proper sampling design and may be satisfied by ensuring that the field sampling plan is followed, that proper sampling techniques are utilized, that proper analytical methods are established, and proper quality assurance objectives are used and documented.

For long term monitoring projects such as plume stability assessments, data comparability is extremely important. Project data will be compared to previously generated data to determine the possibility of misidentification, poor recoveries, matrix interferences, comparative data abnormalities or irregularities.

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The following tables provide a general program list of MQO and DQI elements for project field and analytical control standards. Site-specific criteria may be modified.

**Table 2 Quality Assurance/Quality Control – Soil (SW 846)**

| QC Sample | Frequency/ Number | Data Quality Indicator (DQI) | Measurement Quality Objective (MQO) | Corrective Action if Out of Control |
|---|---|---|---|---|
| Equipment Blank | 1 per sample location when non-disposable sampling equipment used | Effectiveness of field decontamination procedures | All analytes < Reporting Limit | All affected data considered biased (High or Unknown) due to possible cross-contamination. Field decontamination procedures should be reviewed. |
| Field Duplicate | 1 per 20 samples | Effectiveness of field sampling procedures | < 40% Relative Percent Difference (RPD) | All affected data considered biased (High, Low, or Unknown) due to sampling error. Sample collection procedures should be reviewed. |
| Laboratory Control Sample (LCS) | Per Method and/or Laboratory SOP | Evaluation of laboratory and instrument capability | % Recovery and % RPD as per Method or Laboratory SOP | All affected data considered biased (High, Low, or Unknown) due to laboratory or instrument error. |
| Internal Std (IS) | Per Method and/or Laboratory SOP | Evaluation of laboratory analysis procedures | % Recovery and Method or Laboratory SOP | All affected data considered estimated (High, Low, or Unknown) due to cross-contamination during transport or storage |
| Matrix Spike/ Matrix Spike Duplicate (MS/MSD) | 1 per 20 samples | Evaluation of matrix interferences | < 40% RPD, % Recovery as per Method or Laboratory SOP | All affected data considered biased (High, Low, or Unknown) due to Matrix Interference. |
| Method Blank(MB) | Per Method and/or Laboratory SOP | Evaluation of laboratory and instrument conditions | All analytes < Reporting Limit | All affected data considered biased (High or Unknown) due to laboratory or instrument cross-contamination. |
| Surrogate Spike(SS) | Per Method and/or Laboratory SOP | Evaluation of instrument capability | % Recovery and % RPD as per Method or Laboratory SOP | All affected data considered biased (High, Low, or Unknown) due to laboratory or instrument error. |

**Table 3 Quality Assurance/Quality Control – Groundwater (SW 846)**

| QC Sample | Frequency/ Number | Data Quality Indicator (DQI) | Measurement Quality Objective (MQO) | Corrective Action if Out of Control |
|---|---|---|---|---|
| Equipment Blank | 1 per sample location when non-disposable sampling equipment used | Effectiveness of field decontamination procedures | All analytes < Reporting Limit | All affected data considered biased (High or Unknown) due to possible cross-contamination. Field Decontamination Procedures should be reviewed. |
| Field Duplicate | 1 per 20 samples | Effectiveness of field sampling procedures | < 20% RPD | All affected data considered biased (High, Low, or Unknown) due to sampling error. Sample collection procedures should be reviewed. |
| Laboratory Control Sample (LCS) | Per Method and/or Laboratory SOP | Evaluation of laboratory and instrument capability | % Recovery and % RPD as per Method or Laboratory SOP | All affected data considered biased (High, Low, or Unknown) due to laboratory or instrument error. |
| Internal Std(IS) | Per Method and/or Laboratory SOP | Evaluation of laboratory analysis procedures | % Recovery and Method or Laboratory SOP | All affected data considered estimated (High, Low, or Unknown) due to cross-contamination during transport or storage |
| Matrix Spike/ Matrix Spike Duplicate (MS/MSD) | 1 per 20 samples | Evaluation of matrix interferences | < 20% RPD, % Recovery as per Method or Laboratory SOP | All affected data considered biased (High, Low, or Unknown) due to Matrix Interference. |
| Method Blank(MB) | Per Method and/or Laboratory SOP | Evaluation of laboratory and instrument conditions | All analytes < Reporting Limit | All affected data considered biased (High or Unknown) due to laboratory or instrument cross-contamination. |
| Surrogate Spike(SS) | Per Method and/or Laboratory SOP | Evaluation of instrument capability | % Recovery and % RPD as per Method or Laboratory SOP | All affected data considered estimated (High, Low, or Unknown) due to laboratory or instrument error. |
| Trip Blank | 1 per 20 samples | Evaluation of sample integrity during transport and storage | All analytes < Reporting Limit | All affected data considered estimated (High, Low, or Unknown) due to cross-contamination during transport or storage. |

## A.8. Special Training/Certification

### A.8.1. Owner/Operator Consultant Training/Certification

Consultants are responsible for ensuring that their staff are adequately educated and trained in safety, sampling protocols, and IDEM program guidance. In addition, the following training/certifications are mandatory:

- UST closure contractors must be certified by the Department of Fire and Building Safety to perform UST upgrades, repairs, removals, change-in-service and closures;
- Health and safety plans for field work should be prepared, and should include a list of personnel training, qualifications, and certifications;
- All reports of release investigations must be signed by one of the following environmental professionals.
    1) Registered professional engineer;
    2) Licensed professional geologist;
    3) Certified hazardous materials manager;
    4) Professional soil scientist.

### A.8.2. IDEM Staff Training/Certification

The SCs provide new staff with in-house training on UST issues, federal regulations, state regulations, technical guidance, and records management. UST program staff receive intensive office and field training through document review as well as office and field mentoring on program specific practices, procedures, policies and laws. All IDEM staff that conduct field work must have successfully completed:

- Initial 24 or 40-Hour OSHA Safety Training
- Annual 8-Hour OSHA Safety Training Updates

In addition, IDEM Remediation Services Branch project managers and Science Services Branch staff are required to attend in-house provided training modules including:

- Environmental Chemistry
- Geology/Hydrogeology
- Risk Assessment
- Environmental Sampling
- Quality Management
- Office of Land Quality Overview
- Environmental Restrictive Covenants

Technical staff must have completed specific educational and experience requirements in the pertinent field (e.g. environmental chemistry, geology/hydrogeology, engineering), to qualify for hiring. Technical staff supplement that knowledge through workshops, in-services, and on-the-job training in a peer review structure, as well as the above-listed courses. The SC ensures that staff receive the necessary training at the earliest opportunity.

## A.9. Documents and Records

### A.9.1. IDEM *Investigation of UST Releases QAPP*

The most current, approved version of this QAPP will be available in two places to accommodate both IDEM staff and owner/operators and their consultants: 1) The IDEM Quality Management System Library, available to staff on the IDEM extranet; 2) The Leaking UST Program Website .

### A.9.2. UST Program Deliverables - Information Submitted by Owner/Operator Consultants

***UST Releases Reporting Requirements***

A list of the tasks requiring reports is included in Table I. These reports include:

- Abatement/Free Product Recovery Reports
- Underground Storage Tank Closure
- Release Investigation and Confirmation
- Initial Site Characterization
- Further Site Investigation
- Corrective Action Plan
- Corrective Action Plan Implementation
- LUST Quarterly Monitoring
- No Further Action Request

IDEM is creating new report templates that will improve consistency in data reporting, and ensure that information considered essential for decision making and quality control has been submitted. Each template lays out specific attachments, including laboratory data records, which should be assembled to represent a concise and accurate record of all activities impacting data quality. The report templates that include sampling collection and analysis results include the following fields:

- Text describing field-sampling methodologies, analytical results, conclusions and recommendations.
- Field screening results, including a description of how field screening instrumentation is calibrated and maintained.
- Figures showing the property boundaries, adjacent property locations and land use, sampling locations, monitoring well locations, geologic cross sections, etc.
- Tables comparing all laboratory data to the applicable RISC residential and industrial/commercial default closure levels OR IDEM approved site-specific RISC closure levels.
- A narrative describing the results of quality control samples
- Copies of soil boring and monitoring well logs.
- Groundwater elevation calculations.
- Other relevant material needed to support site decisions.

Owner/operators and their consultants currently have two options: 1) Contact the LUST Section directly for copies of draft report templates, or 2) follow report requirements as outlined in 329 IAC 329 Rules 4-6, and the *RISC User's Guide Chapter 3* (Appendix C*)*.

***UST Releases QA/QC Documentation***

329 IAC 9-5-5.1 requires the owner/operator (or responsible party) of a UST submit required documentation in a technical adequate manner. The rule discusses sampling information, laboratory procedures, and documentation requirements. The Minimum Data Documentation Requirements (MDDRs) (Appendix E) were developed in order to satisfy the rule requirements. While this level of data documentation is a subset of the complete quality assurance and quality control (QA/QC) documentation generated by the analytical method, it may be adequate to allow IDEM to provide meaningful evaluation and interpretation of analytical results. In the event that evaluation indicates questions or concerns, full QA/QC documentation (as presented in Appendix 2 of the *RISC Technical Resource Guide*) may be requested.

***UST Releases Reporting Formats***

Electronic Report & Data Submittal Guidelines are available at the IDEM website at http://www.in.gov/idem/5064.htm

### A.9.3. UST Program Deliverables – IDEM Sampling Events

In the event IDEM project manager staff are engaged in sampling activities and/or utilize IDEM Contract Laboratories, the following types of records may be generated, depending on the goal of the sampling. These records will become part of the site project file.

***Field Collection Records*.** These records document sampling protocol in the field. The records may include:

- *Field Log Book/Sheets*. The field log book or field sheets will document personnel present, time spent, weather conditions, other information collected during a site investigation. The field log book should include information recorded on the sample containers, a description of the sample, when the sample was sealed and preserved, equipment used, field measurements, calibration and maintenance checks for instruments used, decontamination procedures, and deviations from the standard UST release sampling design.
- *Chain of custody records*. For IDEM OLQ contract lab sampling, refer to the IDEM SOP *Chemistry Support Field Documentation* for more details.
- *Site Map*. The site map will document sampling locations and sample numbers, locations of access, surface features, buildings and other points of interest.
- *Geographic Positioning System (GPS) coordinate data*. IDEM guidance encourages that all data gathering activities conducted by the agency be undertaken utilizing GPS techniques. IDEM staff should collect GPS data in accordance with Section 5.5 of the IDEM SOP *OLQ Geographic Information System Data Creation*. The IDEM *Sampling Database Users Manual* (Appendix A, Reference 11) discusses how IDEM receives data collected in this manner.

***Sample Management Records and Raw Data*.** IDEM may request additional laboratory documents when anomalies are identified, or if they are necessary to complete the case narrative, e.g. enforcement cases. OLQ contract laboratories shall keep all raw data for at least five (5) years. The laboratory will discard the samples in accordance with applicable State contract requirements.

***QC Sample Records*.** These records document the generation of QC samples, such as field, trip, and equipment rinsate blanks and duplicate samples. They also include documentation of sample integrity and preservation; and documentation of calibration. Quality control sample records should contain information on the frequency, conditions, level of standards, and instrument calibration history.

***Chemistry Verification and Validation Memorandum.*** This memorandum is prepared in accordance with the IDEM SOP *Chemistry Support Data Verification and Validation*.

#### A.9.4. Data Reporting Package Archiving and Retrieval

IDEM utilizes the electronic filing system, the 'Virtual File Cabinet' (VFC) for archive of program records. The public interface for this system can be found at IDEM Virtual File Cabinet .

# B. Data Generation and Acquisition

## B.1. Sampling Process Design

#### B.1.1. Rationale for the Design and Design Assumptions

In the UST Program, samples are typically collected from subsurface soil and groundwater media. Depending on the site-specific characteristics, they may also be collected from surface soil (spills or overfills) and surface water. In addition, soil gas and or indoor air samples may be collected to assess the vapor intrusion exposure pathway.

IDEM's default sampling design is based upon the goal of locating sample points at areas most likely to be impacted by a release from a UST system. Therefore, the default design initially includes sampling at the UST pit area, piping runs, and dispenser islands. IDEM does allow flexibility in the selection of sampling points if appropriate justification is provided to the agency from the consultant performing the work (for instance, if the default sampling point location is inaccessible).

The COCs to be included in the analytical suite for petroleum USTs are in four main groups: gasoline, mid-range liquid hydrocarbon fuels, hydrocarbon oils, and waste/used oil. Owner/operator consultants should check with the IDEM LUST website to obtain the latest list of COCs specific to the UST Program. If non-standard COCs were stored in USTs, acceptable SW-846 methods for each COC are listed in the tables presented in Appendix 2 of the *RISC Technical Resource Guidance Document – Analytical Methodology for Risk Assessment* (Appendix D).

#### B.1.2. Procedures for Locating and Selecting Environmental Samples

Chapter 3 of the *RISC User's Guide* (Appendix C) describes the sample location procedures for this program. A judgmental and subjective sampling approach, entitled the 'Step-Out' approach, is utilized. Consult either:

1. For UST closure sampling design, Section 3.1.3 of Chapter 3 of the *RISC User's Guide* (Appendix C).
2. For site characterization (i.e., nature and extent investigation) after a release is suspected or confirmed, Section 3.5.1 of Chapter 3 of the *RISC User's Guide* (Appendix C).

Field screening instrumentation such as photoionization detectors (PIDs) or flame-ionization detectors (FIDs) should be used (as applicable for the relevant contaminants of concern) to assist in the selection of soil samples to be submitted for laboratory analysis.

For IDEM staff directly involved with the collection of samples, field screening equipment standard operating procedures (SOPs) are available and should be utilized for select equipment. In addition, equipment user's guides are available for staff to review prior to utilization of equipment. In addition, sample collection SOPs should be followed. Approved IDEM SOPs are available to staff through the QA library on the IDEM extranet.

#### B.1.3. Validation of Nonstandard Sampling/Measurement Methods

IDEM staff must approve all nonstandard sampling or measurement methods in advance. IDEM may request additional data be collected if nonstandard sampling or measurement methods are utilized without prior approval.

## B.2. Sampling Methods

#### B.2.1. Owner/Operator Consultant Sampling Events

Sampling for UST release sites shall be conducted in accordance with IDEM program guidelines and state laws. IDEM encourages all consultant firms to utilize their own SOPs, including sample collection procedures; use, maintenance, and calibration of field equipment; decontamination of equipment; and disposal of investigative derived waste.

UST Program reports shall include a description of the sample and data collection procedures followed. IDEM recognizes that deviations to procedures may occur from time to time due to site-specific conditions or due to problems that may occur such as equipment failure. The owner/operator consultant should have backup plans in the event that problems such as equipment failure or need for additional supplies might arise. All deviations and corrective actions will be thoroughly documented.

#### B.2.2. IDEM Sampling Events

If IDEM staff conduct sampling events, sample/data collection procedures will be in accordance with IDEM sample collection SOPs. IDEM staff may utilize field equipment available for check-out through the OLQ Site Safety Officer or through the Site Investigation Program team. IDEM staff conducting sampling are required to work under a site-specific Health and Safety Plan approved by the OLQ Site Safety Officer.

## B.3. Sample Handling and Custody

Proper sample handling and custody procedures are crucial to ensuring the quality and validity of data obtained through field and laboratory analysis. The admissibility of environmental data as evidence in a court of law is dependent on the custody of the data. The possession and handling of samples should be documented from the time of collection to delivery to the laboratory. A sample is considered in custody if it is:

- In a person's possession;
- In view of the person after being in their possession;
- Sealed in a manner such that it can not be tampered with after having been in physical possession; or
- In a secure area restricted to authorized personnel.

#### B.3.1. Owner/Operator Consultant Sampling Events

All site reports submitted by owner/operator consultants will be reviewed and the following elements assessed for appropriate sample handling:

- Preservatives;
- Cooler temperature (compared to 4º ±2 º Celsius standard);
- Holding times;
- Designation of persons responsible for maintaining field notebooks, sample custody, and sample receipt by the laboratory;
- Project sample tracking system including a unique project numbering system;

- Chain of Custody information that includes at a minimum: date and time of collection; number of each type of sample; matrix type; method of preservation; type of analysis; turnaround time; sampler name; and sampler's signature.

All sample containers should be labeled in waterproof ink at the time of sample collection but prior to being filled. Each label will indicate at a minimum:

- Sample identification (Note: The suggested sample identification nomenclature to use is described in Chapter 3 of the *RISC User's Guide* (Appendix C), Section 3.5.4, Pages 3-42 through 3-43;
- Date/time of sample collection;
- Sampler's initials;
- Required analyses;
- Type of preservative.

The owner/operator consultant is responsible for ensuring that samples are packaged and transported in a manner that maintains the integrity of the sample and permits the analysis to be performed within the prescribed holding time. Samples may be shipped by courier or overnight mail to the laboratory. IDEM recommends the use of bubble-wrap packing materials and ice stored in resealable plastic bags. The cooler should be taped closed using custody seals.

#### B.3.2. IDEM Sampling Events

Occasionally, IDEM personnel conduct sampling and utilize analytical services by IDEM OLQ contract labs. IDEM staff who conduct field sampling must follow the IDEM SOP *Chemistry Support Sample Request Sheet Sign-Off*, completing the Sample Request Sheet and submitting it to the OLQ chemistry section.

IDEM staff shall perform field sampling record collection in accordance with the IDEM SOP *Chemistry Support Field Documentation*. This SOP includes site information sheets, sample field sheets, and chain of custody forms to be completed by the IDEM Project Manager or lead sampler.

- The sampler will provide each sample with a unique OLQ number;
- The PM will retain one copy of the Chain of Custody documentation and the laboratory will retain a second copy;
- The laboratory will return the original Chain of Custody to IDEM along with the laboratory deliverables (data package).

#### B.3.3. Laboratory Custody

For both owner/operator consultant and IDEM sampling events, the laboratory utilized must sign the chain of custody when the samples are received. The laboratory verifies that all samples are accounted for and are not broken. The laboratory must store the samples in a secure refrigerated area that maintains the temperature at 4 º +/- 2 º C and is responsible for disposal of samples. The laboratory must submit a cooler inspection report (or equivalent) along with the laboratory report.

### B.4. Analytical Methods

#### B.4.1. Description of Analytical Methods to be Used

The selection of COCs depends on the type of petroleum or, in rare instances, hazardous substances stored in the UST system. The typical petroleum categories include gasoline, diesel, high-end hydrocarbon oils, and used/waste oil. For each of these categories, the standard target COCs, acceptable sample collection methods, and analytical methods for each group are listed in Chapter 8 (Table 7.1) of the *RISC*

*Technical Resource Guidance Document* (Appendix D). In addition, the *Supplemental Guidance for Sampling Soil and Waste Samples for VOCs* should be consulted for all sites with VOC analysis requirements.

If non-standard COCs were stored in USTs, acceptable SW-846 methods for each COC are listed in the tables presented in Appendix 2 of the *RISC Technical Resource Guidance Document – Analytical Methodology for Risk Assessment* (Appendix D).

Owner/operator consultants should familiarize themselves with RISC closure levels in order to select the analytical method with an appropriate detection or quantitation limit. Owner/operator consultants must obtain the approval from the IDEM PM for any deviations or modifications to analytical methods prior to sample collection. For any nonstandard methods, the owner/operator consultant will provide method validation information such as determination of detection limits, quantitation limits, typical recoveries, analytical precision, bias, or other applicable criteria.

#### B.4.2. Laboratory Turnaround Times

Owner/operator consultants are responsible for ensuring samples are analyzed within their recommended hold time.

For IDEM contract laboratories, laboratory turnaround times are set out in Appendix E of the current contract. IDEM staff may request project-specific laboratory turnaround times when the sampling request is submitted on the "Sample Request Sheet". A copy of this form is included as an appendix to the IDEM SOP *Chemistry Support Sample Request Sheet Sign-Off*.

## B.5. Quality Control

#### B.5.1. Quality Control (QC) Activities for Sampling, Analytical or Measurement Techniques

Refer to Chapter 3 (Section 3.4.4) of the *RISC User's Guide* (Appendix C) for details regarding required QC. IDEM requires the collection of QA/QC data throughout different stages of the site characterization, corrective action, and closure process.

QA/QC documentation requirements include:

- *Minimum Data Documentation Requirements for LUST Sites* (Appendix E) for screening, trending, and groundwater quarterly monitoring.
- Full QA/QC documentation available upon request for final nature and extent delineation, closure, or the last quarter of groundwater monitoring. The elements of full QA/QC documentation may be found in *Appendix 2 of the RISC Technical Resource Guide* (Appendix D).

If a non-default risk assessment is conducted, IDEM will request DQO focused sample collection and relevant DQI and MQO laboratory QA/QC requirements.

#### B.5.2. Control Limits and Corrective Actions

The difference between the reported and actual concentrations of a sample is a function of both sampling or field error and analytical error. Sampling or field error is assessed with field QC samples. The magnitude of analytical error may be assessed by evaluating the laboratory quality control samples.

The IDEM PM, with input from chemists, will determine the usability of data. In some cases, data of poor quality may necessitate the collection of new or additional samples.

IDEM OLQ contract lab control criteria are identified in the IDEM OLQ lab contract. The laboratory QC measures and their results must be documented and should be submitted as supporting documentation along with the analytical report of sample results.

**Accuracy**

Accuracy is used to determine systematic or random error of results. The accuracy objectives for quantitative analyses are expressed in part in terms of recovery of surrogate compounds (organic compounds) or recovery of spike analyses (inorganic analyses). For other analytes the accuracy should be within the recovery ranges listed in the referenced analytical method. Recovery outside these criteria will be flagged by OLQ Chemistry Section personnel in their technical review memoranda submitted to the PM.

**Precision**

Field precision will be assessed through the collection and analysis of field duplicate samples. Groundwater matrix samples can be readily duplicated due to their homogenous nature; conversely, the duplication of soil samples is much more difficult due to their non homogenous nature. Due to this discrepancy by media type, maximum RPDs of 20% for groundwater samples and 40% for soil sample field duplicates will be used as advisory limits for analytes detected at concentrations greater than or equal to five times the quantitation limit.

Laboratory precision will be based upon laboratory matrix spike/matrix spike duplicate (MS/MSD) analyses. The criteria for precision are specific to the parameter being measured.

**Completeness**

For this program the desired goal is at least 90% of samples should yield valid data. If completeness falls below 90%, it shall be noted by chemists in their review memoranda submitted to the PM.

## B.6. Instrument/Equipment Testing, Inspection, and Maintenance

### B.6.1. Owner/Operator Consultant

The Owner/Operator Consultant is responsible for ensuring that equipment is tested, inspected, calibrated, and maintained. IDEM expects that owner/operator consultants have documented standard operating procedures (SOPs) for maintenance and calibration of field and laboratory equipment, although copies of SOPS are not routinely requested as submittals. In the event that questions arise during data evaluation, IDEM reserves the right to request full QA/QC documentation from the sampling event and the laboratory utilized. Faulty sampling protocols or findings of inappropriate use of field equipment may result in requests for corrective action, including the possibility of resampling.

### B.6.2. IDEM Sampling Event/OLQ Contract Laboratories

In the event that IDEM conducts field sampling support or utilizes OLQ contract laboratory services, the following testing, inspection and maintenance requirements apply:

- A list of field measuring and testing equipment that is owned and maintained by IDEM is included as Appendix H. IDEM equipment will be maintained in accordance with manufacturers' specifications and, if applicable, IDEM SOPs. Equipment supplied by others will be tested and maintained by the supplier in accordance with manufacturers' specifications.

- The PM, or other assigned field staff, will inspect each piece of equipment upon checkout, or when the item is delivered to determine that it is operational. The PM will identify any noted problems for equipment owned by IDEM, and will inform the IDEM personnel responsible for equipment maintenance. The PM is responsible for ensuring spare parts are available through coordination with the supply warehouse or via OLQ's Operations and Finance Section.
- For IDEM Contract Laboratory equipment, the laboratory QA manager will be responsible for ensuring that the laboratory's data precision and accuracy are maintained in accordance with specifications. Laboratory equipment will be as specified in the laboratory contract.

## B.7. Instrument/Equipment Calibration and Frequency

Instruments used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Trained personnel will operate and calibrate field measurement equipment in accordance manufacturer's specifications.

**Field Equipment**

Field personnel are responsible for the calibration of field equipment, such as PIDs and FIDs. The following UST Program Reports require calibration data:

- *UST Closure Report*
- *ISC Report*
- *Further Site Investigation*

When equipment that is owned and maintained by IDEM is to be used in the field, the IDEM PM will ensure that it is properly calibrated.

**Laboratory Equipment, Including Mobile Laboratories**

Equipment will be calibrated using reference standards having known relationships to nationally recognized standards or accepted values of physical constants. Laboratory calibration records will be maintained by the laboratory QA officer.

## B.8. Inspection/Acceptance of Supplies and Consumables

The Owner/Operator consultant is responsible for the inspection and acceptance of supplies utilized for investigative purposes.

When field activities are performed by IDEM personnel, the PM is responsible to ensure that proper supplies are available. The laboratory QA Officer will be responsible for ensuring that proper supplies are on hand for laboratory activities.

## B.9. Non-direct Measurements

Data from non-direct measurement sources, such as computer modeling, is subject to review by IDEM Science Services Branch technical evaluation staff. Consultants are encouraged to contact the IDEM PM for approval prior to utilizing non-direct measurement methods.

## B.10. Data Management

### B.10.1. Data Recording

**Laboratory Data**

When environmental sampling is part of a required report, the report shall present all sample results, including all QA/QC samples. Laboratory data is to be recorded and

submitted in accordance with approved UST Program Guidance and the *Minimum Data Documentation Requirements* (Appendix E). If specifically requested, full QA/QC documentation as presented in Appendix B of the *RISC Technical Resource Guide* should be submitted. IDEM OLQ contract lab data will be maintained and submitted in compliance with the IDEM OLQ lab contract.

**Field Data**

Owner/operator consultant field staff will record data such as groundwater elevation data, calibration data, field screening readings, and pilot test results on field forms or in field logbooks. All field records should be signed by the person who performed the analysis or collected the data.

As appropriate, the owner/operator consultant may need to transfer raw data to computer databases or spreadsheets (ex. field screening equipment with data download capabilities).

When IDEM staff collect field data, IDEM staff will use field logbooks and the "Site Information and Sample Field Sheet" provided in the IDEM SOP *Chemistry Support Field Documentation* to record data..

### B.10.2. Data Transformation/Data Reduction

Data transformation is conversion of individual data point values into related values or possible symbols using conversion formulas. Data resulting from the analyses of samples should be reduced according to protocols described in the laboratory procedures. This information may include weight or volume of sample used, percent dry weight for solids, extract volume, dilution factor used, and background-correction protocols followed. For soil samples, IDEM requests that results be reported on a dry weight basis.

### B.10.3. Data Transmittal/Transfer

Data transmittal occurs when data are transferred from one person or location to another or when data are copied from one form to another. The current guidance for program documentation submittals may be found on IDEM's Leaking Underground Storage Tank web site.

IDEM prefers that laboratory data be transferred in accordance with "IDEM Electronic Data Submittal Guidelines" (Reference 7, Appendix A).

### B.10.4. Data Assessment

The QA review consists of internal and external assessments to ensure that QA/QC procedures are in use and to ensure that laboratory staff conform to these procedures. As documented in the *IDEM SOP Chemistry Support Data Verification and Validation*, the chemist also reviews field records for compliance with IDEM and/or EPA guidance.

### B.10.5. Data Storage and Retrieval

Records provide the direct evidence and support for the necessary technical interpretations, judgments and discussions concerning project activities. These records, particularly those that are anticipated to be used as evidentiary data, must directly support technical studies and activities, and provide the historical evidence needed for later reviews and analyses. Records should be legible, identifiable and retrievable, and protected against damage, deterioration, unauthorized modification or loss.

Project related documents (release reports, investigation reports, corrective action plans, quarterly monitoring reports, etc.) that are submitted to or generated by IDEM

will be indexed and imported or scanned into IDEM's electronic image storage system, entitled the Virtual File Cabinet (VFC). Documents will be archived in accordance with the applicable retention schedule.

#### B.10.6. Data Security

All data and analytical reports, including QA/QC results, will become part of the project file record and will be retained in the VFC in accordance with the applicable retention schedule.

# C. Assessment and Oversight

## C.1. Assessments and Response Actions

**Assessment of the Program**

External Assessments

- Semiannual Performance Measures Report (also referred to as the Strategic Targeted Activities for Results System or STARS Report). UST Program responsibilities are documented in a Cooperative Agreement with the EPA, which provides partial funding for the program through a federal grant. The UST Program develops an annual work plan, and progress is traced by reporting to the EPA via the Semiannual Performance Measures Report.
- EPA Management System Reviews (MSRs) – On an agency level, IDEM plans on inputs from EPA-lead MSRs to be a key quality system assessment tool.

IDEM assessments:

- IDEM Quality System Audits – The IDEM Quality Managers will perform agency-wide quality system audits of each IDEM branch at least once every five years. These audits focus on both agency-wide and branch level quality system components. Details on IDEM Quality System Audits may be referenced in paragraphs 2.2.2 and 9.1.1.1 in the *IDEM Agency Wide Quality Management Plan.* Personnel involved in assessment of the RSB quality system include the IDEM quality managers, RSB management, members of the OLQ quality team, the Science Service Branch QA Coordinator, and technical personnel (e.g. chemists, geologists, risk assessors). Assessments by non-RSB staff such as the IDEM quality managers and by SSB personnel ensure independence.
- IDEM Contract Laboratory Audits – During the contract procurement phase, responding laboratory quality system assessments are conducted. The Science Services Branch QA Coordinator reviews Quality Management Plans (QMP), SOPs, internal QA and QC requirements, control charts, Performance Evaluation Samples, and other technical documents. A lab Management System Review is then conducted at qualifying laboratories. Mid-contract audits may also be performed for various reasons; if a contract laboratory moves, undergoes a merger or reorganization.
- Periodic Internal Reviews - From time to time, staff or managers identify strengths or shortcomings of the quality system. These often coincide with the development of technical guidance such as *RISC Technical Guide*, or technical specifications for analytical work such as the IDEM Contract Laboratory program. The need for updates to program planning documents, technical guidance and SOPs may be dictated by rule changes, technology changes, extramural agreements or changes in internal practices.

- Performance Evaluations – Technical knowledge of all personnel is evaluated annually as a component of individual performance appraisals, and may be addressed at any time if problems arise. Personnel training is provided as course availability and funding allow, and is augmented by courses prepared by the Professional Development Committee. Further information about the types of training available for staff may be referenced in the *IDEM RSB Quality Management Plan.*

**Assessment of Individual Project Activities**

*Surveillance*. The PM is responsible for monitoring the status of a project and to review records and reports ensuring that they meet the requirements of the project. The deficiency and any corrective action shall be noted in writing and a follow-up audit may be completed if deemed necessary by the PM.

*Peer Review – Project Mangers.* Project Manager work products (reports, memoranda, correspondence, etc.) are subject to review by other PMs, Senior Environmental Managers, or Section Chiefs. Depending on the nature of the document, the Branch Chief, Assistance Commissioner or Commissioner may also review it.

*Peer Review – Technical Review Staff*. Technical staff in the SSB will perform data quality assessments to confirm that data meets the requested criteria in accordance with the project standards. There is a peer review function within each technical review staff specialty area. Peer reviewers have technical expertise in the subject area, and are not in the management chain of the RSB, maintaining independence. The Chemist I will perform peer reviews of data QA reviews that are performed by the site chemist. The Geologist I will perform peer reviews of data QA reviews that are performed by the site geologist.

*Field Evaluations.* IDEM staff periodically perform field oversight activities to obtain qualitative assessments of environmental data collection activities.

## C.2. Reports to Management

- Reports to EPA – IDEM reports periodically to the EPA on LUST program performance, typically referred to as STARS reporting. Data for this report is currently pulled from the Underground Leaking, Community Right-to-Know, and Emergency Response System (ULCERS) database. In addition, IDEM provides the EPA with a Financial Status Report.

- IDEM Quality System Audits – Audit planning and reporting will involve the participation of the appropriate levels of IDEM management (Assistant Commissioners, Branch Chiefs, and Section Chiefs). Those involved in assessment of the RSB quality system include the IDEM quality managers, RSB management, members of the OLQ quality team, the Science Service Branch QA Coordinator, and technical personnel. Assessments by non-RSB staff such as the IDEM quality managers and by SSB personnel ensure independence.

- IDEM OLQ Contract Laboratories – Whenever IDEM OLQ contract laboratories are involved in a discrepancy, the SSB QA Coordinator and management will be included in the decision making hierarchy and will review any decisions as to corrective action. In any event, the SSB QA Coordinator will provide guidance regarding these issues to the PM.

- Project Documentation - At a project level, the chemist typically reports negative data quality assessment findings to the PM. The PM is responsible to ensure that any necessary corrective actions are identified, documented for the public file, and implemented. If necessary, the PM will document

corrective actions to be taken in correspondence to the RP. The following are examples of topics that may be included:

- Non-Conformance of program guidance/procedures.
- Unauthorized deviations from the program guidance or approved corrective action steps.
- Results of data validation activities.
- Sufficiency of usable data generated.
- Required corrective actions and effectiveness of corrective action implementation.
- Data quality assessments in terms of precision, accuracy, representativeness, completeness, comparability, and sensitivity.

Section Chiefs review and must approve any documentation regarding the data and any corrective action, such as memoranda, reports or correspondence. When staff or managers identify program quality issues, they may elevate those issues to Branch Chiefs and subsequently to the senior management level if adequate resolution cannot be achieved.

# D. Data Validation and Usability

## D.1. Data Review, Verification, and Validation

Data review is the examination to ensure that the data have been recorded, transmitted and processed correctly. That includes checking for data entry, transcription, calculation reduction, and transformation errors. It also includes ensuring there is a complete list of sample information, such as field documentation, sample matrices, blanks, duplicates, shipping date, preservatives, holding times etc.

Data verification evaluates performance against the pre-determined set of specifications e.g., the sampling design, the analytical method, the appropriate COC selection, or other project criteria.

Data validation identifies beyond the verification process the quality or the appropriateness of the data set beyond procedural, lab method, or contract compliance criteria to be used to meet the project objective. Data validation procedures will be performed for both field and laboratory operations. The criteria that will be evaluated are discussed further in D.1.1 through D. 1.7.

### D.1.1. Sampling Design

The UST Program utilizes a judgmental 'step out' sampling design, as described in the RISC User's Guide Chapter 3. Any subsequent changes in the sampling design are reviewed to ensure that adequate decision data is available.

The PM and technical reviewers should check for compliance to the sampling design (e.g. site map), or for adequate documentation and justification when the sampling design has been modified.

### D.1.2. Sample Collection Procedures

Review of the data submittals (*UST Closure Reports, Initial Site Investigation*, etc.) will include a review of whether the appropriate procedures were followed, or whether any necessary variation in the procedures affected the value of the data.

### D.1.3. Sample Handling

Review of the data will include a review of sample handling. Discrepancies (holding time, temperature, etc.) are typically noted by the assigned SSB chemist and noted in the technical review memorandum.

#### D.1.4. Analytical Procedures

Each sample will be verified to ensure that the procedures used to generate the data were implemented as specified. Data validation activities will be used to determine how seriously a sample deviated beyond the acceptance limit so that the potential effects of the deviation can be evaluated.

#### D.1.5. Quality Control

QC checks that are to be performed during sample collection, handling, and analysis are specified in Sections B4 and B5. During data validation, the corrective actions that were taken, which samples were affected, and the potential effect of the actions on the validity of the data will be documented.

#### D.1.6. Calibration

Field and laboratory instrument calibration information will be evaluated to ensure that calibrations were performed.

#### D.1.7. Data Reduction and Processing

SSB chemists will provide checks on data. These checks will include checks where duplicate rekeying of data may have resulted in data entry errors. In order to avoid IDEM review staff rekeying errors, chemistry staff have been advised to not re-tabulate sample results in technical review memoranda.

### D.2. Verification/Validation Methods

SSB chemists provide data review, verification, and validation of analytical data packages and field documentation in accordance with the IDEM SOP *Chemistry Support Data Verification and Validation*. Verification and validation is provided both for Owner/Operator Consultant laboratory data and IDEM OLQ contract laboratory data as shown in Figure 2. SSB personnel in geology, engineering, or risk assessment discipline areas may also conduct technical reviews.

#### D.2.1. Verification

The PM and SSB chemist will verify field data by reviewing field records (screening results, monitoring well diagrams, soil boring logs, etc.), chain of custody records, and laboratory analytical results packages. Reports will be checked to ensure field work was documented and field equipment was calibrated. The laboratory data will be verified in respect to the COC, units of measure, and citation of analytical methods, including method and method criteria. The SSB chemist will review the laboratory case narrative for deviations or corrective actions taken, will verify the use of blanks and duplicates, and will document concerns within technical review memoranda.

For UST Release sites, IDEM sometimes utilizes the Minimum Data Documentation Requirements (MDDR) (Refer to Section B.5.1). While this level of data documentation is a subset of the complete quality assurance and quality control (QA/QC) documentation generated by the analytical method, it may be adequate to allow IDEM to provide meaningful evaluation and interpretation of the sampling and analytical results to determine attainment of the project objective. In the event that data evaluation indicates questions or concerns, full QA/QC documentation may be requested from the laboratory.

#### D.2.2. Validation

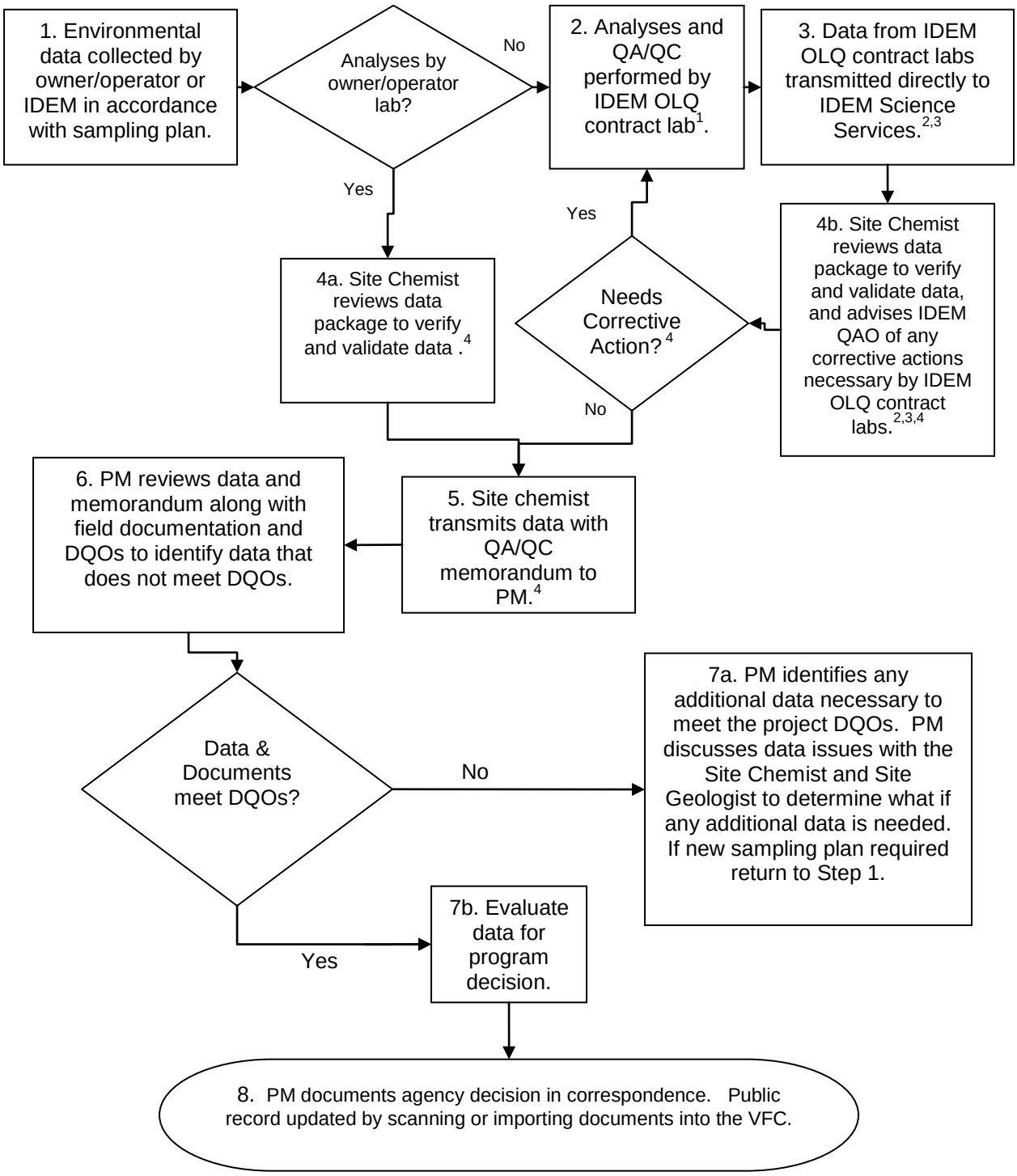
Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedure, or contractual compliance (i.e., data verification) to determine the quality of a specific data set relative to the end use. It

focuses on the project's specifications or needs, designed to meet the needs of the decision makers/data users and should note potentially unacceptable departures from the quality management system.

*Owner/Operator Consultant Reports*. For data submitted from Owner/Operator Consultants associated with any of the UST Program reporting tasks (Table 1), SSB chemists review the data in accordance with the IDEM SOP *Chemistry Support Data Verification and Validation.*

*OLQ Contract Lab Packages.* When a laboratory data package from an OLQ contract lab is received by IDEM, the package is logged, collated with field documentation, and assigned for data validation in accordance with the IDEM SOPs *Chemistry Support Data Package/Field Documentation Receipt, Chemistry Support Field Documentation,* and *Chemistry Support Data Verification and Validation.*

**Figure 2 OLQ Data Verification and Validation Process**




[1] Refer to IDEM SOP *Chemistry Support Contract Lab Sample Set-up.*
[2] Refer to IDEM SOP *Chemistry Support Field Documentation.*
[3] Refer to IDEM SOP *Chemistry Support Data Package Field Documentation Receipt.*
[4] Refer to IDEM SOP *Chemistry Support Data Verification and Validation.*

## D.3. Reconciliation with User Requirements

The PM and chemistry staff will conduct a data quality assessment (DQA) to determine whether data are of the correct type, quality and quantity to support environmental decision making for each project. When any of the project required measurement performance criteria are not met, then the chemist will document the evaluation in a memorandum to the PM which will address:

1. The specific nature of the problem with the data;
2. The probable source of the error;
3. The potential impact of the error on the usability of the data.

The PM will meet with chemistry staff as needed to discuss the significance of the problem(s), and will write correspondence to the owner/operator that documents the agencies official decision including:

1. A summary of problems (if present);
2. The potential need for corrective action.
3. Recommendations for further actions based on program goals, which may include resampling if data is determined to be unusable.

PMs and chemistry staff should estimate the potential effect that each deviation or deficiency may have on the usability of the associated data item and its contribution to the quality of the reduced and analyzed data. All technical review memoranda and program correspondence generated in the data review, verification, and validation process will be retained in the project file. The official agency decision record is publicly available via the public interface to the electronic filing system, the Virtual File Cabinet (VFC).

# APPENDIX A
# REFERENCES


| | |
|---|---|
| 1 | IDEM Leaking Underground Storage Tank Program Web Site (Main Menu) |
| | http://www.in.gov/idem/4997.htm |
| | |
| 2 | IDEM 2001. *Risk Integrated System of Closure Technical Resource Guidance Document* |
| | http://www.in.gov/idem/4200.htm |
| | |
| 3 | IDEM 2006. *Risk Integrated System of Closure User's Guide*, Chapter 3 – UST, LUST, and ELTF Programs |
| | http://www.in.gov/idem/files/riscuserch3.pdf |
| | |
| 4 | IDEM 2007. *IDEM Agency-Wide Quality Management Plan* |
| | http://www.in.gov/idem/5158.htm |
| | |
| 5 | IDEM 2007. *IDEM Remediation Services Branch Quality Management Plan* |
| | |
| 7 | IDEM Electronic Report and Data Submittal Guidelines |
| | http://www.in.gov/idem/5064.htm |
| | |
| 8 | USEPA 2002. *EPA Guidance for Quality Assurance Plans,* EPA QA/G5, EPA/240/R-02/009. |
| | http://www.epa.gov/QUALITY/qs-docs/g5-final.pdf |
| | |
| 9 | IDEM 2008. *IDEM Supplemental Guidance for Sampling Soil and Waste Samples for Volatile Organic Compounds (VOCs)* |
| | http://www.in.gov/idem/catalog/guidance/la-074-gg.pdf |
| | |
| 10 | IDEM 2006. *IDEM Draft Vapor Intrusion Pilot Program Guidance* |
| | http://www.in.gov/idem/catalog/guidance/la-073-gg.pdf |
| | |
| 11 | IDEM 2007. *Sampling DB User's Manual* |
| | |
| 12 | USEPA 2001. *EPA Requirements for Quality Assurance Plans,* EPA QA/R5, EPA/240/B-01/003. |
| | http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf |
| | |
| 13 | Referenced IDEM Standard Operating Procedures/Policies |
| | *QAPP Development and Approval SOP,* June 2006 |
| | *Policy, Standard Operating Procedure, and QAPP Documentation Policy,* Feb. 2007 |
| | *Chemistry Support Sample Request Sheet Sign-Off,* May 2007 |
| | *Chemistry Services Contract Laboratory Sample Set-up,* December 2006 |
| | *Chemistry Support Field Documentation,* June 2007 |
| | *Chemistry Services Data Package/Field Documentation Receipt,* December 2008 |
| | *Chemistry Support Data Verification and Validation,* May 2007 |
| | *OLQ Geographic Information System Data Creation,* Dec. 2006 |

# APPENDIX B
# LIST OF ACRONYMS

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| | |
|---|---|
| CA | Cooperative Agreement |
| CAP | Corrective Action Plan |
| COC | Contaminants of Concern |
| DQA | Data Quality Assessment |
| DQI | Date Quality Indicator |
| DQO | Data Quality Objective |
| ELTF | Excess Liability Trust Fund |
| EPA | Environmental Protection Agency |
| FID | Flame Ionization Detector |
| FSI | Further Site Investigation |
| GC/MS | Gas Chromatograph/Mass Spectrometry |
| GIS | Geographic Information System |
| GPS | Geographic Positioning System |
| IAC | Indiana Administrative Code |
| IC | Indiana Code |
| ICP | Inductively Coupled Plasma Atomic Emission Spectroscopy |
| IDEM | Indiana Department of Environmental Management |
| IS | Internal Standard |
| ISC | Initial Site Characterization |
| LCS | Laboratory Control Sample |
| LEL | Lower Explosive Limit |
| LUST | Leaking Underground Storage Tank |
| MB | Method Blank |
| MCL | Maximum Contaminant Level |
| MDDR | Minimum Data Documentation Requirements |
| MQO | Measurement Quality Objectives |
| MS/MSD | Matrix Spike/Matrix Spike Duplicate |
| MSR | Management System Review |
| NFA | No Further Action |
| OLQ | Office of Land Quality |
| OSHA | Occupational Safety and Health Administration |
| PARCC | Precision, Accuracy, Representativeness, Comparability, Completeness |
| PID | Photoionization Detector |
| PM | Project Manager |
| QA | Quality Assurance |
| QA/QC | Quality Assurance/Quality Control |
| QAM | Quality Assurance Manager |
| QAO | Quality Assurance Officer |
| QAPP | Quality Assurance Project Plan |
| QC | Quality Control |
| QMP | Quality Management Plan |
| RCRA | Resource Conservation and Recovery Act |
| RISC | Risk Integrated System of Closure |
| RPD | Relative Percent Difference |
| RSB | Remediation Services Branch |
| SC | Section Chief |
| SEM | Senior Environmental Manager |
| SOP | Standard Operating Procedure |
| SRM | Standard Reference Material |
| SS | Surrogate Spike |

# APPENDIX B
# LIST OF ACRONYMS

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| | |
|---|---|
| SSB | Science Services Branch |
| STARS | Strategic Targeted Activities for Results System |
| SVOA | Semivolatile Organic Analysis |
| TPH | Total Petroleum Hydrocarbon |
| ULCERS | Underground Leaking, Community Right-to-Know and Emergency Response System |
| UST | Underground Storage Tank |
| VFC | Virtual File Cabinet |
| VOC | Volatile Organic Compounds |
| WP | Work Plan |

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# APPENDIX C

# RISC USER'S GUIDE – CHAPTER 3

UST, LUST, and ELTF PROGRAMS

## 3.0 Introduction

**Overview of Chapter 3**



This section of the Risk Integrated System of Closure (RISC) User's Guide provides a stand-alone RISC resource for underground storage tank (UST) owners, operators, and consultants dealing solely with petroleum and regulated hazardous substance releases. As such, this chapter contains extensive guidance for regulated USTs, including information on initial notification, UST removal, release reporting, site characterization, corrective action, Excess Liability Trust Fund (ELTF) reimbursement, and closure.

In addition, this chapter describes how to achieve closure of sites with contaminated soil and ground water associated with leaking underground storage tanks, and is an update of the RISC User's Guide Chapter 3, dated February 15, 2001. The User's Guide applies to all UST closures and UST releases reported after February 15, 2002. However, rules and statutes that are referenced may have been amended, so the applicable rule or statute must be examined in conjunction with using this Guide.

## Applicable Regulatory Programs Located Within the IDEM

Throughout the lifecycle of an UST system including site assessment and subsequent remedial activities that involve a substance release, it will be necessary to work with several different programs located within the Indiana Department of Environmental Management (IDEM) to achieve compliance and/or closure for your facility. The following is a brief introduction to each respective program's roles and responsibilities:

**Underground Storage Tank Program**

The UST program is responsible for the following –

- Processing "Notification of Underground Storage Tanks" form submittals
- Coordinating with the Department of Revenue regarding UST fee assessment
- Inspecting UST equipment and operation and maintenance of UST systems for compliance with the current standards
- Overseeing and reviewing UST closures
- Educating the regulated community regarding UST requirements.

**Leaking Underground Storage Tank Program**

The LUST program is responsible for the following –

- Receiving release reports for USTs
- Reviewing and commenting on technical reports including, but not limited to, 20-Day Abatement, Initial Site Characterization, Further Site Investigation, Corrective Action Plan, and Corrective Action Progress Reports submitted for LUST sites
- Ensuring substantial compliance with LUST requirements
- Reviewing site information for no-further-action determination
- Education of the regulated community regarding LUST requirements

**Excess Liability Trust Fund Program**

The ELTF program is responsible for the following –

- Determining ELTF eligibility for expenditures related to UST releases
- Reviewing "Notice of Intent" submittals for UST system property transfers
- Reviewing claims for eligible expenses
- Prioritizing claims for payment as necessary

The following tables provide contact numbers and web addresses to support/assist you when working within the different State programs:

## Table 1. Program and Related Topic Contact Information

| Program | Telephone | Fax | Email |
|---|---|---|---|
| IDEM Hotline | 317/232-8603<br>800/451-6027 | Not available | Not available |
| Office of Land Quality | 317/232-8941 | 317/234-0428 | Not available |
| Emergency Response Spill Line | 317/233-7745<br>888/233-7745 | 317/308-3063 | Not available |
| Leaking UST release reporting and corrective action | 317/232-8900 | 317/234-0428 | LeakingUST@idem.in.gov |
| UST notification, reporting and closure | 317/308-3024 | 317/308-3063 | Not available |
| UST fee assessment | 317/234-0343 | 317/234-0428 | jmendel@idem.in.gov |
| ELTF notice of intent, eligibility and claims | 317/234-0990 | 317/234-0428 | ELTFClaims@idem.in.gov |
| Geology and technology review | 317/234-0991 | 317/234-0428 | Not available |
| Chemistry | 317/232-3512 | 317/234-0428 | Not available |
| Risk Integrated System of Closure | 317/232-8997 | 317/234-0428 | idemrisc@idem.in.gov |
| Engineering | 317/242-5884 | 317/234-0428 | Not available |
| State Cleanup Program | 317/234-0360 | 317/234-0428 | Not available |
| Voluntary Remediation Program | 317/234-0360 | 317/234-0428 | Not available |
| State Fire Marshal | 317/232-2222<br>800/423-0765 | 317/233-0307 | Not available |
| IOSHA | 317/232-2655<br>800/743-3333 | 317/233-3790 | Not available |
| American Petroleum Institute | 202/682-8375 | Unknown | www.api.org |

## Table 2. Program Web Sites

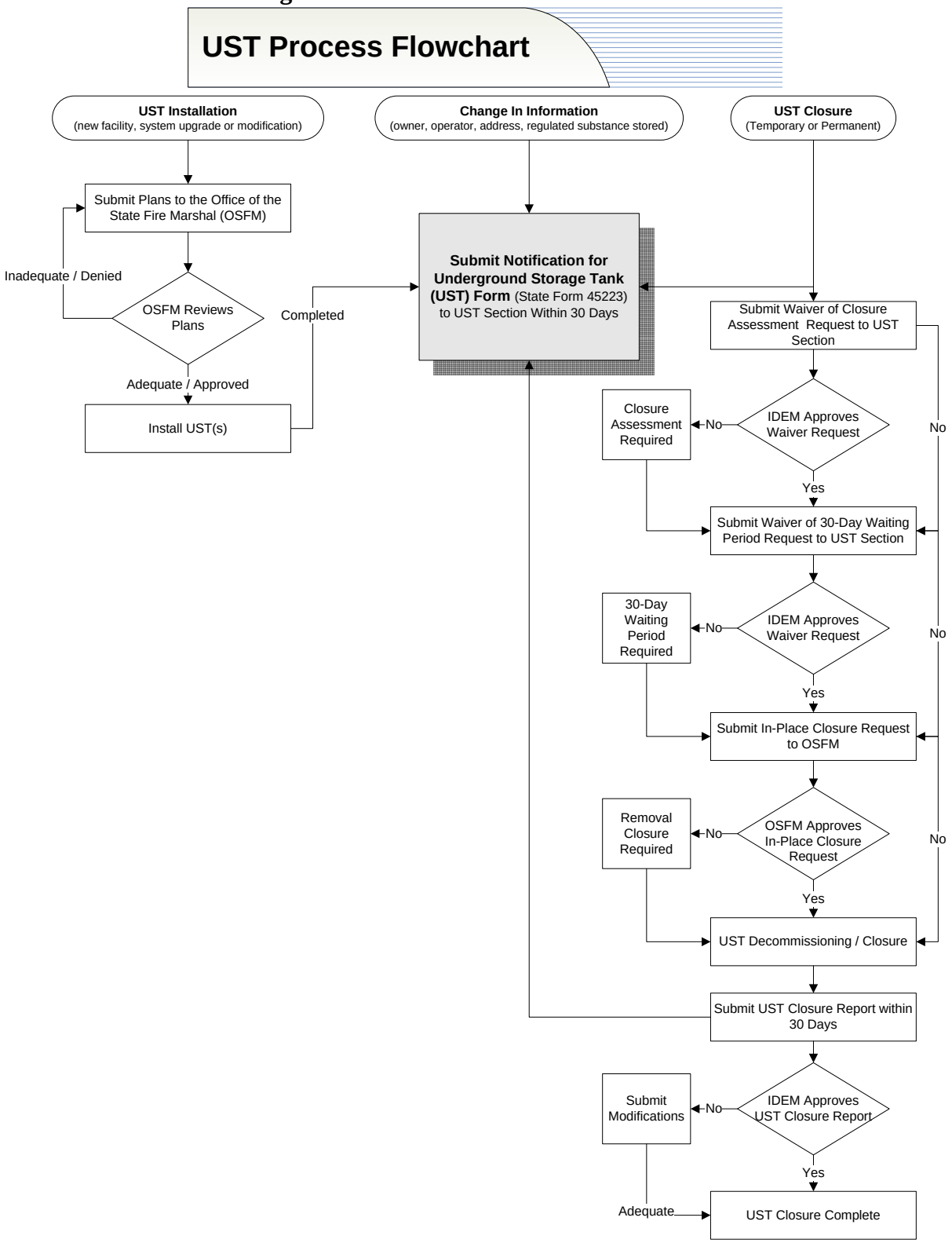
| Program | Web Site |
|---|---|
| Underground Storage Tank (UST) | http://www.in.gov/idem/4999.htm |
| Leaking Underground Storage Tank (LUST) | http://www.in.gov/idem/4997.htm |
| Excess Liability Trust Fund (ELTF) | http://www.in.gov/idem/5063.htm |
| Risk Integrated System of Closure (RISC) | http://www.in.gov/idem/4153.htm |

## 3.1 Underground Storage Tank Notification, Reporting, Fees, and Closure Requirements

This information provides an overview of UST systems regulated in accordance with Indiana Administrative Code, Title 329, Article 9 (329 IAC 9). This information will aid tank owners/operators in UST system notification, registration, and permanent closure procedures. The applicable section(s) of 328 IAC 1 and 329 IAC 9 (including definitions); IC 13-23 and IC 13-11 (for statutory definitions) should always be consulted in conjunction with this chapter.

Figure 3-1 is a flowchart illustrating the lifecycle of an UST system. The chart also indicates the appropriate actions to take if a release is discovered.

**Figure 3-1 – UST Process Flowchart**



### 3.1.1 Notification Requirements

**General Notification**

As described in 329 IAC 9-2-2 and 329 IAC 9-3-1, the owner/operator must complete a Notification for Underground Storage Tanks form (State Form 45223), within 30 days when:

- UST systems or tanks are brought into use
- UST systems are acquired by a new owner
- UST systems are upgraded (tank lining, piping replacement, leak detection system, or equipment installation, spill/overfill prevention equipment, or corrosion protection) or repaired (restoration of a tank or UST system component that has caused or could potentially cause a release of product from the UST system)
- UST systems are temporarily closed
- UST systems undergo a change-in-service
- UST systems are closed

**Closure Notification**

In accordance with 329 IAC 9-6-2.5 and 329 IAC 9-3-1, a request for closure should be provided to the IDEM UST Section at least 30 days before an UST system closure (removal, in-place, or change-in-service), UST system repair, or UST lining. Please use State Form 45223 Notification for Underground Storage Tanks form when requesting closure.

Within 30 days after an UST system closure, this form (Notification for Underground Storage Tanks, State Form 45223) must be submitted *again* with an UST System Closure Report. If these documents are not submitted *together*, they will be returned to the UST owner/operator as incomplete.

**Document Submittal**

In accordance with the requirements established in 329 IAC 9-2-2, all documents required by the UST Section must include an original signature *in ink* by either the owner/operator or an authorized representative. If an owner/operator authorizes a representative to sign forms, then a document must be submitted to authorize the representative. This authorization document must include the following:

- UST system facility name and address;
- Representative name and address;
- Listing of documents that the representative is authorized to sign; and
- Owner name signed *in ink*.

A copy of the authorization must accompany each document that is signed by the owner/operator's representative.

As the State requires that individuals/companies performing tank installations, closures, upgrades, removals, change-in-service, and testing be certified by the Office of State Fire Marshal (OSFM), the contractor must also sign and provide the OSFM certification number on the Notification for Underground Storage Tanks, State Form 45223.

### 3.1.2 Tank Fee Assessment Program

The Underground Storage Tank Fee Assessment Program was established in 1989 to collect tank fees from *owners* of regulated USTs. For the purposes of the Tank Fee Assessment Program, regulated USTs are defined as follows:

- Greater than 110 gallons in commercial or industrial use
- Greater than 1,100 gallons in agricultural or residential use
- Not otherwise exempt by State statute or rule

This assessment program pertains to USTs containing regulated petroleum products or hazardous substances as defined in Section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980. The list of hazardous substances is found at 40 CFR 302.4.

**Fee Assessment and Use of Fee Monies**

As described in IC 13-23-12, a regulated petroleum UST fee is $90.00/year and a hazardous substance UST fee is $245.00/year. These fees are divided among three funds:

- $45.00/tank/year of the petroleum UST fee goes to the Underground Petroleum Storage Tank Excess Liability Trust Fund (ELTF). The ELTF provides financial assurance for tank owners and operators, and reimburses them for cleanup of their sites in compliance with 40 CFR Part 280 and 329 IAC 9. In addition to cleanup costs, administrative costs of the ELTF Program are taken from this fund.

- $45.00/tank/year of the petroleum UST fee goes to the Underground Petroleum Storage Tank Trust Fund (UPSTTF). The UPSTTF pays for State funded cleanup of abandoned leaking petroleum USTs (or for sites where the owner/operator
- is recalcitrant), administrative costs and state match for the LUST grant funding received from the U.S. Environmental Protection Agency.
- $245.00/tank/year of the hazardous substances UST fee goes to the Hazardous Substances Response Trust Fund (HSRTF). The HSRTF pays for cleanup of uncontrolled hazardous waste sites, administrative costs, and state match for grant funding and federally funded cleanups.

**Fee Assessment Period**

Currently, the fee assessment period begins July 1 of each year and concludes on June 30 of the following year. The IDEM coordinates the Fee Assessment Program with the Indiana Department of Revenue's Special Tax Division. Although the assessment period begins on July 1, the Special Tax Division does not mail invoices until the fall of the year. Receipt of payment is due no sooner than 30 days after the assessment date. This due date is specified on each year's invoices (UST-1 form).

For questions regarding the processing of a payment, the Department of Revenue can be contacted.

**Fee Payment**

As described in IC 13-23-12, payment of tank fees can be made in two ways:

- Payment may be made in full on the due date specified on the invoice (UST-1 form).
- For owners whose tank fee exceeds $500.00, payment may be made in four (4) equal installments. The applicable payment portion of the voucher sheet (UST-2 form) must be included with each installment payment.

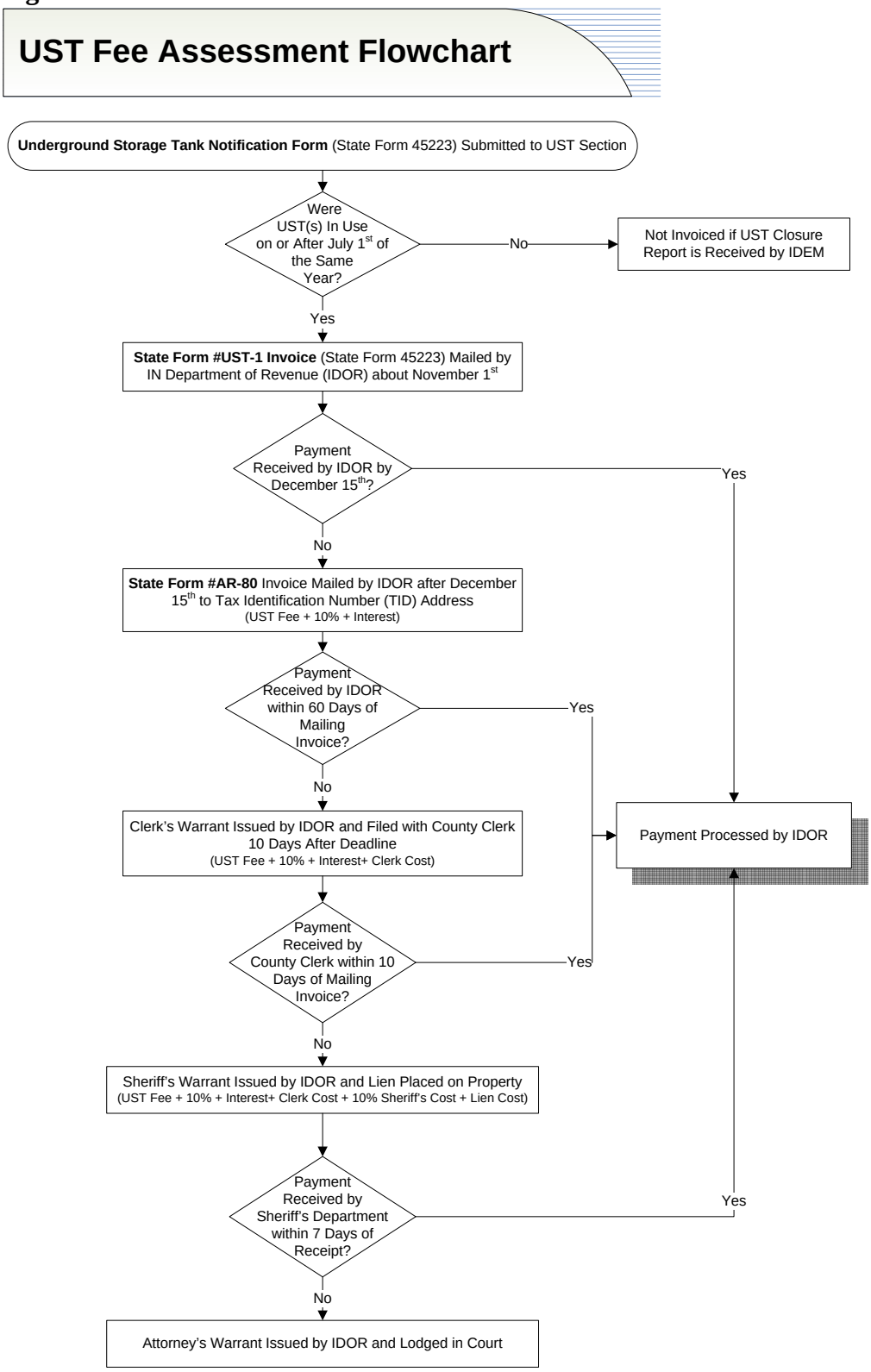
**Fee Assessment Information**

The UST Section obtains fee assessment information on owners, facilities, and tanks from the IDEM's UST database. The database information is gathered from the Notification for Underground Storage Tanks form (State Form 45223), submitted by owners and operators. If there have been any changes in an UST facility since the last notification submittal (i.e., if a tank has been closed at a facility), this

should be indicated on a Notification for Underground Storage Tanks form (State Form 45223) in order for accurate fee assessments to be made.

Figure 3-2 illustrates the UST fee assessment process.

**Figure 3-2 – UST Fee Assessment Flowchart**



For questions regarding why or how a tank fee was assessed, the UST Section of the IDEM should be contacted.

### 3.1.3 UST System Closure

In order to close a regulated UST system in Indiana, the following rules **must** be followed:

- 40 CFR 280 (Federal Regulations)
- 329 IAC 9 and 327 IAC 2-6.1 (State Rules)
- 675 IAC 22 (Indiana Fire Prevention Code)

**Regulated vs. Unregulated Tank Status and Registration Requirements**

Tanks closed or out of operation (a tank is considered out of operation if it is completely empty and the fill pipe is not accessible) on or before January 1, 1974, are **not regulated**. There are no notification requirements to the IDEM prior to closure, although the Fire Code still applies during removal activities. If at any time during the closure of unregulated USTs contamination is discovered, the contamination must be reported to IDEM Emergency Response and cleaned up as required by 327 IAC 2-6.1, IC 13-24-1, IC 13-25-4, etc.

All tanks in the ground before May 8, 1986 (unless taken out of operation), are **regulated**, but were **not required to have been registered**. You must notify the IDEM prior to closure and perform an UST closure assessment as required by 329 IAC 9-6-2.5.

All tanks in the ground on or after May 8, 1986, (unless taken out of operation) **are regulated**, and are **required to be registered**. You must notify the IDEM prior to closure and perform an UST closure procedure as required by 329 IAC 9-6-2.5.

If you are unable to determine the regulated status of a particular UST after consulting the applicable regulations, contact the IDEM, UST Section.

**UST System Closures**

There are **three types of regulated UST system closures**: removal, in-place closure, and change-in-service closure.

- **Removal** – A "removal" closure is when all USTs, piping and dispensers are physically removed.
- **In-place** – An "in-place" closure is when a portion or all of the USTs, piping, and dispensers are closed without removal. In-place closures require prior approval from IDEM. The conditions for obtaining approval include, but are not limited to, all or a portion is inaccessible due to buildings or structures.
- **Change-in-service** – A "change-in-service" closure is when a UST system is converted from being used to store regulated substances to unregulated substances. Change-in-service closures require prior approval from IDEM.

**Notification Requirements Prior to Removal, In-place Closure and Change in Service**

UST System Removal, In-place Closure, and Change in Service

- All UST systems in place after May 8, 1986, must be registered with the IDEM UST Section (completed Notification for Underground Storage Tanks form (State Form 45223).
- For all tanks in place after January 1, 1974, Notification of intent to close must be given using the Notification for Underground Storage Tanks form (State Form 45223), at least 30 days before closure activity begins.
- IDEM UST Section will respond in writing with the closure approval date (closure approval letter will expire 90 days after date given).
- The closure approval letter must be kept onsite at all times during closure activities.
- A contractor or individual certified through the Office of State Fire Marshal (OSFM) must be used for closure (at least one certified person must be on site at all times).
- In addition to the 30-day notice, the IDEM UST Section, the OSFM and the local fire department should be given at least 14 days prior notice (by phone) of the intended closure date.
- An UST system closure site assessment must be performed to determine if contamination is present. Within 30 days after permanent closure, a completed Notification for Underground Storage Tanks form (State Form 45223), and an UST System Closure Site Assessment Report must be filed with the IDEM UST Section. (This will prevent improper assessment of annual UST system fees for permanently closed UST systems).
- An in-place closure or a change-in-service may not begin until the owner receives written approval from the IDEM UST Section.

UST System Closure Waiver

If a permanent closure is determined necessary due to a release or leak from an UST system, then a waiver of the 30 day period may be granted. All UST systems must be registered with the IDEM UST Section prior to waiver approval. The following conditions apply when requesting a waiver:

- An IDEM Spill Number or LUST Incident Number is required before a waiver is given. Follow the reporting procedures outlined in Section 3.3
- The OSFM and local fire department must be notified prior to closure.
- Within 30 days following closure, a completed Notification for Underground Storage Tanks form (State Form 45223), and one copy of the UST System Closure Site Assessment report must be sent to the IDEM UST Section.

**Requirements for the UST System Closure Environmental Site Assessment**

An environmental site assessment is required for all regulated UST system closures and must be included into the UST System Closure Report. The report must be submitted to IDEM within 30 days after UST system closure completion. In addition, the site assessment must be consistent with RISC Technical Resource Guidance Document and User's Guide. The following is a summary of the requirements:

**Soil sampling** – Soil samples should always be collected from the area most likely to be contaminated based on visual observations, odor and appropriate field screening, e.g. photoionization detector (PID), flame ionization detector (FID) or gas chromatograph. Samples are required from the bottom of the excavation. Soil samples always must be collected from native soil (i.e., the soils that were in place at the site prior to tank installation). The only exception to this would be samples collected from excavated materials which typically consist of fill.

Specific UST soil sampling requirements are presented in the tables that follow:

### *UST Removal Soil Sampling Requirements*

| | |
|---|---|
| **Bottom Soil Samples** | USTs <10,000 gallons - two (2) within two (2) feet below both ends of the each UST |
| | USTs >10,000 gallons, one (1) additional within two (2) feet below the middle of the UST |
| **Sidewall Samples** | UST pit perimeter <80 feet – four (4) sidewall samples collected from half the distance between the surface and the bottom of the UST excavation or the area most likely to be contaminated based on field observation. |
| | UST pit perimeter >80 feet – one sidewall sample for every 20 linear feet collected from half the distance between the surface and the bottom of the UST excavation or the area most likely to be contaminated based on field observation. |
| **Piping Samples** | Pipe run <20 feet – one (1) sample half way between UST and dispenser or fill port |
| | Pipe run >20 feet - one (1) sample for every 20 linear feet of pipe run |
| | One sample under every piping elbow or connector |
| **Dispenser Samples** | One sample under each dispenser |
| **Excavated Material** | Sampling of excavated material must occur for every 50 cubic yards of material that is treated, disposed or returned to the excavation area as backfill. Soils with COCs exceeding the RISC IDCLs should not be returned to the excavation. |

### *In-place Closure and Change-in-service Boring Placement and Soil Sampling Requirements*

| | |
|---|---|
| **Tank Pit Samples** (Samples obtained from one (1) continuously sampled boring within three (3) feet of the UST and then placed every 20 linear feet around the UST, with a minimum of four (4) borings and extended at least two (2) feet below the bottom of the UST) | Borings <15 feet – Two (2) samples: one at midpoint and one at bottom of boring |
| | Borings >15 feet – Three (3) samples: one at >1 foot below ground surface, one at the midpoint, and one at the bottom |
| **Piping Samples** (Samples obtained from borings placed within three (3) feet of and two (2) feet below pipe run, elbow or connector) | Pipe run <20 feet – one (1) sample half way between UST and dispenser or fill port |
| | Pipe run >20 feet - one (1) sample for every 20 linear feet of pipe run |
| | One sample under every piping elbow or connector |
| **Dispenser Samples** (Samples obtained from boring placed within three (3) feet of a dispenser island. The sample should be obtained from a depth of approximately 2 feet beneath each dispenser location | One sample under each dispenser |

**Note:** If the exact location of the UST and piping is not known, the borings locations should be determined based upon non-invasive methods such as ground penetrating radar (GPR).

**Ground Water Sampling –** If ground water is encountered during UST removals or change-in-services ground water samples are required to be collected.

### *Removal, In-place, and Change-in-Service*

| | |
|---|---|
| **UST Excavation** | One (1) ground water sample from each excavation where it is encountered (for removal only) |
| **Soil Borings** | A water sample must be collected within the first saturated zone located below the top of the UST. If ground water is not encountered at 30 feet or there is refusal, a soil sample should be collected at the base of the boring |

**Soil and Ground Water Sample Analyses—** Groundwater and soil sampling requirements for gasoline range organics, diesel range organics, high end hydrocarbon oils, and waste oil are located in Chapter 8 (Table 7.1) of the RISC Technical Guide. Note: The IDEM

reserves the right to modify these requirements dependent upon historical site conditions and the type and nature of the release.

If at any time, during the closure process, you suspect or confirm a release, you must report the release to IDEM within 24 hours:

**UST System Closure Report**

The following information is **required** in an UST Closure Report:

Responsible Party

- The UST system facility's owner/operator name, IDEM owner I.D. number (if known), address, phone number;
- The name of the UST system facility contact person, owner/operator affiliation, phone number; and
- Owner/operators for the past twenty-five years.

UST Contractor

- UST closure contractor company name and address; and
- Name and OSFM certification number of person(s) on site during closure.

UST Site

- Facility name, IDEM Facility I.D. number (if known), address and phone number;
- Type of facility and past and current operations;
- Coverage (turf, concrete, asphalt, etc.);
- History of any spill reports, by incident number;
- Site proximity to both human and environmentally sensitive areas;
- Site native soil texture (i.e., percent of sand, silt, and clay); and
- Site specific map(s) with appropriate scale and legends to show site details described below:
    - Illustrated legends and compass directions at appropriate scale;
    - Drainage features (surface slope/surface water runoff direction);
    - Identified above ground features (buildings, roadways, pump islands, utility lines, etc.);
    - Property lines;
    - Identified subsurface features (tanks and excavation pit, piping, utility conduits, etc.);
    - Locations of samples (S1, S2, etc.), soil borings (SB1, SB2, etc.), and monitoring wells (MW1, MW2, etc.);

- Locations of previously closed tanks (if applicable); and
- Site surroundings (adjacent buildings, land use, business descriptions).

Underground Storage Tank(s):
(The following information refers to the tanks being closed);

- Previous owner history (past 25 years)
- Number and volume of tank(s);
- Past and present contents of tank(s);
- Construction material of tank(s);
- Age and installation date of tank(s);
- Leak detection methods used;
- Records of tank tightness test results (most recent);
- Most current records of any other leak detection method results (inventory records, ground water or vapor monitoring results); and
- Information on any previously closed UST systems (date closed, number, size, and product stored).

Sample Results

- Data from analysis of soil samples presented in tabular format;
- Data from analysis of water samples presented in tabular format;
- A signed Laboratory Certificate of Analysis listing analytical method, preparation method, date of sample receipts, and date of analysis (data submission requirements explained in detail in Section 3.4.4 of this chapter);
- Proper sample numbers for cross reference to UST site maps;
- Chain-of-Custody documentation and data from analyses of soil and water;
- Decontamination procedures/sampling procedures and techniques; and
- Data from analysis of waste oil sampling (where applicable).
- Quality Assurance/Quality Control documentation.

Miscellaneous Closure Documentation

- Soil and water disposal documentation
- Remaining product and sludge documentation. Tank and piping disposal documentation
- LUST Referral Sheet for Closure (all sites with contamination must fill out a LUST Referral Sheet—this includes contaminated backfill sites and sites where over excavation occurs).

As stated previously, the closure report must be submitted to the UST Section of the IDEM within **30 days** of tank closure. The IDEM UST Section will review each closure report and supply the owner of the tanks with a System Closure Report Review Checklist (SCRRC) within six months of the UST Section's receipt of the UST Closure Report. The SCRRC will document which areas have been sufficiently completed and those that are insufficient and require further documentation.

**The SCRRC is only intended to document the completeness of the UST system closure and reporting activities. A SCRRC deemed "complete" in no way releases an owner/operator from performing additional environmental investigations in the event that a release has occurred.**

**LUST Referral and Incident Reporting**

During **any** UST closure, if a release is suspected or discovered, it must be reported to the IDEM **within 24 hours.** The release must be reported to IDEM following the procedures outlined in Section 3.3. A copy of the Initial Incident Report Form can be obtained by calling the IDEM Leaking Underground Storage Tanks Section at 317/232-8900 (toll-free 800/451-6027, ext. 28900). If at any time during the closure process, an emergency condition is discovered such as explosive vapors found in buildings or utilities, call 911 and IDEM Emergency Response **immediately**. If conditions exist that require an immediate response such as non-explosive vapors in buildings or utilities or if free product is present on surface water, call the IDEM Emergency Response program **within 2 hours**.
Only releases from **regulated tanks** are reported to the LUST Section as described above. Releases from **non-regulated tanks** should be reported to the IDEM Emergency Response Program. Contact information for this program has been included in Table 1.

If a release is confirmed, under most circumstances, the nature and extent of contamination must be determined and corrective action is required.

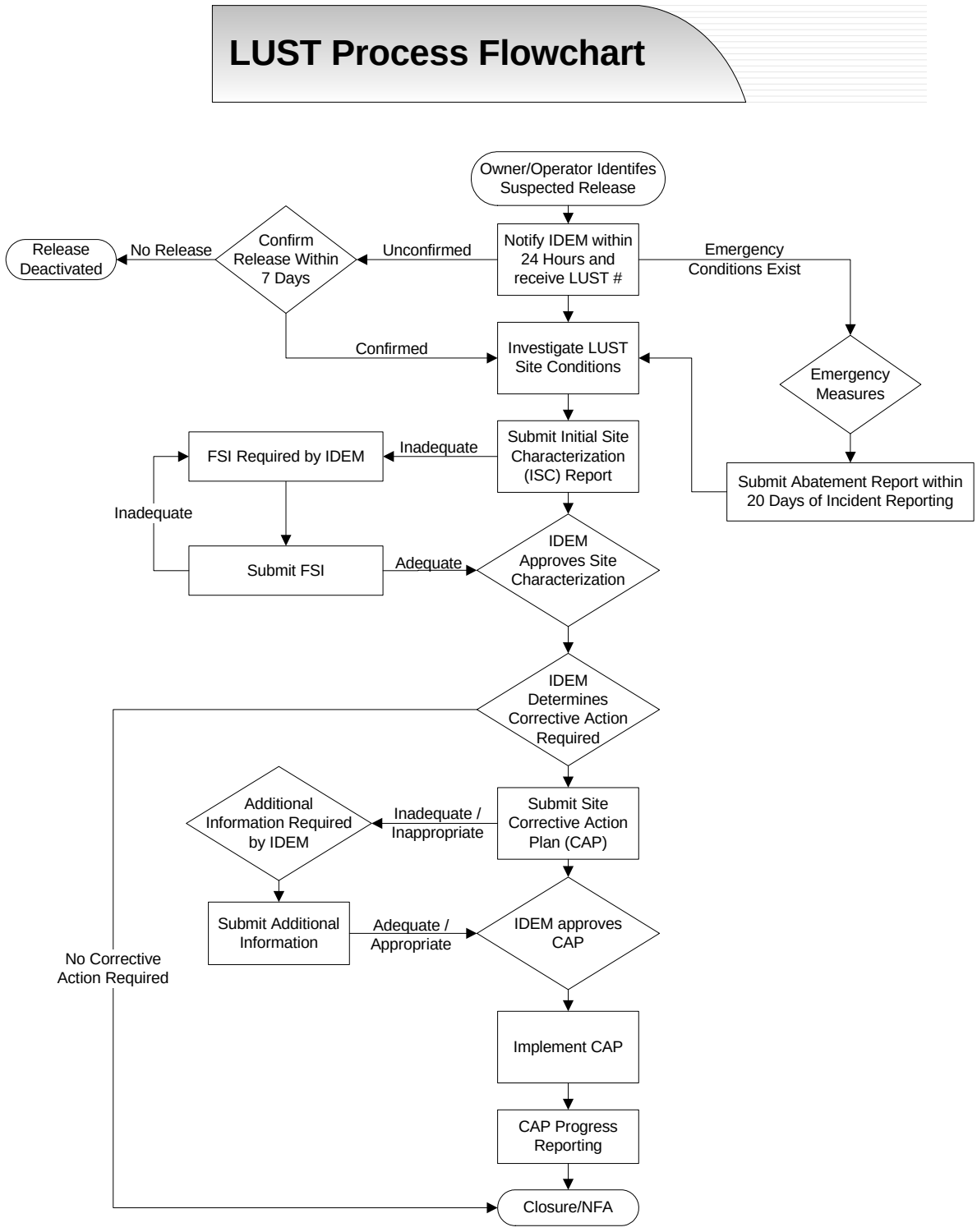
## 3.2 The LUST Process

The following sections describe how to achieve closure of petroleum- and regulated substance-contaminated soil and ground water associated with leaking underground storage tanks using RISC.

**Note:** the term "regulated substance" includes hazardous substances; however, this chapter **does not** apply to waste tanks regulated under RCRA.

The following flowchart provides a broad overview of the LUST process:

**Figure 3-3 – LUST Process Flowchart**



## 3.3 Initial Incidents and Releases

In accordance with 329 IAC 9-4-1 and 329 IAC 9-4-4, there are three basic release situations: Emergency conditions, suspected releases, and confirmed releases. **Initial incident and release reporting to IDEM is required for all suspected and confirmed releases. Failure to report your incident within the time frame specified by IDEM will affect future ELTF eligibility.** A copy of the Initial Incident Report Form can be obtained by calling the IDEM Leaking Underground Storage Tanks Section at 317/232-8900 (toll-free 800/451-6027, ext. 28900). Suspected and confirmed releases must be reported within **24 hours** of discovery to IDEM. This can be accomplished in one of three ways:

- Telephone – Report to LUST Program staff during normal business hours or Emergency Response Program staff after hours and weekends
- Fax – Send completed "LUST Release Report"
- E-mail – Send completed "LUST Release Report" to the LUST Program

See the contact information located in Tables 1 and 2 of this section for telephone and fax numbers as well as applicable e-mail addresses.

### 3.3.1 Emergency Conditions

If emergency conditions exist, such as vapors in a habitable building, product or vapors in utility conduits, free product on surface water, and surface spills and overfills exceeding 25 gallons, initial reporting must be made in accordance with 327 IAC 2-6.1 within **2 hours**. All applicable phone and fax numbers have been included in Table 1 of this Chapter.

ELTF claims may be reimbursable using "Confirmation of Emergency Measures Status" procedures included in the ELTF Application, State Form 47139 (R3/11-02). Claimants should coordinate with the assigned IDEM Project Manager.

### 3.3.2 Suspected Releases [329 IAC 9-4-1 and 329 IAC 9-4-3]

In accordance with 329 IAC 9-4-1 and 329 IAC 9-4-3, suspected releases are recognized by the following conditions:

- Erratic behavior of product-dispensing equipment
- Sudden loss of product through inventory control checks
- Tank tightness test failure (Two consecutive failed tank tightness tests is considered a confirmed release.)
- Water present in UST
- Free product present
- Vapors are reported in basements, buildings, or nearby utility conduits
- Discovery of off-site impacts in soils, surface water, or ground water

**When obvious visual signs of contamination or odors are present, release notification should not be delayed by waiting for laboratory confirmation.** Suspected release reports must be reported to IDEM within **24 hours** by telephone, fax or email. All applicable phone and fax numbers have been included in Table 1 of this Chapter.

In accordance with 329 IAC 9-4-3, suspected release reports should include information specified in Part A of the release reporting information provided in Section 3.3.5. Owners and operators then have **7 days** to negate or confirm suspected release reports by providing **written documentation** via facsimile or mail to the following address:

Indiana Department of Environmental Management
Leaking UST Section
100 North Senate Avenue, Room 1101
Indianapolis, IN 46204-2251

An incident number will be assigned at the time of the report. If information submitted negates the release report, the incident number will be "deactivated".

### 3.3.3 Confirmed Release

A confirmed release must be reported to the IDEM within **24 hours** by either using one of the mechanisms outlined in Section 3.3.2.

A confirmed release is defined as follows:

- Soil contamination is present
- Ground water contamination is present
- Free product is present
- Contamination is confirmed in conduits such as utility lines or sewers
- Vapors are detected inside a building

**Any detection of contaminant(s) requires a release report.** Confirmed release reports should include items specified in the release reporting information provided in Section 3.3.5.

### 3.3.4 20-Day Abatement and Free Product Removal Reporting

One or more of the following conditions at LUST sites warrant immediate corrective action or mitigation:

- Presence of free product greater than $^{1}/_{16}$ of an inch
- Presence of explosive vapors in utility conduits
- Presence of vapors in a habitable building
- Contamination of a drinking water supply at levels that exceed residential default closure levels
- Other conditions determined by IDEM that require mitigation

If any one of these conditions occurs, the owner or operator must submit a 20-day abatement report to IDEM within **20 days** from the date of release confirmation. **Note:** the free product discovery and abatement activities performed and documented on the 20-day Abatement Report will satisfy the free-product abatement and reporting requirements of 329 IAC 9-5-3.2.

### 3.3.5 Initial Incident and Release Reporting

Reporting information requirements for suspected and confirmed releases are summarized below.

**Both suspected and confirmed releases**

1. Site name, address, contact person and telephone number, and UST facility identification number
2. UST system size and products contained

3. Owner or operator name, address, and telephone number
4. Reason(s) for suspecting a release
5. Future investigative steps

**Confirmed releases only**

6. Location of release (piping lines, dispensing island, USTs, joint connections, etc.)
7. Knowledge of release (failed tank tightness test, analytical results, catastrophic spill, etc.)
8. Affected area(s) (backfill, natural soil, ground water, surface water, utility lines, basements, etc.)
9. Site-specific information (affected utility conduits, drinking water intakes, or detection of free product)

Upon receipt of an Initial Incident Report, IDEM will assign a LUST incident number. This number and the UST facility identification number (FID) should appear on all future correspondence to IDEM. Failure to include these numbers may delay document review.

### 3.3.6 LUST Site Prioritization

After initial incident reporting, the LUST site is prioritized so that the appropriate IDEM resources can be allocated to the project management. Site prioritization is based on the most appropriate site information typically available during initial LUST reporting. However, if site conditions change, the site priority could also change.

**High-priority** LUST sites are defined as sites with actual or potential receptor impacts that threaten human health or the environment through one or more of the following:

- Habitable buildings with vapors present
- Drinking water contamination
- Utility conduits with vapors or free product present
- Ecologically susceptible area affected
- Free product present
- Ground water contamination within a 1-year time of travel to a designated wellhead protection area

**Medium-priority** LUST sites are defined as sites where ground water has been affected, but no imminent threat to human health or the environment exists. The potential for receptor contamination will be evaluated for medium-priority sites.

**Low-priority** LUST sites are limited to sites where soil is contaminated but ground water contamination is not present or is unproven.

Factors used to rank sites within each priority category include the following:

- Type of product released
- Predominant soil type in the area
- Ground water flow direction and velocity

At times, site reprioritization may be necessary. For example, during tank removal, initial indications may show that only soil has been contaminated. However, further investigation may indicate ground water contamination as well. In this case, a site is reprioritized from low to medium priority. If a site requires higher prioritization, the owner or operator must notify IDEM within 24 hours of discovery.

## 3.4 The LUST Process and How it Relates to RISC

Once a release associated with an UST system is discovered, the nature and extent of contamination must be determined using the RISC process. The remaining sections of this chapter are devoted to explaining how to define the nature and extent of contamination and ultimately achieve closure of your facility using RISC.

### 3.4.1 Transition of LUST Sites from the 1994 Guidance to RISC

While all releases reported after February 15, 2002, are **required** to use the RISC process to achieve closure, it is also possible to transition a site with an earlier release into RISC.

Because the RISC process uses different sampling methods and different laboratory analyses than the 1994 LUST Guidance, a re-evaluation of the site is permitted; however, the owner should also be aware of the following:

- The IDEM may require a cost feasibility study prior to field activities as it is not always cost-effective for a site to be transferred into RISC. Also, once approved, the RISC evaluation should be conducted in one mobilization to the site.

RISC evaluations requiring two or more mobilizations may be eligible for reimbursement under ELTF when approved by IDEM. Under most circumstances, a Sampling Plan should be submitted to IDEM for review and approval prior to beginning field activities. You should consult the IDEM LUST Project Manager prior to proceeding with this plan.

- During the re-evaluation, all borings should be advanced in strict accordance with RISC sampling procedures (i.e., step-out) and analyzed for the appropriate RISC contaminants of concern unless otherwise approved by IDEM. Whenever possible, data obtained from previous investigations should be substituted in lieu of installing additional borings or submitting additional samples to the laboratory for analysis. Excessive boring and sampling efforts during this re-evaluation will not be eligible for reimbursement under ELTF.
- Finally, once a site has been transferred into RISC, and this transfer has been approved by the IDEM Project Manager, it **may not** be transferred back to the 1994 LUST Guidance at a later date.

Remember that sometimes it is easier to transfer to RISC earlier in the closure process rather than later. For example, if an owner decides to transfer to RISC during the Corrective Action Plan (CAP) development phase, the Site Characterization approved under the 1994 LUST Guidance may no longer be acceptable under RISC, and additional delineation may be necessary prior to the development of the CAP.

In some scenarios, this transition may enable a tank owner to achieve a more cost-effective and expeditious closure; however, prior to initiating the transition of an existing LUST site into RISC, it is **strongly recommended** that the tank owner or tank owner's representative contact IDEM technical staff to explore options and identify expectations before any field activities are conducted.

### 3.4.2 RISC Default vs. Nondefault Guidance

Most of the guidance presented in this Chapter contains default procedures for site characterization. The term "**default**" refers to the use of a standard constant, equation, or evaluation that is prescribed for *general application* within the RISC Technical Guide. Typically, the default procedures described in this section can streamline a site investigation as they attempt to be a "one size fits all" approach.

The IDEM does realize however, that this "one size fits all" approach may not always provide the most practical, cost-effective, or expeditious route to closing a LUST site. Therefore, nondefault options are also available for conducting site activities. The term "nondefault' is essentially defined as any constant, equation, model, process, strategy, or evaluation that is not prescribed for general application. Examples of nondefault approaches are presented in the RISC Technical Guide.

The nondefault process is not, by definition, superior or inferior to the default process. However, if a nondefault approach is employed, there will be a greater need to interact with IDEM technical review staff throughout the closure process. For example, a rationale for the technical validity of the nondefault application may be required (such as the technical rationale for sampling differently from the default approach while demonstrating that closure objectives have been obtained). It should also be noted that certain nondefault procedures will require greater technical sophistication on the part of the professional performing the evaluation.
Finally, the nondefault approach will generally require the development of a quality assurance project plan (QAPP). Below are some examples where QAPP development would be appropriate:

- Petroleum products that do not have standardized contaminants of concern (COCs).
- Nondefault screening and characterization methods are used.
- Nondefault closure sampling is performed.

Additional information on QAPPs is provided in the RISC Technical Guide.

Because of the greater uncertainty associated with the nondefault approach, IDEM **strongly recommends** that such approaches be reviewed in a meeting with IDEM technical staff to explore options and identify expectations prior to conducting the assessment.

### 3.4.3 Petroleum Contaminants of Concern (COCs)

The four (4) groups of petroleum hydrocarbons for which RISC has determined standard COCs are gasoline, mid-range liquid hydrocarbon fuels, hydrocarbon oils, and waste/used oil. Table 7.1 in Chapter 8 of the RISC Technical Guide lists the petroleum COCs depending on the source type. For source types not listed in the table, call the IDEM

Leaking Underground Storage Tank Section at 317/232-8900 or toll free at 800/451-6027 ext. 28900.

Some petroleum hydrocarbon products do not have standardized COCs. Contaminants are determined on a site specific basis for these contaminants. These sites require a complete and detailed QAPP to identify the COCs. All parts of the QAPP must be completed, including data quality objectives (DQOs), a health and safety plan, a sampling and analysis plan, and a data quality assessment. Additional information on QAPPs is presented in the RISC Technical Guide. Guidance on acceptable analytical methods for appropriate estimated quantitation limits (EQLs) is provided in the RISC Technical Guide. OLQ's Chemistry Section may be contacted for information regarding analytical requirements for other contaminants.

Occasionally, as new information becomes available, the IDEM may need to update the RISC Default Closure Level Tables. Generally, this is done every two years, but may be more frequent for specific COCs. If and when this happens, any remediation for which the IDEM has already received a submittal, or a notice of intent to apply as of the date of the new posting, will be allowed to use the pre-existing values if they choose to do so. Those submitting after the effective date of change will be subject to the new values. Certain transition policies may apply.

### 3.4.4 Data Submission Requirements

Proper sampling and laboratory analyses are required to verify site conditions. These requirements cover sample acquisitions, containers, preservation, shipping, holding times, storage, chain of custody, decontamination of equipment between samples, and sample analysis.

Sampling and analysis methods must be consistent with U.S. Environmental Protection Agency's (U.S. EPA) publication SW-846, "Test Methods for Evaluating Solid Wastes, Physical and Chemical Methods," Third Edition including all updates. Alternative laboratory methods should be approved by IDEM in advance. **Please note:** the IDEM requires that all soil analytical results be reported on a dry weight basis.

Quality Assurance/Quality Control (QA/QC) procedures outlined in the methods must be followed and the documentation should be available for submission to IDEM upon request. Laboratory detection limits for all analyses should be low enough to effectively evaluate

contaminant concentrations against RISC residential default closure levels.

When submitting sampling and analysis documentation, you should follow the "Minimum Data Documentation Requirements" (pursuant to 329 IAC 9-5-5.1(b)(2)(F) discussed in the remaining parts of this section. The information that must be included with all analytical submittals is as follows:

**Sampling Quality Assurance/Quality Control (QA/QC) Data and Information:**

- Completed chain-of-custody form
- Date and time each sample was taken
- Map or diagram indicating sample locations
- Any notable observations *(*color, clarity, texture, reaction with preservatives, etc.)
- Identity of field duplicates (a minimum of one duplicate for every 20 or fewer samples)

As outlined in IDEM's Minimum Data Documentation Requirements, IDEM requires the collection of various QA/QC samples throughout different stages of the site characterization, corrective action, and closure process. These samples are identified as follows: Matrix Spike/Matrix Spike Duplicate (MS/MSD), Equipment Blank, Field Duplicate, and Trip Blank. The QA/QC requirements may vary depending on the stage in the process and site-specific conditions.

The IDEM LUST section **requires** the submittal of a MS/MSD sample for both soil and ground water during initial site characterization activities. The MS/MSD samples are **not required** during further site investigative activities or corrective action monitoring activities unless otherwise directed by IDEM staff. Prior to requesting site closure (during confirmatory soil and ground water sampling) an additional MS/MSD sample (for all affected media) will be required.

The following table outlines IDEM's QA/QC sampling requirements and rationale:

| QA/QC Samples | Media Sampled | Comments |
|---|---|---|
| **MS/MSD** | Soil and Ground water | This sample should be collected in a location with the least amount of suspected contamination. This sample indicates whether the matrix that the sample was collected from (i.e., soil) interferes with the accuracy and precision of the analytical method. It compares the relative percent difference (RPD) of each sample result. The MS/MSD sample should be collected at a frequency of 1 per 20 samples. |
| **Field Duplicate** | Soil and Ground water | This sample should be collected in a location with suspected contamination. The duplicate collection should occur as close as possible in space and time to the original sample location. This sample documents the variability of the sampling process and matrix homogeneity. It compares the RPD between the two results. The field duplicate should be collected at a frequency of 1 per 20 samples. |
| **Equipment Blank (Rinseate Blank)** | Soil and Ground water | This sample is collected only when non-dedicated sampling equipment is used. It is used to determine if decontamination procedures were adequate for non-dedicated sampling equipment. |
| **Trip Blank** | Ground water | This sample is to be submitted to the laboratory only when volatile organic compounds (includes BTEX and MTBE) are being analyzed. It indicates whether storage, shipment, or ambient environment of sample collection could have contaminated samples. **Only one trip blank per cooler** containing ground water VOC samples should be submitted for laboratory analysis. |

The following items must be included in every laboratory analytical report submitted to IDEM:

**Laboratory Quality Control Data and Information:**

- Completed chain-of-custody
- Date and time of receipt at the laboratory
- Condition of samples upon receipt at the laboratory (i.e., temperature)
- Sample identification number or designation
- Sample preparation, extraction, cleanup, or digestion method(s) and date(s)
- Analytical method (name, number, and source) and date of analysis
- Final analytical results
- Case narrative (Includes deviations from standard analytical or preparatory procedure(s); quality control problems encountered--whether stemming from system, instrumentation, analyst error, or sample matrix; corrective measures taken; if

corrective measures as called for in the method were not taken; results of corrective measures taken; etc.)

These QA/QC procedures only apply if you are using a default approach to achieve closure. If a **nondefault approach** is being employed, **more stringent** sample collection and laboratory analyses QA/QC may be required.

For additional information on the minimum documentation of analytical quality assurance/quality control required by IDEM, please visit the IDEM Office of Land Quality web site.

IDEM also requests that all sampling results be submitted electronically to LeakingUST@idem.in.gov. Guidance on formatting sampling results for electronic submittal is posted on the IDEM Office of Land Quality web site. At this time, IDEM is not requiring the electronic submittal of data, but is encouraging electronic submission to improve the quality and timeliness of technical reviews.

Any questions regarding sample handling and analysis should be directed to OLQ's Chemistry Section.

## 3.5 LUST Site Characterization

In accordance with 329 IAC 9-5-5.1, a LUST site characterization must be conducted at all UST sites where a release of a regulated substance (i.e., petroleum or hazardous substance) to soil or ground water is confirmed. The goals of the site characterization are as follows:

- Define the full nature and extent of soil and ground water contamination related to the release,
- Evaluate the potential pathways and receptors, and
- Evaluate the remediation alternatives.

The LUST Site Characterization includes the Initial Site Characterization (ISC) and, in most cases, one or more subsequent Further Site Investigations (FSIs).

### Initial Site Characterization

The ISC must be completed and a report submitted to the IDEM within 60 days from the date the release is confirmed. No time extensions

will be granted. The ISC report should include, but is not limited to, the following information:

- Site background
- Receptor evaluation
- Soil and ground water characteristics including ground water flow direction
- Environmental sampling results including a minimum of three soil borings with samples submitted for soil and ground water analysis
- Scaled maps
- Detailed description (work plan) of additional work to be completed for a FSI (including an ELTF Scope of Work (SOW) form if you are submitting claims for ELTF reimbursement)
- Health and safety plan

**Note:** although piezometers are acceptable for determining ground water flow direction during the ISC, monitoring wells are needed in order to do temporal monitoring of the ground water when ground water contamination is present.

Even though the ISC only requires three borings, the goal of the ISC is to fully determine the nature and extent of contamination. As such, an attempt should be made to completely define the soil and ground water plume by installing additional borings as time allows.
**Note:** All additional borings should be advanced following the default step-out procedures defined in Section 3.5.1.

If the ISC fails to fully define the nature and extent of contamination in the soil and ground water, a Further Site Investigation (FSI) may be necessary. An estimate of anticipated fieldwork required for the completion of a FSI should be included with the ISC Report.

**Further Site Investigation**

If IDEM then determines that a FSI is required in accordance with 329 IAC 9-5-6, it should be submitted within the timeframe required by IDEM. An extension may be granted if a written request is submitted to IDEM before the due date. The written request should include both a justification for the additional time needed and provide a date by which the report will be submitted to IDEM. When offsite access issues are encountered, the justification should include information required by the "Access to Third Party Property" Non-Rule Policy Document available on the IDEM Office of Land Quality web site. The FSI Report should include, but is not limited to, the following

information:

- Details regarding soil borings and monitoring well installation and sample collection
- Environmental sampling results
- Scaled maps
- Detailed description (work plan) of additional work to be completed, including anticipated pilot study(s) as appropriate (an ELTF SOW form must be included if you have or plan to submit claims for ELTF reimbursement)
- An evaluation of remediation alternatives including effectiveness, ability to achieve cleanup, duration, reliability and permits (include estimated costs if you have or plan to submit claims for ELTF reimbursement)
- A Health and Safety Plan

The ISC and FSI reports must be submitted using the standardized templates included in Appendix 3.2 of this Chapter. All requirements of 329 IAC 9-5-5.1 and 6 must be met, in addition to the guidelines presented in this User's Guide and the RISC Technical Guide. If the standardized templates are not used, the IDEM may reject any non-standardized reports concerning the site characterization. Sites using the 1994 UST Branch Guidance Manual are also required to use these standardized forms.
As previously stated, if you wish to seek reimbursement under the ELTF program, once site characterization is complete and approved by IDEM, an ELTF Scope of Work Form for the CAP, detailing proposed corrective actions, pilot studies and their estimated level-of-effort must be submitted to IDEM for approval along with the CAP.

The following sections describe subsurface soil and ground water procedures used for default site characterization.

### 3.5.1 Default Subsurface Characterization

The RISC default characterization process outlined in this section is slightly abbreviated from the process presented and outlined in the RISC Technical Guide. This does not mean that steps in the RISC process are skipped or eliminated. The RISC Technical Guide was designed to deal with a wide variety of waste sites and to address an extensive list of contaminants. This, in turn, necessitated the creation of numerous mechanisms to deal with a variety of site characterization scenarios. For typical LUST sites, the release has a source area less than 0.5 acre in size and occurs in a known location with the main media of concern being subsurface soil and ground water.

As such, rarely would it be appropriate to screen the surface soil during a LUST investigation. And although area screening for subsurface soil is an option, its use at LUST sites is infrequent, as most LUST source locations are generally known. Accordingly, the ELTF may not approve reimbursement for subsurface screening.

If you do have a site where subsurface screening is necessary (i.e., unsure as to the presence/location of historical USTs, please refer to Chapter 3 of the RISC Technical Guide for guidance). Likewise, when either the UST vault or source area exceeds 0.5 acre, the nondefault, large source-size characterization in Chapter 7 of the RISC Technical Guide should be consulted.

## Step-Out Procedure

This default site characterization process screens and determines the nature and extent of subsurface soil and ground water contamination. **It is called the Step-Out Procedure and is a two-step process.**

## Step 1

Step 1 is typically performed in the event that a release is suspected at a facility. It consists of advancing five borings in the immediate area of the release (i.e., UST tank pit, dispenser island, etc.). One boring should be located at the spot expected to be the most contaminated (usually the center of the tank pit). Four borings should be placed at a uniform distance from the center boring (5 to 20 feet out) in each of the four general directions at perpendicular axes (see Figure 3-1). In areas where it may be impractical to use perpendicular axes, random orientation of the axes is acceptable. Wherever possible, an attempt should be made to orient one axis in line with the suspected or known ground water gradient.

Obviously, drilling a soil boring inside the center of an UST vault cannot occur when the USTs are present. So for screening that involves in-place UST systems, product lines, or dispenser islands these same steps should be followed with the exception that the center boring is to be omitted.

**Note:** While this step appears similar to the UST closure assessment, it is intended for screening purposes and different requirements apply.

Typically, one to two soil samples will be submitted from each soil boring for laboratory analysis. If possible, a ground water sample should also be collected from each boring.

*Step 1 Soil Evaluation*

Following receipt of laboratory analytical results, the highest concentration of each individual soil COC is assigned as the **boring concentration** for its respective boring location.

Boring concentrations are then evaluated for each COC as follows:

- If all five boring concentrations are below the RISC Residential Default Closure Levels (RDCLs) for subsurface soils (see note below), soil characterization is complete and the soil is eligible for residential closure.

- If the boring concentrations in the four outer borings are below the RDCLs but the concentration in the center boring is above, a potential exposure concentration (PEC) should be calculated as the mean of the boring concentrations in all five borings plus one standard deviation. If the PEC is less than the closure level, the soil is eligible for residential closure. If the PEC is
- greater than the RDCL, then additional investigation (Step 2) will be required.

**Note:** The PEC can only be calculated for contaminants in unsaturated soils and should always be compared to the appropriate source size and land use-specific closure levels included in the RISC Technical Guide.

*Step 1 Ground Water Evaluation*

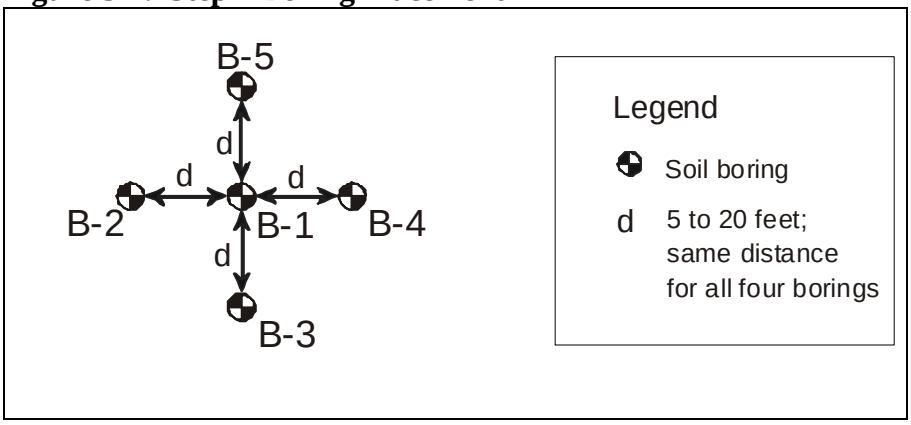
Ground water contamination is evaluated as follows:

- If all ground water COCs are below the RDCLs, ground water characterization is complete, and the ground water is eligible for residential closure.
- If the ground water COCs in the four outer borings are below the applicable RDCLs, and the COCs in the center boring are above the RDCLs but below the RISC Industrial/Commercial Default Closure Levels (IDCLs), the site may attempt immediate closure under industrial closure guidelines.

- If any of the perimeter ground water COCs are at or above the RDCLs, then additional delineation (Step 2) is required.

**Note:** if all soil and ground water COCs are below the laboratory detection limits during the Step 1 Process, then the IDEM should be notified, and the suspected release deactivated. Likewise, once the presence of contamination is established, the IDEM must be notified, and the release confirmed.

**Figure 3-4. Step 1 Boring Placement**




## Step 2

Step 2 is to be performed once the release is confirmed and accordingly, expands the sampling area to complete the nature and extent of characterization.

The Step 2 characterization consists of placing additional borings outward from the center boring in each direction where the residential default closure levels were exceeded. These borings should be continuously placed 5 to 20 feet from each other along the axis until the boring concentration is at or below the closure levels for each COC. Distances between all borings along the two lines should be equal, if possible.

Releases around pump islands and lines should be characterized following the same procedures as used for the tank pit area. Generally, four soil borings should be sampled around the suspected release area and continue outward until sampling results do not exceed residential closure levels. Source removal rather than characterization is an option, but approval will be made on a site-by-site basis.

In areas where the pump islands and lines are located directly over the tank pit, a separate sampling event is not necessary. Likewise, if

portions of the pump islands or lines fall within areas of the tank pit, it is not necessary to conduct a separate sampling event.

If possible and/or necessary, ground water samples should be collected from all Step 2 soil boring locations in order to establish the nature and extent of the dissolved-phase contamination. In addition to determining nature and extent, ground water sampling from the source area outward can also be useful for determining locations for plume stability wells and to evaluate the presence of free product in the source area. Plume characterization may be completed using any appropriate technology. For guidance regarding the installation of permanent ground water monitoring wells, you should refer to IDEM's Non-Rule Policy Document entitled "Drilling Procedures and Monitoring Well Construction Guidelines" located on the IDEM Leaking Underground Storage Tanks web site.

[**Note:** In this section, the IDEM has allowed the flexibility of stepping out 5 to 20 feet between boring locations so that it is possible to work around above- or underground obstacles that may be encountered in the vicinity of the source. This policy was not intended to encourage the practice of consistently stepping out the maximum distance of 20 feet between boring locations, as this may not accomplish adequate source characterization. Accordingly, it is **strongly recommended** that once the step-out procedure has potentially identified non-affected soils and/or ground water, that a conservative attempt be made to find the leading edge of the plume which may involve stepping back. Figure 3-5 illustrates an example of the Step 2 boring strategy for tanks that remain in place.]

*Step 2 Soil Evaluation*

Once the extent of soil contamination has been determined in all compass directions **(note: all soil COCs must be delineated to RISC RDCLs before site characterization can be considered complete)**, the PEC can again be calculated. During Step 2, the PEC of each analyte is determined as the mean plus one standard deviation of all boring concentrations exceeding the residential closure level plus a *maximum* of four boring concentrations (one in each direction from the source and close to the source) less than the residential closure level. Samples below the estimated quantitation limits (EQL) are calculated as ½ the EQL.

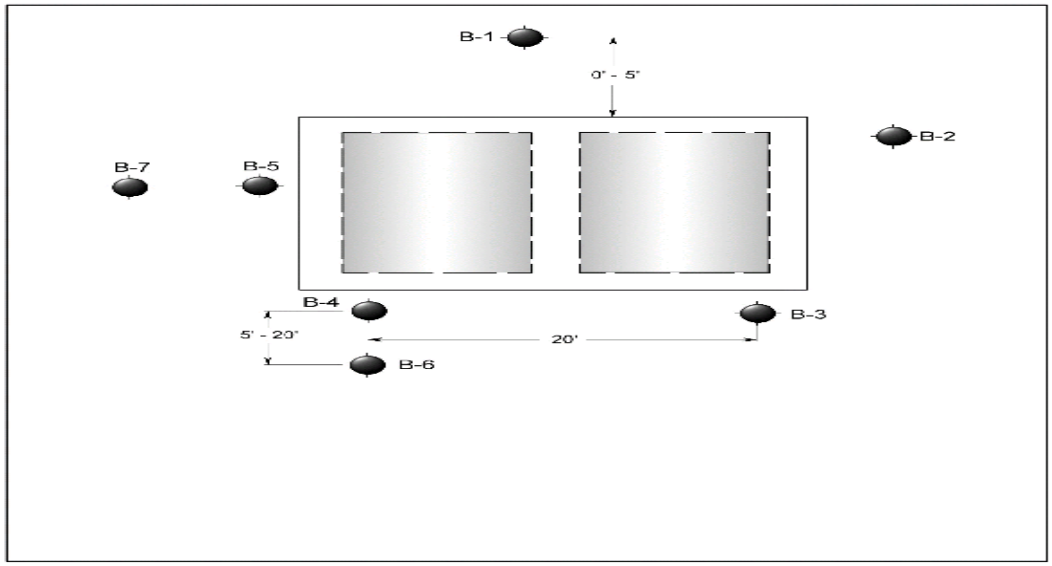
The PEC should be compared to the appropriate source size and land use-specific closure level defined in the RISC Technical Guide. The source size should be calculated by squaring the length of the longest

transect. Source size categories are less than 0.25 acre and 0.25 to 0.5 acre.

- If the PEC is less than the appropriate default closure level, and the soil contamination is confined to the site, the site is eligible for soil closure. Be aware that if industrial closure is pursued, the site must also be prepared to have an institutional control in place (i.e., environmental restrictive covenant) which limits access and prevents exposure to the contamination remaining at the facility.

- If the PEC exceeds the default closure level, a Corrective Action Plan must be developed so that the soils can be remediated to the appropriate default closure levels.

**Figure 3-5: Illustration of Sampling Locations**




The circumference of the UST vault is 90 feet. Because borings should be placed within 20 feet of each other, the number of initial borings required is five. If any boring concentrations are greater than residential closure levels at B-5 and B-4, at least two additional borings are required (B-6 and B-7). This step-out method is repeated until the extent of contamination is defined. The source size area will be the square of the greater distance between B-6 to B-1 or B-7 to B-2. The PEC is calculated by averaging each boring concentration and adding one standard deviation. For example, the following contaminants and concentrations were encountered in soil samples from borings B-1 through B-7: benzene (30, 3, 55, 234, 88, 3, and 15 parts per billion [ppb]); ethylbenzene (6, 3, 35, 102, 22, 3, and 3 ppb); toluene (60, 3, 80, 145, 48, 3, and 7 ppb); and xylenes (3, 3, 50, 85, 10, 3, and 3). It should be noted that nondetects should be represented by one-half of the EQL, which is approximately 3 ppb in this case. The resultant PECs would therefore be 143 ppb for benzene, 61 ppb for ethylbenzene, 102 ppb for toluene, and 55 ppb for xylenes. The site can close using commercial/industrial levels and institutional controls. However, it would fail residential default closure values because the benzene PEC of 143 ppb is greater than the residential risk-based closure level.

*Step 2 Ground Water Evaluation*

After the nature and extent of ground water contamination has been determined in all compass directions **(note: all ground water COCs must be delineated to RISC RDCLs before site characterization can be considered complete)**, remedial/closure options can be evaluated.

- If all ground water COCs are below the RDCLs, the site can be evaluated for immediate residential closure.

- If all ground water COCs are below the IDCLs, and the COCs are confined to the site, the facility may attempt immediate ground water closure using industrial closure guidelines. However, closure may not be possible until additional monitoring occurs and plume stability is demonstrated. Be aware that if industrial closure is pursued, the site must also be prepared to have an institutional control in place (i.e., environmental restrictive covenant) which limits access and prevents exposure to the contamination remaining at the facility.

- If ground water COCs exceed the RISC IDCLs in any one location, a Corrective Action Plan must be developed so that the ground water can be remediated to the appropriate default closure levels.

For information concerning the various ground water monitoring programs, please consult the RISC Technical Guide.

### 3.5.2 Smear Zone Characterization

The IDEM does not require smear zone sampling for the evaluation of the migration to ground water and direct contact pathways. If the smear zone is sampled, you would not use the analytical results for calculation of a potential exposure concentration (PEC). However, investigation of the smear zone is often an important consideration for selection of a remedial technology, and for evaluating progress in remediation. Also, it is often important to sample the smear zone when evaluating ground water impacts. Contaminant of concern concentrations in ground water can fluctuate seasonally. They can be present at safe concentrations (or perhaps below detection limits) during the dry periods of the year when the water table is low. During wetter periods when ground water levels are higher, COCs can exceed safe levels due to aquifer contact with the smear zone. If ground water concentrations fluctuate seasonally, IDEM staff may wish to evaluate

the smear zone to determine if this is the source of the fluctuation. For these reasons, IDEM technical staff may require samples from the smear zone.

### 3.5.3 Soil Gas and Indoor Air Sampling

Sites with petroleum contamination may present a public health hazard if compounds volatilizing from ground water or soil migrate into a building where people are exposed. The completion of this human exposure pathway from volatile organic compounds (VOCs) in the subsurface environment is termed "Vapor Intrusion".

Though relatively rare at LUST sites, this human exposure pathway must be evaluated. Initial field observations can determine if your site is a potential candidate for soil gas or indoor air sampling. Some things to be evaluated before considering the possibility of soil gas and/or indoor air sampling are as follows:

- What contaminants are found at the site? Is benzene present?
- Are there noticeable petroleum odors or complaints of petroleum odors?
- Is ground water present within five feet of the basement, crawl space, slab, or ground surface?
- Do preferential pathways exist?
- What soil types are present?

IDEM approval and notification is required prior to any soil gas or indoor air sampling. Contact your IDEM project manager if (based upon the initial screening criteria) you believe this human exposure pathway exists at your facility.

### 3.5.4 Sampling Point Nomenclature and Mapping

**Sampling Point Nomenclature**

Consistent sampling point nomenclature should be used. The IDEM realizes that different consulting companies have different protocols concerning sampling point nomenclature and when a project is transferred to a new company, there is the potential for inconsistencies.

For sites regulated under the LUST and ELTF programs, the following prefixes are suggested:

| | |
|---|---|
| GP-## | Used for all borings advanced using a direct-push (Geoprobe™) technology |
| SB-## | Used for all soil borings advanced using conventional drilling technologies (hollow-stem auger, air-rotary, etc.) |
| MW-## | Used for all permanent monitoring wells |
| PZ-## | Used for ground water observation points or other temporary ground water monitoring points |
| AS-## | Air-Sparge point |
| SVE-## | Soil vapor extraction point |
| DPE-## | Dual-phase extraction well |
| MPE-## | Multi-phase extraction well |

When labeling wells numerically, no numbers should be skipped. Additionally, the suffix "R" should follow any replacement well or boring. For example: if monitoring well "MW-1" were destroyed during excavation events, its replacement would be labeled "MW-1R". Please note: a well is typically considered a "replacement well" if it is installed within the same geologic unit approximately10 ft of the original monitoring point.

The IDEM realizes that inevitably, variations will occur. However, every effort should be made to use this uniform naming system for each facility; one that is appropriate for the current work being performed as well as compatible with all previous work performed at the site.

## Sampling Point Mapping

As required previously, all permanent monitoring wells and sampling points must be surveyed and presented on a scaled site map. The IDEM is now also requiring at least one Global Positioning System (GPS) reference point for every facility. This point should also be depicted on a site map so that it may be viewed relative to the sampling (borings and monitoring well) locations.

The IDEM has developed the following data field information as guidance to external sources of GPS data collectors so that data accurately and reliability can be verified and supported. The following information also facilitates future use of the data. IDEM would prefer copies of the data (data dictionary [if available], each [raw] data file, any base station files used for corrections, and the final product) as an electronic file in either text, Access, or Excel format(s).

| GPS Reporting Parameters | |
|---|---|
| Identifier | Identification of the facility or unit that is being regulated or managed (FID Number, LUST Incident Number, etc.) |
| Collector Name | The name of the individual that collected the data |
| Time/Date Recorded | The time/date when the latitude and longitude were collected |
| Receiver Type | Description of the GPS receiver used to collect the locational coordinates |
| Total Positions | Number of GPS positions used to determine the locational coordinates of the feature |
| Feature Indicator | Describes the feature that was collected (access point, corner point of a boundary, boundary point (general), etc. |
| State Program of Facility | The state program the facility is regulated under (i.e., LUST) |
| Correction Status | Description of the correction method applied to the GPS data. (i.e., Differential Correction, Realtime Correction, No Correction, etc.) |
| Maximum PDOP | Position Dilution of Precision (GPS unit calculated measurement) |
| Data File Name | Name of the GPS rover file containing the locational data information |
| Standard Deviation | Measure of the variance within the positions used to calculate the feature coordinate |
| Datum | Name of the reference datum used to collect the latitude and longitude. (The standard state Datum is NAD83) |
| Projection | Describes the projection the latitude and longitude were collected in. (The standard Projection is UTM Zone 16N in meters) |
| Units | Describes the units the latitude and longitude were collected in. (feet, meters, dd:mm:ss, dd.dddd, etc.) |
| GPS Comments | Information concerning data collection—particularly if there is any offset information, important factors, nearby objects, etc. |
| Address | Street address of the facility or nearest intersection if address is not available |
| City Name | Name of the city in which the facility is located |
| County Name | Name of the county in which the facility is located |

| | |
|---|---|
| Zip Code | Five-digit zip code |

## 3.6 Closure Options

RISC provides flexibility in selecting the type of remedy that best achieves closure goals for the site. Closure can be achieved with or without institutional controls.

The goal of RISC procedures is to reach closure, which is defined as: *IDEM's written recognition that a party has demonstrated attainment of specific remedial or screening objectives (closure levels) for COCs at a particular area.*

Closure options can differ for each medium. For example, even if site characterization demonstrates that no further action is needed for closure with unrestricted exposure for soil, closure with institutional controls may be necessary if the site has a stable ground water plume.

The following sections describe closure procedures both with and without institutional controls.

### 3.6.1 Closure With Institutional Controls

If engineering controls or restrictions of site activities are used to prevent exposure to site contamination, evidence of the suitability, effectiveness, and continued protection of those controls must be supplied. Institutional controls provide this evidence.

Closure with institutional controls generally requires the use of an Environmental Restrictive Covenant (ERC), that provides information on the nature and extent of residual contamination and the methods used to control that contamination. The ERC must stipulate that the exposure prevention mechanism established at the site will be maintained, and it must prohibit future changes to the site that would interfere with any such mechanism.

The Environmental Restrictive Covenant must be recorded on the deed of the affected property. **An ERC is also required for any property where industrial criteria were used to achieve closure.** Appendix 3.3 in the User's Guide provides more information on the Environmental Restrictive Covenant and ground water ordinance requirements. Nondefault institutional controls are discussed in the RISC Technical Guide.

Additional post-closure care activities are required for engineering controls and may be required for activity restrictions. In addition, property control must be obtained and demonstrated where a ground water plume has affected an off-site property. Sites where closure has been achieved with institutional controls may pursue closure with unrestricted exposure at any time by remediating contamination to default residential closure levels. Additionally, if contamination has attenuated over time down to the residential closure levels, a site can petition to have the ERC modified to reflect that the site is now safe for unlimited exposure.

### 3.6.2 Closure With Unrestricted Exposure

There are two ways to achieve closure with unrestricted exposure: either the site characterization must demonstrate that contamination is below residential closure levels, or active remediation must reduce contamination to residential closure levels. For closure utilizing remediation, a Corrective Action Plan (CAP) should be developed. For closure without remediation, the investigation report can serve as both the CAP and the closure report.

**Please note:** In accordance with 328 IAC 1-3-5(d)(13), the ELTF fund will only reimburse for remediation efforts to commercial/industrial closure levels. If a site in the ELTF program wishes to continue remediation efforts in order to achieve residential closure levels, they must do so at their own expense. Exceptions to this do occur, and are outlined in 328 IAC 1-3-5(d)(13)

## 3.7 Corrective Action Plans

Once the site characterization is approved by IDEM and corrective action is determined to be necessary, a CAP must be developed in accordance with 329 IAC 9-5-7. **A CAP will not be considered for review by IDEM unless an adequate site characterization has been completed.** The goal of the CAP is to design a remedial strategy to reduce contamination levels in the soil and ground water to levels that pose an acceptable risk for human health and the environment

The CAP must include, but is not limited to the following:

- Remedial design
- Scaled maps

- Listing of required permits
- Schedule for implementation including construction, operation and maintenance as appropriate
- Remedial monitoring and reporting program
- Health and safety plan
- ELTF SOW if you have submitted or plan to submit claims for ELTF reimbursement

Information should be current for items such as quarterly monitoring results, sampling results, and ground water flow maps. The CAP must discuss various available options and provide justification for the closure option selected.

The CAP will differ depending on which remedial option is selected and whether active remediation is used to achieve cleanup goals. Sites that demonstrate compliance with closure levels during characterization can include CAP information in the site investigation report. Sites where remediation is conducted to attain closure must also demonstrate that the selected remedial technology will be effective if not already addressed in the FSI.

Standardized reporting formats for the CAP have been provided in Appendix 3.2 of this Chapter. These templates are also available on the LUST website.

More information and more justification for proposed remedial options will be required for sites that are high priority, that impact an exposure pathway not considered by the default (such as surface water), and technologies that lack adequate information demonstrating effectiveness. These sites will also undergo a higher level of IDEM review. In addition, for the high priority sites with the potential to impact the surrounding community and in accordance with 329 IAC 9-5-8, the IDEM may decide to hold public meetings or solicit public comments concerning the proposed CAP.

### 3.7.1 Remediation Technology Evaluation

The IDEM recognizes a variety of proven effective remedial technologies for certain site conditions. These include, but are not limited to: soil vapor extraction (SVE), dual- or multi-phase extraction (DPE/MPE), oxygen release compounds (ORCs) injection, air sparging, soil excavation and disposal, etc.

Site-specific conditions determine which technology would be most effective at any given site and accordingly, every site must be evaluated individually as there is no "one-size-fits-all" approach to remediation.

Land farming or land treatment of petroleum-contaminated soils is also a remediation option; however, this method should be approached with caution. If a land treatment cell is not constructed properly or, if it is placed in an inappropriate location (i.e., steep slope, topographic low-lying area, close vicinity to human receptors, close proximity to surface waters), it could inadvertently create additional environmental problems at a LUST site, and potentially delay closure. **Accordingly, written IDEM approval is required before any land treatment can occur**.

**Note**: The Land Treatment Guidelines (included in the 1994 LUST Guidance) should be used as a reference when designing a land treatment cell and a quarterly sampling program.

For assistance with selecting the most appropriate and cost-effective remedial technology for your site, you can visit US EPA's Technology Innovation Program web site or the Hazardous Waste Clean-up Information (CLU-IN) web site. You also should consult the Geological Services program for new or innovative technologies at 317/234-0991.

### 3.7.2 CAP Implementation

A CAP must be implemented immediately in accordance with the schedule included in the CAP upon receipt of the approval letter from IDEM. Once CAP system installation and start up or construction is complete, a CAP Implementation Report documenting all implementation activities should be submitted within 60 days.

### 3.7.3 Quarterly Reporting

As described in 329 IAC 9-5-7(f)(1)(L), quarterly reporting is required under three circumstances:

- Quarterly monitoring prior to corrective action (should be submitted only when requested by IDEM)
- Corrective Action monitoring

- Monitored natural attenuation (MNA) and closure monitoring such as plume stability

The type and frequency of monitoring and reporting should be detailed in the CAP.

## 3.8 LUST Report Formatting, Signatures and Submittals

### Formatting

All LUST reports should use the standardized report formats:

- LUST Initial Incident Report
- Suspected Releases Confirmation Steps Report
- 20-day Abatement and Free Product Removal Report
- Initial Site Characterization (ISC) Report
- Further Site Investigation (FSI) Report
- Corrective Action Plan (CAP)
- Corrective Action Implementation Report
- Corrective Action Progress Report (CAPR) for non-engineered approaches
- CAPR for engineered systems
- LUST Closure (No-Further-Action) Request Report

These forms are included in Appendix 3.2 and can be found at the LUST web site. Three copies of all submittals are required by IDEM unless otherwise directed by your project manager.

### Signatures

All LUST reports must be signed by one of the following individuals registered or licensed in the State of Indiana:

- Professional Engineer
- Professional Geologist
- Certified Hazardous Materials Manager
- Professional Soil Scientist

### Submittal

All LUST Reports should be sent to the following address:

Indiana Department of Environmental Management
Leaking UST Section
100 North Senate Avenue, Room 1101
Indianapolis, IN 46204-2251

For information about the form and number of reports to submit, consult the IDEM OLQ Project Managers

## 3.9 ELTF Eligibility and Claims Guidance

The ELTF is administered by the Excess Liability Trust Fund (ELTF) Program and was created under IC 13-23-7 through 9 (previously IC 13-7-20) to provide the following:

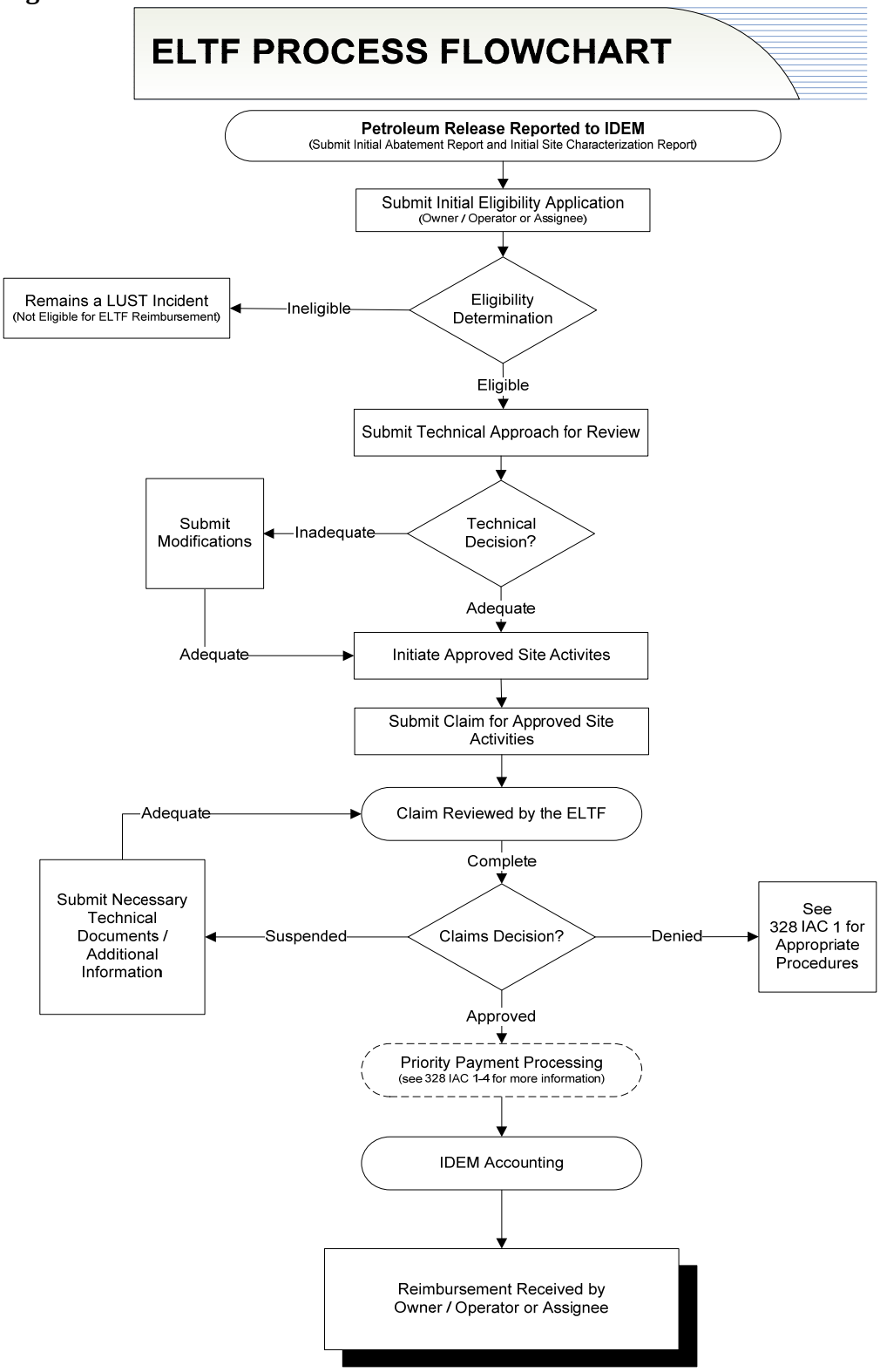
- A method to reimburse eligible tank owners for LUST cleanup costs and any third-party liability costs
- A method to help tank owners fulfill federally required financial assurance requirements
- A method to guarantee loans for tank owners who wish to upgrade their present systems but are unable to obtain financing

It is the ELTF Program's responsibility to ensure that ELTF-eligible remediation activities associated with characterization and corrective action are appropriate, cost-effective, and performed only as necessary to meet the clean-up objectives for the site. All investigation and corrective action activities must be consistent with the requirements of 329 IAC 9, and other applicable State and Federal laws and regulations. The applicable sections of 328 IAC 1 (including definitions) IC 13-23 and IC 13-11 (for statutory definitions) should always be consulted in conjunction with this chapter.

Once a release is discovered at a site, the responsible party is encouraged to file a claim as early in the LUST process as possible to determine ELTF eligibility status.

Figure 3-6 depicts the ELTF Claims Process.

**Figure 3-6 -ELTF Process Flowchart**



UST owners who want to make claims to the ELTF need to be aware of eligibility requirements that relate to their particular release. These requirements have changed since the original statute was passed and 328 IAC 1 has been amended. The current eligibility requirements are contained in 328 IAC 1-3-3 and are summarized below:

- All regulated USTs must have been registered with IDEM at the time of the discovery of the release. If unregistered tanks are present, a percentage-based reimbursement will be made depending on the number of tank fee payments that have been missed.
- All tank registration fees must be current. If tank fee payments have been missed, a percentage-based reimbursement will be made depending on the number of tank fee payments that have been missed. If less than 50 percent of the payments have been made, the claim will be deemed completely ineligible. The formula for reimbursement for owners and operators who have failed to pay tank fees due under IC 13-23-12-1 is available in 328 IAC 1-3-3(b).
- Any release from the UST system must be reported to IDEM and have an incident number assigned.
- Site Characterization or No Further Action have been approved in writing by IDEM, or a CAP for remediation of the site has been approved in writing by IDEM or deemed approved in accordance with IC 13-23-8-4.
- The UST owner or operator must have been in compliance with all applicable federal and State laws and regulations governing USTs by the date the requirements became effective.
- The UST owner or operator has not defaulted on a loan with the loan guaranty program.
- The deductible specified in IC 13-23-8 has been paid.

**Note**: Approved emergency measures are eligible for reimbursement from the fund prior to Site Characterization Approval.

Additional information relating to activities involved with the site remediation process can be obtained by sending a letter to the address below or calling (317) 234-0990.

Leaking Underground Storage Tank Section
Indiana Department of Environmental Management
100 North Senate Avenue, Room 1101
Indianapolis, IN 46204-2251

The following subsections discuss ELTF site prioritization, deductibles, examples of eligible expenses, examples of ineligible expenses, and instructions for application for ELTF eligibility. Application packages are available by calling (317) 234-0990.

### 3.9.1 ELTF Site Prioritization

The ELTF has a **separate** ranking system to determine the priority with which release investigation and clean-up costs will be eligible for reimbursement. This ranking system allows IDEM to first reimburse for the releases that pose the greatest risk to human health and the environment. For more specific information, consult 328 IAC 1-4-1 and 1-4-1.5.

Site prioritization begins when the ELTF balance drops below $25,000,000.00. Prioritization of claim payments begins when the ELTF balance drops below $5,000,000.00. When this happens, Emergency Measures costs are paid first. Other costs are not reimbursable until Site Characterization approval, Corrective Action Plan approval, or until a No Further Action letter has been issued. Once one of these milestones is reached, claims are then paid according to the following prioritization:

- **Category 1 (Paid First)**
  - Concentrations of vapors in sewers or conduits are greater than 10% of the lower explosive limit (LEL)
  - Concentrations of vapors in habitable buildings are greater than long-term, risk-based exposure limits
  - Contaminants in the drinking water supply are greater than the RISC default residential closure level or maximum contaminant levels (MCLs)

- **Category 2**
  - Free product in a thickness of at least one (1) foot is present in any monitoring well
  - At least one (1) inch of free product is present in any two monitoring wells spaced 20 feet or more apart
  - Surface water contamination is present above the water quality standards defined by the rules of the Water Pollution Control Board defined in 327 IAC 2

- **Category 3**
  - Offsite contamination is present at concentrations greater than the RISC default cleanup objective appropriate for land

use in soil (100 ppm TPH for sites using 1994 UST Branch Guidance) or ground water
- Free product with a thickness of at least 1/16 of an inch is present in any monitoring well
- On site ground water contamination is attributable to a gasoline release greater than the RISC default closure level based on the current land use

- **Category 4**
  - On site contamination is present at concentrations greater than the RISC default industrial cleanup objective in two or more monitoring wells that are spaced 20 feet or more apart
  - On site contamination is present at concentrations greater than the RISC default industrial cleanup objective (100 ppm TPH for sites using 1994 UST Branch Guidance) in two or more borings spaced 20 feet or more apart

- **Category 5**
  – Any other releases

All claims submitted under identical categories will be paid by priority ranking in chronological order according to the date and time received by the administrator.

### 3.9.2 Deductibles [IC 13-23-8-3]

The applicable deductible for petroleum UST involved in an incident for which claims are made is $35,000 if the conditions below both apply.

- The UST is NOT in compliance with rules adopted by the Solid Waste Management Board concerning technical and safety requirements relating to the physical characteristics of petroleum USTs before the date the tank is required to be in compliance.
- The UST is in compliance with rules cited above on a date required in IC 13-23-8-4 at the time the release was discovered.

The deductible for a petroleum UST involved in an incident for which a claim is made is $30,000 if the conditions below both apply.

- The UST is in compliance with rules adopted by the Solid Waste Management Board concerning technical and safety requirements relating to the physical characteristics of

petroleum USTs before the date the tank is required to be in compliance.
- The UST is not a double-walled petroleum UST with double-walled piping.

The deductible for a petroleum UST involved in an incident for which a claim is made is $25,000 if the conditions below both apply.

- The UST is in compliance with rules adopted by the Solid Waste Management Board concerning technical and safety requirements relating to the physical characteristics of petroleum USTs before the date the tank is required to be in compliance.
- The UST is a double-walled petroleum tank with double-walled piping.

If the owner or operator has 100 or fewer USTs, the owner or operator cannot receive more than a total of $2,000,000 minus the deductible from the ELTF per year. If the owner or operator has more than 100 USTs, the owner or operator cannot receive more than a total of $3,000,000 minus the deductible per year from the ELTF. The maximum amount allowed per occurrence (including 3rd party liability claims) is $2,000,000 minus the deductible. [IC 13-23-8-2 and IC 13-23-8-8].

### 3.9.3 Examples of Eligible Expenses

The following partial list is provided to assist owners and operators in recognizing the types of expenses eligible for reimbursement under the ELTF program. A complete listing of reimbursable costs is available in 328 IAC 1-3-5.

- Costs incurred from releases first discovered or suspected on or after April 1, 1988.
- Administrative costs such as the following:
  - Travel, lodging, and per diem costs to be paid in accordance with the most current Indiana Department of Administration financial management circular covering State travel policies and procedures
  - Attorney fees if incurred by the owner or operator in defense of litigation in a third-party liability claim
  - Sales tax and governmental administrative fees for local, State, or federal permits necessary for corrective action.
- Investigation and remediation costs, such as the following:

  - Investigation costs, including environmental assessment, field time, report writing, and clerical support
  - Costs for soil and water sampling of petroleum and petroleum constituents in accordance with IDEM guidelines
  - Expenditures for machinery and equipment[1]
  - Materials and supplies, such as disposable protective equipment, building materials (e.g., piping and cement), and sample preservatives
  - Provision of alternate water supply[2]

- Markup on purchases based on unit rates or lowest bid of 10% with the exception of those listed in the "Ineligible Expenses".
- Miscellaneous costs, including any other costs deemed reasonable and necessary for corrective action or payment of third-party liability claims.

### 3.9.4 Examples of Ineligible Expenses

The following partial list is provided to assist owners and operators in recognizing the types of expenses that are not eligible for reimbursement under the ELF program.

- Capital improvement costs, such as the following:
  - New tanks or equipment
  - Installation of new tanks or equipment
  - Bedding material for new tanks or equipment (such as pea rock, sand, or special fills used to seat or bed tanks)
  - Concrete, asphalt, or other resurfacing materials reasonably necessary for restoration but in excess of 110 percent of the total surface dimensions of the original surface material or where surface material did not previously exist
  - Property improvement
  - Higher quality surfacing than previously existed (for example, replacement of 4-inch non-reinforced concrete with 6-inch reinforced concrete with a gravel base)
- Administrative costs such as the following:
  - Interest expenses and finance charges

[1] These costs must be prorated based on the normal expected life of the item and the length of time the item was used for a single corrective action. In no case will the ELTF pay for purchase of machinery and equipment in excess of the market cost of leasing the item.

[2] This must be included in a CAP approved by IDEM.

  - Fines and penalties
  - Punitive or exemplary damage charges
  - Any other costs not directly related to corrective action or third-party liability or otherwise determined to not be reimbursable
  - Administrative costs and application fees paid to IDEM for participation in the Voluntary Remediation Program (VRP)
- Environmental costs such as the following:
  - Laboratory work related to
    - Testing of tank contents (such as water, sludge, sand, and petroleum product) for disposal
    - Analysis using unapproved testing methods
    - Analysis of inappropriate constituents
  - Cleanup work related to
    - Removal of tank contents
    - Assessment of cleanup of any material other than gasoline, natural gas condensate, jet fuels, diesel fuels, heating fuels, kerosene, crude oils, waste oils, or mixed petroleum products
    - Excavation costs beyond the backfill area of the tank(s) unless part of an approved CAP.
    - Costs associated with remediation that exceeds the minimum requirements to bring a site into compliance with state environmental standards
  - Other items, such as consultant "markups" on
    - Subcontractor expenses
    - Travel
    - Utility bills
    - Per diem expenses
  - Equipment purchases that cannot be charged to a specific site, such as drilling rigs, earth-moving equipment, photoionization detectors, explosimeters, and hand tools.
- Miscellaneous costs such as the following:
  - Business down time
  - Any increased cost of cleanup with the goal of limiting business down time
  - Damage caused by excavation equipment or any other equipment
  - Contractor costs not directly related to corrective action activities, such as preparing cost estimates, preparing bids, accounting billing functions, computer use and time, and preparation of the ELTF application
- Credits, rebates and refunds given to the owner or operator for costs associated with the investigation or corrective action.

- Costs incurred more than 24 hours prior to the date and time of the release report to IDEM.
- Costs to cleanup a release beyond the required cleanup levels/objectives based on the appropriate cleanup guidance, i.e., 1994 UST Branch Guidance Manual or RISC.

### 3.9.5 Instructions for Application for ELTF Eligibility or Reimbursement

The eligibility determination process examines whether or not a person listed under 328 IAC 1-3-1 is eligible to receive reimbursement and, if so, what percentage will be reimbursed. The affected site must have an approved emergency action, site characterization, or corrective action plan before reimbursement will be made for claims relating to these plans. The owner/operator must be in compliance with the eligibility requirements as outlined in 328 IAC 1-3-3. Those seeking an eligibility determination or those seeking to receive reimbursement from the ELTF should submit two completed copies of the ELTF application to the address below:

Indiana Department of Environmental Management
Excess Liability Trust Fund
100 North Senate Avenue, Room 1101
Indianapolis, IN 46204-2251

Applicants will be informed by letter of the status of their eligibility for reimbursement. Any cost(s) that are not reimbursable will be identified.

## 3.10 Additional Resources on the Internet

Additional LUST guidance can be obtained by contacting the LUST Section or visiting the IDEM Office of Land Quality web site. The Indiana Department of Natural Resources and the U.S. Environmental Protection Agency Office of Underground Storage Tanks web sites also provide resources pertaining to leaking underground storage tanks.

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## APPENDIX D

# RISC TECHNICAL RESOURCE GUIDANCE DOCUMENT

(Hard Copy of Chapter 8 and Appendix 2 Included, Entire Document Available on the IDEM RISC Website http://www.in.gov/idem/4200.htm )

# Chapter 8 Total Petroleum Hydrocarbons

**Overview of Chapter 8**

- ◊ Introduction
- ◊ Summary of Approach
- ◊ Site Characterization
- ◊ Closure Levels
- ◊ Sample Collection
- ◊ Sample Analysis

## 8.0 Introduction

## 8.1 Background

Petroleum fuel and oil products represent the single most common environmental contaminant in Indiana. Common sources of these products are motor fuel station underground storage tanks, home and commercial heating oil storage tanks, fuel distribution centers, refineries, crude oil production sites, and accidental spills. In Indiana, alone, there are over 19,000 registered underground storage tanks and over 7,000 confirmed leaks have been reported. These leaks can range from a few gallons to many thousands of gallons.

Petroleum fuels and oils are complex mixtures of hydrocarbons that vary, not only among the fuel types, but also within each fuel type depending upon manufacturer, geographic location, and seasonal use. The compositions of these products are made up of several hundred hydrocarbon compounds. Of these hundreds of compounds, toxicological information is available on only a very few. This makes determining the health risk posed by petroleum hydrocarbons difficult.

Traditionally, petroleum fuel or oil contaminated sites have been characterized by two measures; specific indicator compounds called the chemicals of concern (COCs) and by the total of all the petroleum hydrocarbons, called total petroleum hydrocarbons (TPH). The individual COCs had human health risk derived closure levels, but TPH did not have closure levels based upon human health effects. The Total Petroleum Hydrocarbons Criteria Work Group (TPHCWG) and the states of Washington and Massachusetts have developed approaches that enable the development of human health risk-based closure levels for TPH. IDEM fundamentally agrees with these approaches and has developed similar procedures. The TPH closure levels are based on the non-cancer end points of exposure. IDEM addresses the carcinogenic exposure by analysis for certain carcinogenic COCs (benzene and certain carcinogenic polycyclic aromatic hydrocarbons, cPAHs). Additionally, IDEM still requires source area measurement of certain non-carcinogenic COCs (n-hexane, naphthalene, toluene, ethylbenzene, and xylene, plus non-carcinogenic PAHs for waste oil). The COCs for petroleum products are listed in Appendix 4.1, RISC User's Guide.

This new approach breaks down the composition of specific petroleum products into chemical groups, called fractions, based upon carbon chain length and similar physical/chemical properties. Because the composition of each fraction is variable, and toxicological information

is not available for every compound in each fraction, the physical/chemical and toxicological properties of one or more surrogate compounds are chosen to represent each fraction. A TPH closure level for each major hydrocarbon product type in soil and ground water can then be determined based upon the sum of the individual fractions.

### 8.1.2 Purpose and Scope

The purpose of this chapter is to:

- Provide human health risk-based closure levels for source areas on sites contaminated with TPH.
- Provide details on this new approach.
- Provide details on site evaluation techniques that are unique to TPH.

This chapter is focused on how the health-based closure levels for TPH were determined and how those closure levels are applied at petroleum contaminated sites. Specific guidance on the COCs is found in the RISC Technical Guide and the RISC User's Guide, (Chapter 3 and Appendix 4.1, 4.2).

### 8.1.3 Applicability

The provisions of this chapter apply to all sites that are contaminated by releases of petroleum hydrocarbon products and/or lubricating oils and are addressed by the Leaking Underground Storage Tank Program (LUST), Voluntary Remediation Program (VRP), State Cleanup Program, Brownfields Program, and RCRA Corrective Action Program. In general, IDEM will not require reevaluation of petroleum hydrocarbon contaminated sites that were closed properly prior to the effective date of this NPD. However, the Agency reserves the right, under IC 13-14-2-1; IC 13-23-13; IC 13-24-1; and IC 13-25-5-17, to reevaluate sites where compelling evidence indicates that significant human health or ecological risks exist. Examples of such situations may be when hydrocarbon products have impacted drinking water wells above default closure levels for TPH or COCs, or where hydrocarbon vapors have intruded into indoor air spaces.

The provisions of this chapter do not apply to hydrocarbon releases at manufactured gas plants (MGPs).

### 8.1.4 Effective Date

The provisions of this chapter will be effective 30 days after the presentation to the Solid Waste Management Board.

#### 8.1.4.1 Implementation Milestones

- **Leaking Underground Storage Tank program -** All LUST site responsible parties who file an Initial Incident Report on or after the effective date of this NPD should follow this guidance for TPH as well as COC closure levels. Responsible parties who filed an Initial Incident Report prior to the effective date of this NPD may continue to evaluate and close their sites under the preexisting guidance and closure levels or, with IDEM's written approval, choose to use this guidance.

- **Voluntary Remediation Program –** All VRP site responsible parties that have a Voluntary Remediation Agreement (VRA) approved and signed by IDEM on or after the effective date of this NPD should follow this guidance. VRAs approved and signed prior to the effective date of this NPD may continue to evaluate and close their sites under the preexisting guidance and closure levels or, with IDEM's written approval, choose to use this guidance.

- **State Cleanup Program** – All State Cleanup program responsible parties that have an Agreed Order signed on or after the effective date of this NPD should follow this guidance. Agreed Orders signed prior to the effective date of this NPD may continue to evaluate and close their sites under the preexisting guidance and closure levels or, with IDEM's written approval, choose to use this guidance.

- **Brownfields Program –** All Brownfield Program evaluations of TPH should follow this guidance after the effective date of this NPD.

- **RCRA Corrective Action –** All RCRA Corrective Action site responsible parties that submit a Facility Investigation Work Plan on or after the effective date of this NPD should follow this guidance. Facility Investigation Work Plans submitted prior to the effective date of this NPD may continue to evaluate and close their sites under the preexisting guidance and closure levels or, with IDEM's written approval, choose to use this guidance.

## 8.2 Summary of Approach

### 8.2.1 Concept

For the purposes of this guidance, the term TPH refers to petroleum hydrocarbon mixtures composed of compounds with carbon numbers ranging from $C_5$ through $C_{36}$ that originated from petroleum and have been analyzed by EPA Modified Method 8015D.

Petroleum hydrocarbon products are mixtures of over 250 hydrocarbon compounds. The various product mixtures produced by the manufacturers are based upon physical and performance-based criteria and not specific formulas. As a result, the product compositions can vary depending upon, in part, the crude oil refined to produce the product, the type of product, the season of the year, and any performance additives.

Petroleum hydrocarbon products are also subject to changes in composition once they are released into the environment. The lower molecular weight hydrocarbons are generally more volatile and water-soluble than are the higher molecular weight hydrocarbons. Some of the lower molecular weight hydrocarbons are also more subject to microbial decomposition and the degradation products might include compounds not originally found in the product.

It is not practical to identify and quantify all of the individual compounds contained in a particular hydrocarbon fuel or oil. A further difficulty is that the necessary toxicological information is available for only about 25 of these compounds. The fractionation approach addresses these complications by dividing the hydrocarbon mixture into several fractions that are sufficiently homogeneous with respect to physical and chemical properties. A surrogate compound, (or a mixture with characteristics similar to the fraction), on which adequate toxicological information exists, is selected to represent each fraction. That surrogate is then used to estimate the potential human health risks posed by that fraction. The individual risks of each fraction are then totaled to evaluate the overall risk of the hydrocarbon product.

### 8.2.2 TPH Fractions

For analysis, TPH is broken down into 12 fractions having similar physical-chemical properties within each fraction. These 12 fractions are composed of seven aliphatic (a broad category of carbon compounds distinguished by a straight, or branched, open chain arrangement of the constituent carbon atoms) and five aromatic (benzene ring compounds) fractions. Each fraction is defined by a range of equivalent carbon (EC) numbers. The EC number is related to

a compound's boiling point and retention time on a gas chromatography (GC) column normalized to the actual carbon numbers of n-alkanes. For example, the EC of benzene, a cyclic 6-carbon aromatic compound, is 6.5 because its boiling point and GC retention time are halfway between those of n-hexane (a straight 6-carbon chain compound) and n-heptane (a straight 7-carbon chain compound). The EC numbers are used because they are more closely related to environmental mobility. Surrogate compounds are then selected to represent the toxicological properties of each fraction. While the toxicities of some fractions may be represented by the same surrogate compound, the physical and chemical properties are specific for each fraction. Thus, each fraction is unique. The hydrocarbon fractions, surrogates, toxicological information, and analytical methods are given in Table 2-1. It should be noted that the aromatic fractions EC>5-7 and EC>7-8 are not included because these fractions are almost entirely made up of benzene, ethylbenzene, toluene, and xylene and they are evaluated as COCs.

### 8.2.3 Toxicology

Based upon the available information on the chemistry and toxicology of petroleum hydrocarbons, it is possible to make the following generalizations:

- Petroleum hydrocarbon fuels and oils are mainly composed of aliphatic and aromatic hydrocarbon compounds.
- Petroleum aromatic hydrocarbons generally appear to be more toxic than petroleum aliphatic compounds.

#### 8.2.3.1 Non-Cancer Toxicity

The non-cancer toxicity of TPH is based upon the non-cancer toxicity of specific hydrocarbons selected to represent specific groups of hydrocarbons (fractions) that compose typical products. A toxicity value (oral and inhalation Reference Doses) for each fraction is based upon a representative compound for that fraction. The hazard quotient (HQ) for each fraction is calculated and then summed to determine the hazard index (HI) for the product. The HI is then used to determine the closure level that would be equivalent to a HI = 1. Table 2-1 contains the Non-Cancer reference doses.

#### 8.2.3.2 Cancer Toxicity

The cancer effects of the products are evaluated by quantifying specific chemical compounds that are designated as carcinogens, such as benzene, and certain carcinogenic polycyclic aromatic hydrocarbons

(cPAHs). For waste oil, additional PAH compounds are also quantified ( See *Waste Oil Analyses and Analytes*, at http://www.in.gov/idem/programs/land/lust/waste_oil.html) The cancer risk must be less than, or equal to, 1 X $10^{-5}$ (one in one hundred thousand). For additional information on determining cancer effects see the RISC Technical Guide, Appendix 1. See Appendix 4.1 of the RISC User's Guide for the chemicals of concern for various petroleum products.

**Table 2-1 Hydrocarbon Fractions, Their Reference Doses, and Analytical Methods**

| HYDROCARBON FRACTIONS | | | | |
|---|---|---|---|---|
| Hydrocarbon Fractions | Surrogate | Reference Dose mg/kg - day | | Analytical Method*** |
| Aliphatic | | Oral | Inhalation | |
| EC 5-6 | Cyclohexane | 1.7 | 1.7 | VPH |
| EC > 6-8 | Cyclohexane | 1.7 | 1.7 | VPH |
| EC > 8-10 | JP – 8* | 0.03 | 0.085 | VPH/EPH |
| EC > 10-12 | JP – 8* | 0.03 | 0.085 | VPH/EPH |
| EC > 12-16 | JP – 8* | 0.03 | 0.085 | EPH |
| EC > 16-21 | White Mineral Oil | 2.0 | NA | EPH |
| EC > 21-36 | White Mineral Oil | 2.0 | NA | EPH |
| Aromatic | | | | |
| EC 8-10 | Naphthalene | 0.02 | 0.02** | VPH |
| EC > 10-12 | Naphthalene | 0.02 | 0.02** | VPH/EPH |
| EC > 12-16 | Naphthalene | 0.02 | 0.02** | EPH |
| EC > 16-21 | Pyrene | 0.03 | NA | EPH |
| EC > 21-36 | Pyrene | 0.03 | NA | EPH |

* Jet fuel
** Route extrapolated
*** See http://www.ecy.wa.gov/biblio/97602.html for the analytical methods for volatile petroleum hydrocarbons (VPH) and extractable petroleum hydrocarbons (EPH).

## 8.3 Closure Levels

RISC has developed a default/non-default approach to determining the TPH closure levels at sites (Table 3-1). Default TPH closure levels have been determined for gasoline range organics and diesel range organics from fractionation analysis of theoretical formulations of gasoline and diesel fuel. The closure levels for diesel range organics apply to all of the mid-range liquid hydrocarbon products, high end hydrocarbon oils, and waste motor oil.

### 8.3.1 Default Closure Levels

Consistent with RISC, the default soil closure levels are the more health protective of the surface soil or subsurface soil closure levels. The default soil and ground water TPH closure levels are based upon fraction analysis of a theoretical gasoline composition and a theoretical diesel fuel composition. Limited experience with fractionation of diesel contaminated soils have yielded some site specific closure levels lower than the default closure levels that were based upon a theoretical diesel composition. Because of this, a margin of safety has been added to the diesel fuel default closure level to address this concern. As data are accumulated on products in Indiana, the default compositions (and the resultant default closure levels) may be adjusted to more closely reflect the actual petroleum products. Gasoline and diesel COC closure levels must be met in both the soil and ground water.

When the petroleum contamination is a mixture of gasoline and diesel fuel, the default closure level of the mixture can be determined by the sum of the ratio of the gasoline (GRO) concentration to the default gasoline closure level and the ratio of the diesel (ERO) concentration to the default diesel closure level being equal to a hazard index of 1, as follows:

$$1 = [GRO]/330 + [ERO]/1{,}000$$

### 8.3.2 Non-default Closure Levels

Non-default closure levels provide for site-specific closure levels using the Washington Department of Ecology's 12 fraction VPH/EPH analyses. The method of deriving the closure levels (default and non-default) is described in detail in Appendix 8. Non-default TPH closure levels are site-specific and are based upon fraction analysis of site-specific product compositions. TPH is regulated as the sum of the

fractions and not by the individual fractions. The individual fractions do not have closure levels assigned to them.

Table 3-1 TPH Closure Levels

**TPH Closure Levels†**

| | Hydrocarbon Product | Soil (mg/kg) | | Ground Water (µg/l) | | Caveat |
|---|---|---|---|---|---|---|
| | | Commercial/ Industrial | Residential | Commercial/ Industrial | Residential | |
| Default | Gasoline | 330 | 25 | 3,000 | 220 | No Free Product |
| Default | Diesel | 1,000 | 80 | 1,100 | 100 | No Free Product |
| Non-default | Gasoline | Site Specific (< 2,000) | Site Specific (< 1,000) | Site Specific | Site Specific | No Free Product |
| Non-default | Diesel | Site Specific (< 10,000) | Site Specific (< 5,000) | Site Specific | Site Specific | No Free Product |

†See the RISC User's Guide, Appendix 4, for the COCs. COCs are determined in soil and ground water.

### 8.3.3 Maximum TPH Contaminant Concentrations

Because high concentrations (>1%) of petroleum hydrocarbons in soil have demonstrated phytotoxic properties, as well as the uncertainty about the fate and transport of high concentrations of petroleum in soils and upon human health, the specific fuel nondefault closure levels have maximum limits applied. It is generally recognized that the toxicity, (human and environmental), of petroleum products increases as the molecular weights of the compounds decrease. Research has demonstrated that lighter oils have demonstrated phytotoxic effects at concentrations as low as 1,000– 1,200 mg/kg. As a result, maximum soil TPH closure levels (caps) are set at different levels for gasoline and diesel, both residential and commercial/industrial, but in neither case may the soil attenuation capacity (SAC) be exceeded or free product exist. These limits apply even when a nondefault site specific soil attenuation capacity (SAC) exceeds them.

### 8.3.4 Exposure Prevention Remedies

Sites using exposure prevention remedies (those remedies that eliminate an exposure pathway by using institutional and/or engineering controls) can have soil concentrations exceeding Non-default maximum caps, but cannot have free product. Ground water TPH closure levels are not capped, but no free product may exist. COC closure levels must be met in both the soil and ground water.

### 8.3.5 Chemicals of Concern (COCs)

Petroleum releases are still required to meet the closure levels for the applicable COCs. Chemicals of concern for each of the hydrocarbon product types are discussed further in the RISC User's Guide, Chapter 3, Leaking Underground Storage Tanks, and Appendix 4.1. The analytical procedures for the COCs are described in Appendix 2 of the RISC Technical Guide.

## 8.4 Site Characterization

### 8.4.1 Characterizing TPH in Soil

Sites are normally evaluated in a step-wise procedure that involves screening the area to determine what areas contain contaminants of concern, and then determining the nature and extent of the contamination. Once the nature and extent of contamination is known, then a potential exposure concentration (PEC) can be determined and compared to the default or nondefault closure levels to see if a site is eligible for closure or requires remediation.

At petroleum release sites where the source, location, and type of material are known, such as at a leaking underground storage tank (LUST), screening and determining the nature and extent of contamination can be combined into an expedited process. Chapter 3 and Appendix 4.2 of the RISC User's Guide provide more information on evaluating LUST sites.

#### 8.4.1.1 Screening

Sites with leaking underground storage tanks should follow the special procedures outlined in Appendix 4.2 of the RISC User's Guide. Sites that do not involve leaking storage tanks should apply the recommendations of the RISC Technical Guide, Chapter 3.

#### 8.4.1.2 Nature and Extent of Contamination

Sites with leaking underground storage tanks should follow the special procedures outlined in Appendix 4.2 of the RISC User's Guide. Sites that do not involve leaking storage tanks should apply the recommendations of the RISC Technical Guide, Section 4.4.1. Consistent with RISC, the nature and extent of TPH and COC contamination should be delineated out to the residential closure level at all sites. The nature and extent of the TPH contamination should first be determined by using the appropriate (SW-846-8015D) GRO analysis for gasoline range products and ERO analysis for diesel and other mid-range and high end hydrocarbon oils. These concentrations will be used for calculating the potential exposure concentration (PEC). If it is anticipated that a nondefault closure level will be sought, then samples for fractionation analysis of the most heavily TPH contaminated soil should be taken first (See Section 5.0). The resultant nondefault residential closure level should then be used to define the nature and extent of contamination using the SW-846-8015D method.

#### 8.4.1.3 Determining the PEC

The PEC can be calculated in different ways, depending upon the site specific situation. For sites not regulated by the LUST program, determine the PEC according to Chapter 3, Area Screening, of the RISC Technical Guide. For sites regulated by the LUST program, determine the PEC according to Appendix 4.2 of the RISC User's Guide.

### 8.4.2 Characterizing TPH in Ground Water

Ground water screening for TPH should be conducted in accordance with the default guidance presented in Section 3.4.5 of the RISC Technical Guide. Ground water contaminant plumes should be screened out to the residential closure level. Determine the nature and extent of TPH in the ground water according to the recommendations of Section 4.4.2 of the RISC Technical Guide.

## 8.5 Determining Closure

A stepwise approach is recommended for TPH sites. The nature and extent of the contamination should first be determined by using the appropriate (SW-846-8015D) GRO analysis for gasoline and ERO analysis for diesel and other mid range and high end hydrocarbon oils. Determine the PEC from the GRO/ERO analyses. If the PEC is below

the applicable default closure level, then the site is eligible for closure for TPH. If the PEC exceeds the applicable default closure level, the site should either be remediated or further evaluated by fractionating samples of the petroleum product to determine a site specific nondefault closure level.

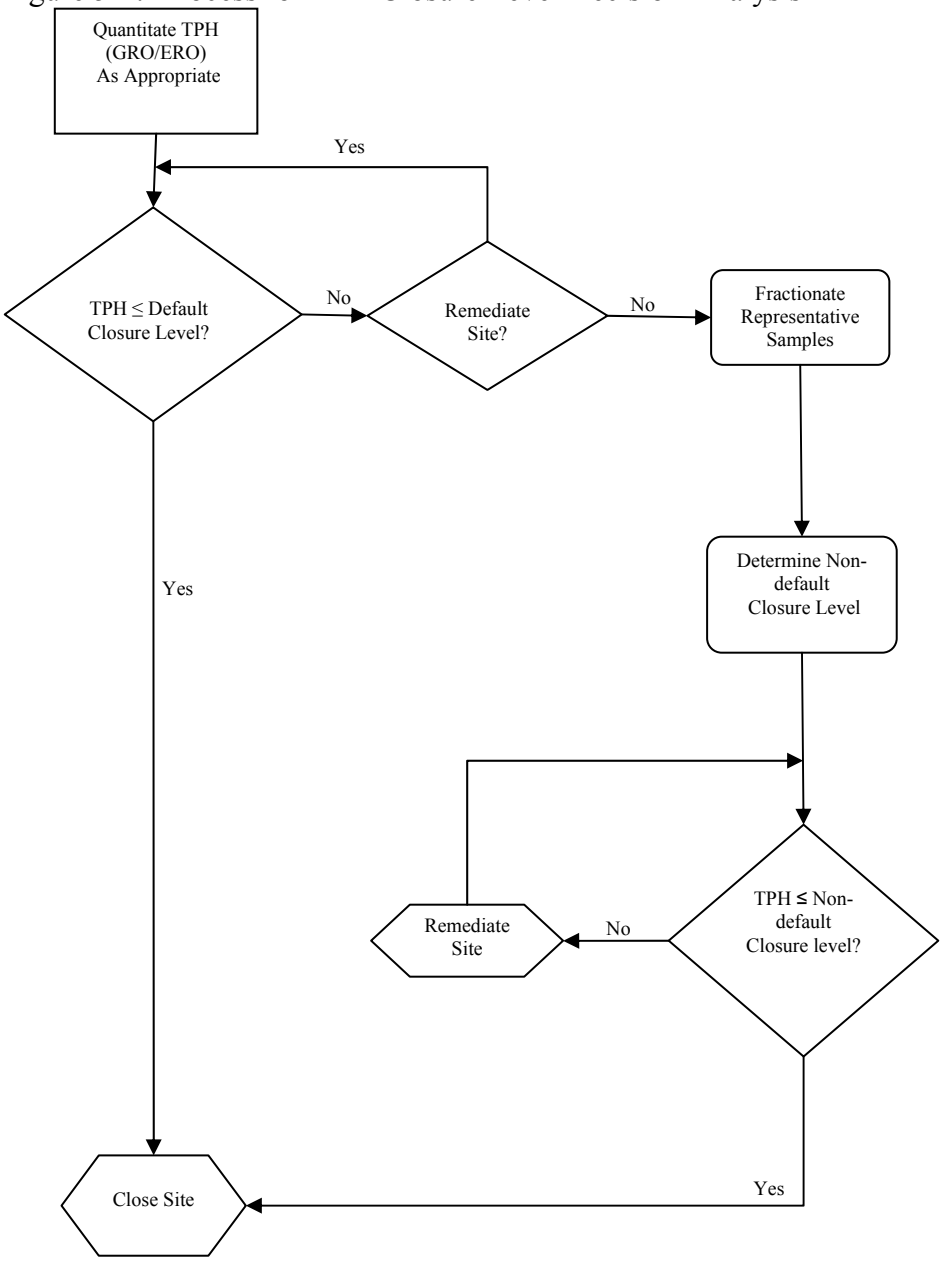
To determine nondefault soil and ground water TPH closure levels, three to five samples of the most heavily contaminated soil should be analyzed using the fractionation method (Section 7.2.2). The lowest (most conservative) closure level should be selected as the nondefault for the site. To avoid double counting the EC>8 – 10 and EC>10 - 12 fractions, use the higher of the VPH or EPH analysis to represent these fractions.

Determine the nondefault site-specific TPH soil closure level from the RISC TPH Spreadsheet (*to be posted on the IDEM web at: http://www.in.gov/idem/programs/land/risc/index.html )* and compare it to the non-default closure level cap. If the site-specific closure level is below the closure level cap, then the site-specific closure level is applied to the entire site. If the site-specific closure level exceeds the closure level cap, then the cap is applied to the entire site. Once site-specific TPH closure levels have been determined using fractionation analysis, compliance with nondefault site-specific closure levels can be demonstrated using simple TPH GRO or ERO (SW-846-8015D) analyses. If the fractionation analysis shows that the contaminant is a mixture of gasoline and diesel fuel, then use the sum of GRO + ERO. Figure 5-1 illustrates the process. As a general rule, mixtures of gasoline and diesel fuel should be compared to the gasoline closure level cap.

As specified in the RISC Technical Guide, Section 6.3.3.1, ground water closure levels must be met throughout the ground water plume for 8 consecutive quarters.

Consistent with RISC, contamination in excess of the residential closure level requires that controls are in place to assure that the public is not exposed to excess risk. See Chapter 6, Closure, of the RISC Technical Guide.

Figure 5-1. Process for TPH Closure Level Decision Analysis



## 8.6 Sample Collection

Proper sample collection and preservation is critical to obtaining accurate measurements of TPH in the environment. TPH samples, especially unknown petroleum products and gasoline range organics (GRO) samples, should be collected and preserved in a manner that minimizes the volatilization and biodegradation of the hydrocarbons. Studies of samples with low concentrations of VOCs (less than 200 ppb) in soils have shown losses of 80% - 95% when using the traditional soil collection procedure of putting the soil into four ounce jars. Because of this, TPH soil samples for gasoline and unknown petroleum products should be taken in accordance with EPA's Method SW-846-5035A, Appendix A.

If it is anticipated that a site-specific TPH closure level will be determined by fractionation, collect duplicate TPH samples so that when the appropriate samples are identified by the standard analytical method (SW-846-8015D) GRO or ERO analysis (extended range organics, $C_8 - C_{36}$) , sufficient samples are available for fractionation (provided analytical holding times can be met). Sampling the ground water for TPH is not affected (see Table 7-1).

It should be pointed out that, while in the past the mid-range hydrocarbon products (*e.g.* diesel) have been characterized by the diesel range organics (DRO, $C_8$-$C_{28}$), IDEM is now requiring that the extended range organics ($C_8$-$C_{36}$) be used. This will facilitate the comparison of the ERO analyses with the fractionation derived closure levels.

## 8.7 Sample Analysis

### 8.7.1 TPH Classes

For the purposes of TPH laboratory analysis in this guidance, petroleum products are broken down into four general classes of TPH:

- Gasoline Range Organics ($C_5 - C_{12}$)
- Mid-Range Liquid Hydrocarbon Products or Diesel Range and Extended Range Organics ($C_8 - C_{36}$)
- High End Hydrocarbon Oils ($C_8 - C_{36}$)
- Waste Motor Oil ($C_8 - C_{36}$)

See Table 7.1 for further explanation of the classes and recommended TPH and COC analytical methods.

### 8.7.2 TPH Analytical Methods

Because the standard DRO analysis for diesel often stops at $C_{28}$ compounds, and the fractionation analysis goes to $C_{36}$ compounds, it is recommended that diesel fuel and other mid-range hydrocarbon product contamination be characterized by running the extended range organics analysis (to $C_{36}$) to facilitate comparison with the fractionation analysis derived closure levels. Table 7.1 presents the various petroleum products and COCs and their appropriate analytical methods for default closure levels.

#### 8.7.2.1 Determining Nature and Extent of Contamination and Potential Exposure Concentrations

The analytical method for determining the nature and extent of contamination and the potential exposure concentration (PEC) is SW-846-8015D. For gasoline contamination, use the GRO analytical range. For diesel and other mid-range petroleum products, use the ERO analytical range. If there is any possibility of a mixture of gasoline and diesel, then both the GRO and ERO analytical ranges should be run and compared to the default mixed contaminant closure level as determined in Section 3.1.

#### 8.7.2.2 Determining Site Specific (Non-default) Closure Levels

Non-default uses fractionation of the TPH sample for determining site and product specific closure levels. The analytical methods to be followed are the Washington Department of Ecology's VPH/EPH methods. These methods can be found at http://www.ecy.wa.gov/biblio/97602.html. A Level 4 Data Quality Package should be submitted with the analytical results.

Table 7.1 Recommended Sample Collection and Analytical Methods

| Product | TPH | | COC | | |
|---|---|---|---|---|---|
| | **Sample Collection and Preparation** | **Analytical Method** | **COCs** | **Sample Collection** | **Analytical Method** |
| Gasoline Range ($C_5$ - $C_{12}$)<br>Auto gasoline<br>Aviation gas<br>Racing gas<br>Mineral spirits<br>Stoddard solvents<br>Naptha<br>Jet fuel JP-4 | 5035A (Soil)<br><br>5030B (Water) | SW-846-8015D | BTEX<br>MTBE<br>n-Hexane<br>Naphthalene | 5035A (Soil)<br><br>5030B (Water) | GC/PID 8021 or GC/MS 8260 or GC/MS 524.2 |
| Diesel Range ($C_8$ – $C_{36}$)<br>No 1 Diesel<br>No 2 Diesel<br>Kerosene<br>Jet fuel (J-5, -7, -8)<br>Light oil<br>Home heating oil | Traditional with Appropriate Extraction | SW-846-8015D | cPAHs<br>Naphthalene<br>BTEX<br>MTBE | 5035A (Soil)<br>5030B (water)<br>and<br>Traditional with Appropriate Extraction | GC/PID 8021 or GC/MS 8260 or GC/MS 524.2<br>**and**<br>GC/MS 8270 SIM<br>or<br>HPLC 8310 or GC/MS 525.2 |
| High End Hydrocarbon Oils ($C_8$ – $C_{36}$)<br>No 4 Fuel oil<br>No 5 Fuel oil<br>No 6 Fuel oil<br>Bunker C<br>Mineral oil | Traditional with Appropriate Extraction | SW-846-8015D | PAHs<br>and<br>Naphthalene | Traditional with Appropriate Extraction | GC/MS 8270 SIM<br>or<br>HPLC 8310 or GC/MS 525.2 |
| Waste Oil* | Traditional with Appropriate Extraction | SW-846-8015D | VOCs<br>PAHs<br>PCBs<br>Metals* | Traditional with Appropriate Extraction | GC/PID 8021 or GC/MS 8260 or GC/MS 524.2<br>8310 or<br>8270 SIM or<br>525.2 and<br>Relevant SW 846 methods for metals<br>8082 |

* See *Waste Oil Analyses and Analytes*, at
http://www.in.gov/idem/programs/land/lust/waste_oil.html

# ANALYTICAL METHODOLOGY FOR RISK ASSESSMENT

Analytical methodology must be evaluated concurrently with factors related to sampling procedures, statistical treatment of data, and risk assessment processes to ensure that the established Data Quality Objectives (DQOs) can be attained. Responsible parties must determine the sampling methods, analytical methods, and quality control measures needed to meet the closure or remedial DQOs (for screening, determination of nature and extent, and confirmation of remediation, as applicable). These considerations must take into account the uncertainty associated with generating data and with determining that statistical criteria have been met. After the data have been generated they must be validated for conformance to quality assurance/quality control criteria, and assessed in terms of applicability to the overall project goal. In other words, data must be assessed as to whether the DQOs have been met.

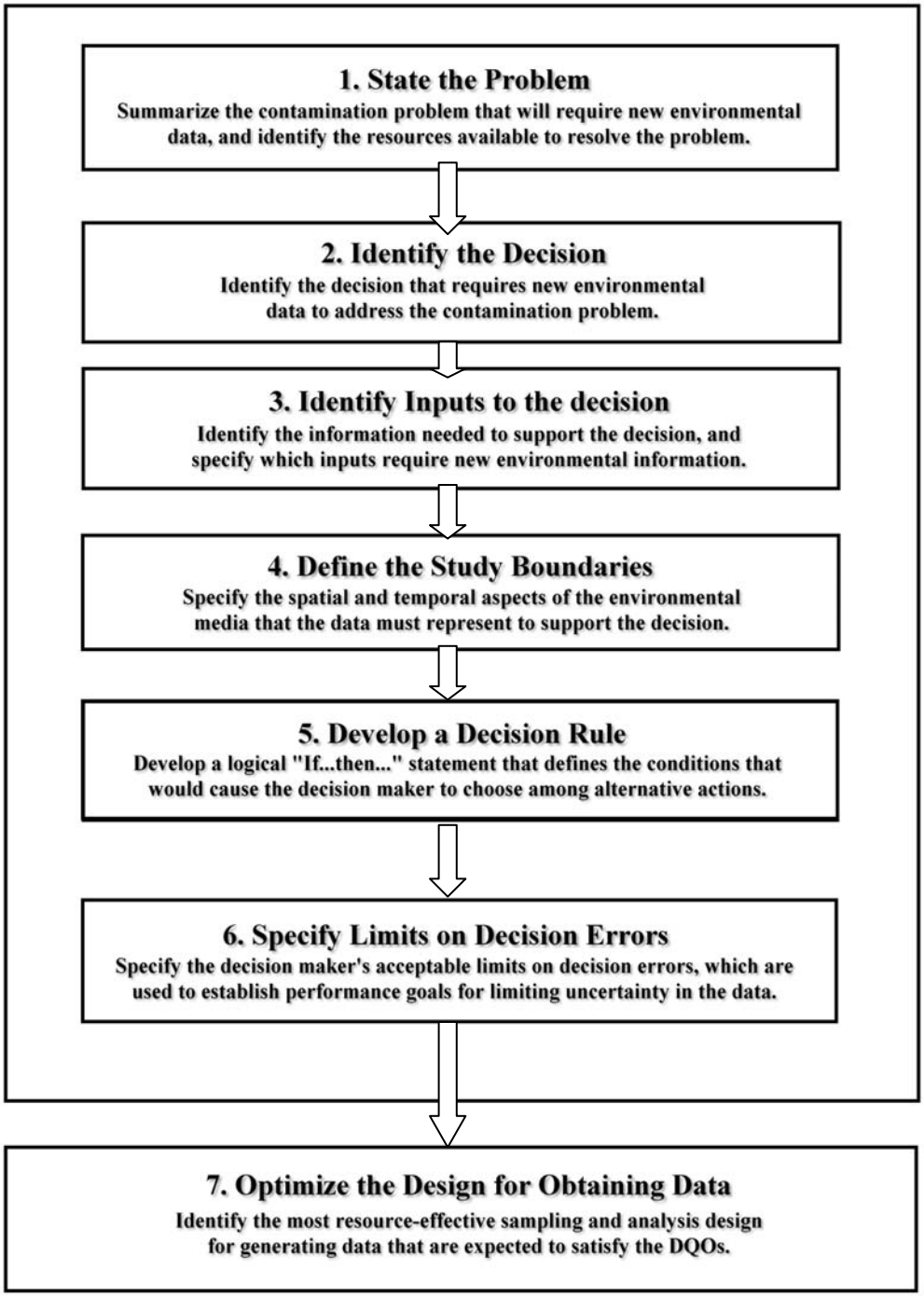
## Remedial Objective and the Data Quality Objective Process

The USEPA (EPA) defines DQOs and the DQO development process as follows:

> **What is the DQO Process?** The DQO Process is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application. The steps of the DQO Process are illustrated in Figure 1 [below].
>
> **What are DQOs?** DQOs are qualitative and quantitative statements derived from the outputs of each step of the DQO Process that:
>
> 1) Clarify the study objective;
> 2) Define the most appropriate type of data to collect;
> 3) Determine the most appropriate conditions from which to collect the data; and
> 4) Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision.
>
> The DQOs are then used to develop a scientific and resource-effective sampling design.
>
> The process allows decision makers to define their data requirements and acceptable levels of decision errors (decision errors occur when variability or bias in data mislead the decision maker into choosing an incorrect course of action) during planning, before any data are collected. Application of the DQO Process should result in data collection designs that will yield results of appropriate quality for defensible decision making.[1]

[1]Environmental Protection Agency, Office of Emergency and Remedial Response, *Data Quality Objectives Process for Superfund: Interim Final Guidance*, 9355.9-01, EPA540-R-93-071, September 1993, p. 1, NTIS, PB94-963203.

**Figure 1**[2]
## The Data Quality Objective Process




[2]Environmental Protection Agency, Office of Emergency and Remedial Response, *Data Quality Objectives Process for Superfund: Interim Final Guidance*, 9355.9-01, EPA540-R-93-071, September 1993, p. 2, NTIS, PB94-963203.

## Choosing Analytical Methods to Reduce Costs

Once the source area COCs have been determined, it is desirable to reduce costs by selecting the most cost effective analytical methods to detect and quantitate those specific COCs. However, the analytical methods selected *must* having quantitation or detection limits that can meet the required Closure Levels for the COCs in the appropriate matrices. The attached table, **Analytical Methods with Reporting Limits for RISC**, lists the COCs from the Closure Look-up Table, their respective Closure Levels for soil and groundwater matrices, and standard (promulgated) EPA analytical methods that are capable of detecting the COC at the concentration of the Closure Level. For each COC methods are included that are generally used by the RCRA (SW-846), Superfund (CLP), and Water ("Water Methods") programs unless the program has no method for that COC. **A method that does not have a quantitation limit low enough to meet the Closure Level cannot be used without adjustment or adaptation to lower the quantitation limit.** Proposed method adaptations or suggested substitute methods must be included in the QAPP. Modified or substitute methods should also be validated prior to use for an environmental project A suggested format for method validation is presented in the IDEM manual, ***Guidance to the Performance and Presentation of Analytical Chemistry Data*** in the form of a checklist entitled "Performance-Based Measurement System (PBMS) Initial Demonstration of Method Performance."

Shaded boxes in the **Analytical Methods with Reporting Limits for RISC** table indicate that the methods for that program are not capable of meeting the Closure Level; the method(s) closest to meeting the Closure Level are listed. **Methods in shaded boxes should not be used unless they are adapted or modified to provide a lower quantitation limit**. Such modification or adaptation will be necessary if site COCs include bis(2-chloroethyl)ether, 2-nitroaniline, or N-nitroso-di-n-propylamine. There are no promulgated EPA methods that can currently meet the human health Closure Level for these analytes in one or both matrices.

Adapted, modified or alternate methods may also be required when the site affects an ecologically susceptible area. When an ecological risk assessment is required, alternate ecological protection levels must be used that often are lower than the human health Closure Levels**. If alternate ecological protection levels cannot be met by unmodified methods, analytical methods must be adapted or modified, or alternate analytical methods must be found, to reach the lower ecological protection levels.** This is true for ecological risk assessments even if the unmodified method does meet the human health Closure Level. Proposed method modifications or alternate methods must be included in the QAPP and should be validated prior to use for the ecological risk assessment using a format similar to the "Performance-Based Measurement System (PBMS) Initial Demonstration of Method Performance Checklist" suggested in the IDEM manual, ***Guidance to the Performance and Presentation of Analytical Chemistry Data***.

To minimize analytical costs yet achieve quantitation limits below the risk-based Closure Levels, it may be necessary to select analytical methodology different than the methods that are most familiar to environmental project managers. For example, many environmental professionals are accustomed to using the SW-846 gas chromatography/mass spectrometry (GC/MS) Methods 8260 for volatile organic compounds (VOCs) and 8270 for semivolatile organic compounds

(SVOCs). However, standard GC/MS procedures usually have higher EQLs than GC using detectors other than MS, meaning that the GC/MS quantitation limits may not meet the required Closure Levels. Another chromatography technique used to analyze semivolatile and nonvolatile organic compounds, high performance liquid chromatography (HPLC), also tends to have lower EQLs than GC/MS methods and may be preferred for some analytes (COCs). In addition, GC/MS methods may be more expensive than GC or HPLC. This is because the larger number of analytes typically targeted in standard GC/MS methods can increase calibration and quality control sample costs. (Note: Limiting the number of analytes by telling your laboratory contact, *prior to analysis*, the exact COC list you must report, might reduce the analysis cost. If you merely request a certain method, the laboratory will analyze for the full list of analytes published in the method.)

In contrast, HPLC methods or GC methods employing detection techniques such as photoionization (PID) or electron capture (ECD) may be preferable when the site-specific chemicals of concern (COCs) are few in number and well known (so as to reduce cost), or when lower detection limits are needed to meet risk-based Closure Levels. These GC and HPLC methods group analytes by *individual (or closely related) chemical class.* They cannot group diverse chemical classes into one analysis (like GC/MS).

## To minimize costs, the project manager should consult the laboratory chemist to determine the best analysis or suite of analyses to meet the project DQOs for the site-specific COCs identified in the QAPP.

Consider the following objectives for a petroleum release site:

- Identify Hazardous Substances and Media

  A default risk assessment will be performed for a petroleum-release site where diesel fuel was stored. No non-petroleum chemicals were ever used at the site, and diesel fuel is a high-end liquid hydrocarbon fuel, so the site-specific COCs are the class B2-carcinogenic polynuclear aromatic hydrocarbons (cPAHs), **Naphthalene**, and BTEX. Per the QAPP, sampling will be performed on subsurface soils and groundwater, and concentrations will be compared to residential Closure Levels.

- Identify Chemicals of Concern (COCs)

  The cPAH group (a subset of the larger class of chemicals, SVOCs) consists of the following compounds: benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene. All of these compounds are on the analyte list for Method 8270C, but they also appear on the compound list for Method 8310, a high performance liquid chromatography (HPLC) technique specifically for polynuclear aromatic hydrocarbons. Benzene, toluene, ethyl benzene, and xylene (BTEX) are volatile organic compounds appearing on the Method 8260B compound list. The BTEX compounds are also listed for Method 8021B, "Aromatic and Halogenated Volatiles by Gas Chromatography." Which methods should be used?

• Identify Analytical Methods

First, the Closure Levels for the COCs in subsurface soil and groundwater should be compared to the estimated quantitation limits (EQLs) for the COCs in the applicable methods. The following table compares the default residential Closure Levels for the COCs in our example to the EQLs for Methods 8260B and 8021B (BTEX) and Methods 8270C and 8310 (cPAHs):

**Residential Closure Level/EQL Comparison Table (Petroleum)**

| **BTEX** | | | | | | |
|---|---|---|---|---|---|---|
| **Compound** | **SS Soil Closure Level, µg/kg** | **8260B EQL, soils, µg/kg** | **8021B EQL soils, µg/kg** | **GW Closure Level, µg/L** | **8260B EQL, µg/L (purge: 5 mL/25 mL)** | **8021B EQL, aqueous, µg/L** |
| Benzene | 33.8 | 5 | 0.09 | 5. | 5* / 1 | 0.09 |
| Toluene | 11,700. | 5 | 0.10 | 1,000. | 5 / 1 | 0.10 |
| Ethyl benzene | 13,400. | 5 | 0.05 | 700. | 5 / 1 | 0.05 |
| Xylene | 200,000. | 5 | 0.20 | 10,000. | 5 / 1 | 0.20 |
| **cPAHs** | | | | | | |
| Benzo[a]anthracene | 4,620 | 660 | 8.78 | 1.17 | 10 | 0.13 |
| Benzo[a]pyrene | 462 | 660 | 16 | 0.2 | 10 | 0.2 |
| Benzo[b]fluoranthene | 4,620 | 660 | 12 | 1.17 | 10 | 0.18 |
| Benzo[k]fluoranthene | 39,400 | 660 | 12 | 0.8 | 10 | 0.17 |
| Chrysene | 25,500 | 660 | 100 | 1.6 | 10 | 1.5 |
| Dibenzo[a,h]anthracene | 462 | 660 | 20 | 0.12 | 10 | (MDL) 0.03* |
| Indeno[1,2,3-cd]pyrene | 3,050 | 660 | 30 | 0.022 | 10 | (MDL) 0.04** |

*Special care required.
**Method adaptation and special care required.

The first inclination of the project manager may be to ask the laboratory to run Methods 8260 and 8270. Looking at the table, we can see the following: The BTEX section indicates that Method 8260 EQLs are sufficiently low to meet the BTEX Closure Levels for both sub-surface soil and ground water. Next the project manager calls the laboratory to obtain pricing for Method 8260 and BTEX by Method 8021. Prices are quoted at $200 for the standard 8260 analyte list and $80 for BTEX by 8021.

The laboratory contact also informs the project manager that to run BTEX compounds alone by 8260 would cost $85-$90. The chemist explains that this is because the benzene analysis by 8260 will require special attention: The laboratory normally purges a 5 mL sample, yielding a 5 µg/L EQL for Method 8260 analytes. The benzene Closure Level (based on the

MCL) is also 5 μg/L. An EQL equal to but no lower than the Closure Level leaves no room for uncertainty, such as matrix interference or random variability. To minimize the possibility of false positive or false negative results, it would be advisable to purge 25 mL sample for the benzene analysis, so that an EQL of 1 μg/L would be obtained. The project manager considers the information supplied by the laboratory chemist and decides on Method 8021, both to save money and to ensure adequate detection levels for benzene.

Next, looking at the cPAH section, we can see that Method 8270 is not suitable for the default risk assessment because EQLs exceed the Closure Levels for all COCs in groundwater and two COCs in subsurface soil (Dibenzo[a,h]anthracene and indeno[1,2,3-cd]pyrene). The project manager requests the laboratory to run Method 8310 for cPAHs, explaining the detection limits that are needed to meet the Closure Levels. The laboratory contact may explain that additional charges will be incurred to adapt the method to lower detection limits for Dibenzo[a,h]anthracene and indeno[1,2,3-cd]pyrene in ground water or suggest an alternate method, if one is available.

Similar reasoning can be applied to objectives for a chemical release site. For example:

- Identify Hazardous Substances and Media

A default risk assessment will be performed for a chemical-release site where paint and varnish waste was processed. A variety of solvents and paint removers were also used at the site. Some of the paints contained inorganic pigments. Sampling will be performed on surface and subsurface soils, and concentrations will be compared to *non*-residential Closure Levels.

- Identify Chemicals of Concern (COCs)

Based on previous sampling, MSDS sheets, and other records, the COCs were determined to be: (1) solvents (used independently and as paint and paint remover components): n-butanol, methyl ethyl ketone (MEK), benzene, toluene, methylene chloride; and (2) metals (from inorganic pigments): titanium, copper, and chromium. The following table compares the default Non-residential Closure Levels for the COCs in this example to the EQLs for SW-846 methods appropriate for the analysis of solvents and metals.

- Identify Analytical Methods

First, the Closure Levels for the COCs in subsurface soil and groundwater should be compared to the estimated quantitation limits (EQLs) for the COCs in the applicable methods. The solvents are all on the 8260 list. Benzene, toluene, and methylene chloride can also be run by Method 8021B, but not by 8015B. MEK and n-butanol can be run by Method 8015B but not by 8021B. The EQLs for all these volatile organic compounds in each appropriate method are lower than the Closure Levels. The project manager may choose to run all these volatile organic compounds by 8260 or may choose to combine methods 8015B and 8021B; the choice depends on which has the lower cost.

Chromium, copper, and titanium are all on the analyte list for Method 6010B, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP). Copper and chromium can also be run by Atomic Absorption Spectroscopy (AA) methods; there is no AA method for

titanium. Either method choice is sufficient to meet the Closure Levels for chromium. Copper and titanium do not have Closure Levels. However, analyses will be run to measure site concentrations, and site-specific Closure Levels will be calculated. All three metals may be run by ICP, or the project manager may choose AA for copper and chromium, depending on which analysis costs least.

**Non-Residential Closure Level/EQL Comparison Table (Paint Chemicals)**

| **Solvents** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Compound** | **SS Closure Level, µg/kg** | **Surface Closure Level, µg/kg** | **8260B EQL, soils, µg/kg** | **8021B EQL, soils, µg/kg** | ***GW Closure Level, µg/L*** | ***8260B EQL, µg/L*** | ***8021B EQL, µg/L*** |
| *Benzene* | *668* | *13,000* | *5* | *0.09* | *98.7* | *5* | *0.09* |
| *Toluene* | *240,000* | *654,000* | *5* | *0.10* | *20,400.* | *5* | *0.10* |
| *Methylene chloride* | *1,770.* | *197,000* | *5* | *0.05* | *382.* | *5* | *0.05* |
| ***Compound*** | ***SS Closure Level*** | ***Surface Closure Level*** | ***8260B*** | ***8015B*** | ***GW Closure Level*** | ***8260B*** | ***8015B*** |
| *Butanol* | *43,700* | *1,000,000* | *100* | *2300* | *10,200* | *100* | *70* |
| *MEK* | *279,000* | *1,000,000* | *100* | *2700* | *61,300* | *100* | *50* |
| ***Metals*** | | | | | | | |
| ***Compound*** | ***SS Closure Level*** | ***Surf Closure Level*** | ***6010(ICP)*** | ***AA method*** | ***GW Closure Level*** | ***6010(ICP)*** | ***AA method*** |
| *Chromium* | *196,000* | *1,000,000* | *1000* | *1000* | *511* | *10* | *50* |
| *Copper* | *none* | *none* | *1000* | *1000* | *none* | *20* | *20* |
| *Titanium* | *none* | *none* | *5000* | *none* | *none* | *50* | *none* |

## Sampling Design and Quality Assurance/Quality Control

Sampling design and sampling field procedures must be supportive of the project DQOs. A Sampling and Analysis Plan (SAP) should be prepared as part of the QAPP. Accurate field notes should be taken. Sampling methods from source documents published by the USEPA, American Society for Testing and Materials (ASTM), U.S. Department of the Interior, National Ground-water Association (NGWA), American Petroleum Institute (API), or other recognized organizations with appropriate expertise should be used, if possible. Field quality control procedures and collection of field quality control samples are necessary to ensure that the precision and accuracy of the measured COC concentrations can be determined. In general the following field QA/QC measures will be required:

- Chain-of-custody
- Trip blank (for volatile organics compounds, one for each day of sampling)
- Field blank
- Equipment blank (rinsate blank)

- Field duplicates (a minimum of one duplicate for every 20 or fewer samples)
- Documentation of field events (sampling procedures, locations, conditions, and characteristics of samples collected)

Appropriate sample containers; preservatives; and handling, storage, and transportation techniques should also be used to maintain the integrity of the samples and analytical data. The control criteria that the field QA/QC measures should meet can be found in the IDEM manual, ***Guidance to the Performance and Presentation of Analytical Chemistry Data.*** **The field QA/QC measures must be documented and should be submitted as supporting documentation to the risk assessment along with the analytical results.**

## Analytical Quality Assurance/Quality Control

The QA/QC procedures described in the analytical method chosen should be followed to ensure that Closure Level criteria and other project DQOs can be met. In general, the following measures will be required:

- Chain-of-custody
- Holding time requirements
- Instrument tuning
- Instrument calibration records
- Initial and continuing calibration verifications
- Laboratory control samples
- Matrix spike/matrix spike duplicate samples
- Raw data

The control criteria that the analytical QA/QC measures should meet can be found in the IDEM manual, ***Guidance to the Performance and Presentation of Analytical Chemistry***. **The laboratory QA/QC measures and their results must be documented and should be submitted as supporting documentation to the risk assessment along with the analytical report of sample results**.

## Documentation Requirements

Documentation requirements for analytical data, field QA/QC measures, and laboratory QA/QC results are listed below. General requirements applicable to all samples are followed by requirements specific to analysis type.

***GENERAL Sampling Quality Control Data and Information:***

- Chain-of-Custody
- Date and time each sample was taken
- Map or diagram indicating sample locations
- Field measurements made (and results)
- Any notable observations (color, clarity, texture, reaction with preservatives, etc.)

- Trip blank (or field blank)
- Equipment blank (rinsate blank)
- Identity of field duplicates (a minimum of one duplicate for every 20 or fewer samples)

***GENERAL Laboratory Quality Control Data and Information:***

- Completed Chain-of-Custody
- Date and time of receipt at the laboratory
- Condition of samples upon receipt at the laboratory
- Sample identification number or designation
- Laboratory sample numbers corresponding to facility sample identification
- Sample preparation, extraction, cleanup, or digestion method(s) and date(s)
- Analytical method (name, number, and source) and date of analysis
- Final analytical results
- Case narrative (Includes deviations from standard analytical or preparatory procedure(s); quality control problems encountered--whether stemming from system, instrumentation, analyst error, or sample matrix; corrective measures taken; if corrective measures as called for in the method were not taken; results of corrective measures taken; etc.)

***SPECIFIC ANALYSES***

***Metals and General Inorganic Analyses***

TOTAL AND DISSOLVED METALS by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) or Atomic Absorption Spectroscopy (AA) and GENERAL INORGANIC ANALYSES

- Method/sample quantitation limits
- Instrument detection limits
- Calibration records and results:
- Blank results
- Matrix spike (sample number of sample spiked, sample concentration for analyte, concentration of spike added, results and % Recovery)
- Matrix spike duplicate or laboratory duplicate (results and Relative Percent Difference [RPD]; if matrix spike duplicate, also report %Recovery)
- Laboratory control sample (QC standard or lab-fortified blank: results and %Recovery)
- Additional deliverables for ICP analysis (if applicable): Interference check sample (results and % recovery), serial dilution results (five-fold analysis), ICP Linear Range, and inter-element correction factors
- Method of Standard Addition (MSA) results (if applicable)
- **Raw data**: To include instrument numerical printouts, instrument peak printouts (all AA and general inorganic, where applicable), lab worksheets, strip chart recordings, sample preparation records, and record of dilutions.

***Organic Analyses***

VOLATILE ORGANIC ANALYSIS (VOA) and SEMIVOLATILE ORGANIC ANALYSIS (SVOA) BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

- Tuning criteria and results
- Initial calibration data and results
- Initial and Continuing Calibration Verification data and results (beginning of run and every twelve hours:
- Method blank summary sheet with results, including detections
- Detection/quantitation limit for each compound
- Internal standards summary
- Surrogate (System Monitoring Compound) results (concentration of surrogate spikes added, measured concentrations, and % Recoveries of all surrogates) for each sample
- Matrix Spike/Matrix Spike Duplicate (MS/MSD) results (sample concentration for analyte, concentration of spike added, results, % Recovery for each compound, and Relative Percent Difference between MS and MSD for each compound)
- **Raw Data** for each sample, field duplicate, blank, matrix spike/matrix spike duplicate.

ANALYSIS OF VOLATILE ORGANIC COMPOUNDS and SEMIVOLATILE ORGANIC COMPOUNDS BY GAS CHROMATOGRAPHY (GC) Using Method-Specified Detectors (FID, PID, HECD, etc.)

- Initial Calibration, data and results
- Retention Time (RT) Summary to include:
  --- RT measured for each target compound from three separate injections over a 72-hour period
  --- Mean and standard deviations of the three RTs measured (over the 72-hour period)
  --- RT window for each target compound (mean ± three standard deviations)
  --- Date and time of injections (or introduction by purge-and-trap)
- Initial and Continuing Calibration Verification (ICV and CCV)
- Method of sample introduction (direct injection or purge-and-trap)
- Detection/quantitation limit for each compound
- Method blank summary and chromatograms
- Surrogate recoveries for samples, blanks, and spikes
- Matrix spike/matrix spike duplicate (MS/MSD) analysis or lab duplicates
- **Raw Data** for each sample, standard, field duplicate, blank, matrix spike, and matrix spike duplicate, including dilutions made, chromatograms and preparatory records.
- Confirmation by GC/MS or on second GC column, if required by determinative method or if interference is suspected. Include results and raw data.

QUALITY ASSURANCE/QUALITY CONTROL INFORMATION FOR ANALYSIS OF PESTICIDES and PCBS BY GAS CHROMATOGRAPHY (GC) WITH ELECTRON CAPTURE DETECTOR (ECD) OR ELECTROLYTIC CONDUCTIVITY DETECTOR (ELCD OR HECD)

- Initial Calibration
- Method blank summary and chromatograms
- Detection/quantitation limit for each compound (in each sample)
- Surrogate recoveries for samples, blanks, and spikes
- Matrix spike/matrix spike duplicate (MS/MSD) analysis or laboratory duplicates
- **Raw Data** for each sample, standard, field duplicate, blank, matrix spike, and matrix spike duplicate, including dilutions made, preparatory records, and chromatograms

- Confirmation of detection **required**: on second GC column *OR* by GC/MS with supporting documentation

## Data Validation

**Validation** is the evaluation of the technical usability of the data in light of its intended use: whether the methods used and results obtained make sense and are scientifically defensible given the study objectives. This is done through a "**PARCC**" evaluation: **precision, accuracy, representativeness, completeness, and comparability**.

- **Precision** is the measurement of agreement of a set of replicate results among themselves without assumption of any prior information as to the true result. Precision is assessed through the analysis or duplicate or replicate samples.
- **Accuracy** is the nearness of a result or the nearness of the mean of a set of results to the true value. Accuracy is assessed through the analysis of reference samples or the introduction of reference materials to field samples and measurement of percent recovery of the known value.
- **Representativeness** is an assessment as to how well the field samples collected reflect the actual site conditions.
- **Completeness** is an assessment as to whether sufficient information has been provided. It includes aspects from whether a sufficient number of samples were collected to whether enough analytical documentation of laboratory operations was provided.
- **Comparability** is how well the data corresponds to data collected in previous sampling events at the site or to site samples from the same event analyzed at different laboratories.

The PARCC evaluation is accomplished through a comprehensive QA/QC review of the data, providing an estimate of the uncertainty in the data values. Guidelines for performing a comprehensive data review are listed below.

## Data Review Guidelines

The criteria listed in the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*[3] **and the *USEPA Contract Laboratory Program Guidelines for Inorganic Data Review***[4]9240.1-05-01, EPA-540/R-94-013, February1994, NTIS: PB94-963502 **provide a good starting point for data review. However, an unmodified "CLP review" is <u>not</u> sufficient for validating data to be used in support of risk assessments**. A "CLP review" results in data that are flagged by "data qualifiers," that is, letter symbols denoting a general category of data quality, such as "estimated" (J) or "unusable" (R). These qualifiers do not explain the scientific evidence in the data leading to the qualification and do not provide a

[3]Environmental Protection Agency, Office of Solid Waste and Emergency Response, Publication 9240.1-05, EPA-540/R-94/012, February 1993, NTIS: PB94-963501.

[4]Environmental Protection Agency, Office of Solid Waste and Emergency Response, Publication 9240.1-05-01, EPA-540/R-94-013, February 1994, NTIS: PB94-963502

measurement or estimate of the uncertainty in the data values, and thereby, their application to the Closure Level values.

Data validation for risk assessment involves reviewing the data using criteria similar to those listed in the CLP *National Functional Guidelines* but going on to document the evidence for qualification and measure or estimate the statistical error or uncertainty. The following is a suggested review process. It can be applied to any type of analytical method used:

1. **Review every criterion listed in the *National Functional Guidelines* for the applicable QC measure and use the evaluation procedure listed, with these exceptions:**

   a. Substitute the control limits/criteria specified in the actual analytical method followed for the CLP limits in the *National Functional Guidelines.* If the actual method followed does not specify set control limits, use the CLP control limits.

   b. After evaluating all applicable criteria for the analysis type, qualify the data if appropriate. To do this, rather than just adding a CLP qualifier (like "J" or "R") to the reported result, write a memo or report explaining in words why the data is estimated or unusable:

      - Go into detail in the text of the review report, listing <u>all</u> criteria or reasons justifying the qualification as estimated or unusable. Explain whether it is a sample matrix problem, a laboratory precision or accuracy problem, a sampling problem, etc.

      - Do this separately for each analyte. However, groups of analytes of the same general class (e.g., "metals" or "semivolatile organics") that have the exact same QC problems for the exact same samples or monitoring wells can be grouped together.

      - If the QC problem affects analysis of *all* samples for that analyte, say so and qualify all. If the problem can be identified as being limited to particular samples, list which samples they are (and do not qualify the others).

      - Provide an abbreviated summary of the reasons in a "Table of Estimated Analytes" to be included at the end of the report.

   c. In the case of accuracy problems, assign a direction of bias where possible. If possible, also attempt to quantify the bias as a percentage or number of measurement units.

   d. In the case of precision problems, state that it is a precision problem in some way–e.g.: "the duplicates compare (or do not compare) well," "results exhibit high variability," "results exhibit poor repeatability," etc.–and that the direction of bias cannot be determined. Again, when possible, estimate the uncertainty expressed as a range: +/- a percentage value or +/- some number of measurement units.

2. **Review <u>100%</u> of the raw data and base your findings mainly on the raw data.**

X Do not rely solely on the certificates of analysis (or "analytical reports"), QA reports, and "Case Narratives" for your determinations. These can be incomplete or include errors.

X Check calculations.

X Look for trends–in matrix effects, blank results, calibration check samples, etc., and use these to help you evaluate the data.

3. **Always keep in mind the question the data is supposed to answer and the objective of the review.** Data submitted for an environmental project is not reviewed in the same way as a data intended to determine a laboratory's conformance to contract requirements. What we are looking for in the data validation is the answer to these questions: Is the quality of the data sufficient to meet the project objectives? What does the data tell us about the site? What relationship does this data have to the exposure assumptions?

The data validation process supports the subsequent Data Quality Assessment activities.

**Data Quality Assessment Process (DQA)**

Data Quality Assessment is the scientific and statistical process that determines whether environmental data are of the right type, quality, and quantity to support project decisions. DQA is built on a fundamental premise: data **quality**, as a concept, is meaningful only when it relates to the intended use of the data. *"Data quality does not exist without some frame of reference. The context in which the data will be used in order to establish a yardstick for judging whether or not the data set is adequate."*[5] **The DQA tells us if the data has answered the questions the project was intended to ask about the site.**

**Definitions of Words and Acronyms appearing in the Analytical Methods with Reporting Limits for RISC Table**:

**Analyte** The substance (element or compound) being identified and measured in the sample. It may be a suspected contaminant, contaminant of concern, or natural background component.

**CAS No.** Chemical Abstract Service (CAS) registry number. A unique numerical identifier that specifies a particular substance no matter what chemical name or synonym is used.
E.g.: *79-01-6 = Trichloroethene = Trichloroethylene = "Tricloran" = "TCE"
*71-55-6 = 1,1,1-Trichloroethane = Methyl chloroform ="Chlorothene"="TCA"
***"TCE" and "TCA" are not the same compound.***

[5]Environmental Protection Agency, Office of Research and Development, *The EPA Quality System*, EPA QA/G-0 Final, August 1997, p. 9-1.

**Quantitation Limit (QL)** The lowest concentration that can be *reliably* achieved within specified limits of precsion and accuracy during routine laboratory operating conditions. Individual sample QLs are highly matrix dependent and may vary widely.

**Method Reporting Limit** The QL reported by the referenced methods manual for a specific substance analyzed by a specific method.

**µg/kg** Micrograms per kilogram. An expression of concentration as mass of analyte per unit mass of sample in "parts per billion." Used for soil, sediment, and waste samples.

**µg/L** Micrograms per liter. An expression of concentration as mass of analyte per unit volume of sample in "parts per billion." Used for aqueous samples.

**Types of Method Reporting Limits referenced in this document and the Table:**

X**EQL** *Estimated Quantitation Limit*. Specified in many SW-846 methods. Often set at 10 times the MDL or at the concentration of the lowest non-zero standard in the calibration curve. Use of the word "estimated" emphasizes matrix dependence: variation between samples will occur, and the EQL may not always be achievable.

**XCR(Q/D)L** *Contract Required Quantitation Limit (CRQL) or Contract Required Detection Limit (CRDL)*, as applicable. Used in the CLP Statements of Work. **CRDL:** Used for inorganic analytes; **CRQL:** Used for organic compounds.

X**MDL** *Method Detection Limit*. Minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Used in Drinking Water methods and some SW-846 methods. Often not achievable in routine analysis of field samples other than low concentration water samples.

**References**

U. S. Environmental Protection Agency. Office of Emergency and Remedial Response. *Data Quality Objectives Process for Superfund: Interim Final Guidance*. Publication 9355.9-01. EPA-540-R-93-071. NTIS PB94-963203. [Washington, D. C.]: U. S. Environmental Protection Agency, Office of Emergency and Remedial Response. September 1993.

U. S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. *USEPA Contract Laboratory Program National Functional*

*Guidelines for Organic Data Review*. Publication 9240.1-05. EPA-540/R-94/012. NTIS: PB94-963501. [Washington, D. C.]: U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. February 1993.

U. S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. Publication 9240.1-05-01. EPA-540/R-94-013. NTIS: PB94-963502. [Washington, D. C.]: U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. February 1994.

U. S. Environmental Protection Agency. Office of Research and Development. *The EPA Quality System, EPA QA/G-0, Final*. Pre-Publication Copy. Washington, D. C.: U. S. Environmental Protection Agency, Office of Research and Development. August 1997.

**RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC** (September 15, 2000)

| Analyte | CAS No. | RESIDENTIAL SOIL (µg/kg) | | | | | RESIDENTIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| Acenaphthene | 83-32-9 | 130,000 | 660<br>18000 | 8270C<br>8310[N] | 330 | OLM04.2-D/SVOA | 460 | 10<br>18 | 8270C<br>8310 | 10 | OLM04.2-D/SVOA | 1.8 610[7]<br>1.9 625[7] |
| Acetone<br>*synonym: 2-Propanone* | 67-64-1 | 3,100 | 50<br>160 | 8260B[K,R]<br>8015B[N] | 10 | OLM04.2-D/VOA | 770 | 5<br>160 | 8260B<br>8015B[N] | 10 | OLM04.2-D/VOA | — — |
| Acrolein<br>*synonym: 2-Propenal* | 107-02-8 | 0.23* | 5 | 8260B[E] | — | --- | 0.055* | 1 | 8260B[D] | — | — | 0.7 603[7] |
| Aldrin | 309-00-2 | 250 | 23 | 8081B[E,M] | 1.7 | OLM04.2-D/PEST | 0.050 | 0.034 | 8081B[F] | 0.050 | OLM04.2-D/PEST | 0.007 505[4]<br>0.045 525.2[4] |
| Anthracene | 120-12-7 | 51,000 | 660<br>6600 | 8270C<br>8310[N] | 330 | OLM04.2-D/SVOA | 43 | 10<br>6.6 | 8270C<br>8310 | 10 | OLM04.2-D/VOA | 0.18 525.2[4] |
| Antimony | 7440-36-0 | 5,400 | 2100<br>200 | 6010B[G]<br>6020A[1b,G] | 3200[C] | ILM04.0/200.7<br>CLP-M | 6.0 | 3<br>0.4 | 7041 (7010[1b])<br>6020[G] | 3 | ILM04.0/**204.2**<br>CLP-M ***(furnace)*** | 3 204.2[5]<br>0.4 200.8[5] |
| Arsenic | 7440-38-2 | 3,900 | 3500<br>600 | 6010B[G]<br>6020A[1b,G] | 500[C] | ILM04.0/**206.2**<br>CLP-M ***(furnace)*** | 5.0[J] | 1<br>1.4 | 7060A(7010[1b])<br>6020[G] | 1 | ILM04.0/**206.2**<br>CLP-M ***(furnace)*** | 1 206.2[5]<br>1.4 200.8[5] |
| Barium | 7440-39-3 | 1,600,000 | 100<br>400 | 6010B[G]<br>6020A[1b,G] | 20000[C] | ILM04.0/200.7 CLP-M | 2,000 | 1<br>0.8 | 6010B[G]<br>6020[G] | 200 | ILM04.0/200.7<br>CLP-M | 1 200.7[5]<br>0.8 200.8[5] |
| Benz[a]anthracene | 56-55-3 | 5,000 | 660<br>130 | 8270C<br>8310[N] | 330 | OLM04.2-D/SVOA | 1.2 | 0.13 | 8310 | 10 | OLM04.2-D/SVOA | 0.20 525.2[4] |
| Benzene | 71-43-2 | 34 | 0.09<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 5.0 | 0.09<br>1 | 8021B[N]<br>8260B[D] | 10 | OLM04.2-D/VOA | 0.02 502.2[4]<br>0.04 524.2[4] |
| Benzo[b]fluoranthene | 205-99-2 | 5,000 | 660<br>180 | 8270C[E]<br>8310[N] | 330 | OLM04.2-D/SVOA | 1.2 | 0.18 | 8310 | 10 | OLM04.2-D/SVOA | 0.3 525.2[4] |
| Benzo[k]fluoranthene | 207-08-9 | 39,000 | 660<br>170 | 8270C<br>8310[N] | 330 | OLM04.2-D/SVOA | 0.80 | 0.17 | 8310 | 10 | OLM04.2-D/SVOA | 0.3 525.2[4] |
| Benzoic acid | 65-85-0 | 590,000 | 3300 | 8270C[V] | — | — | 150,000 | 50 | 8270C[V] | — | — | 50[H] 1625C[8] |
| Benzo[a]pyrene | 50-32-8 | 500 | 230 | 8310[N] | 330 | OLM04.2-D/SVOA | 0.20 | 0.02 | 8310[F] | 10 | OLM04.2-D/SVOA | 0.1 525.2[4] |
| Benzyl alcohol | 100-51-6 | 48,000 | 1300 | 8270C[V] | — | — | 11,000 | 20 | 8270C[V] | — | — | 50[H] 1625C[8] |
| Beryllium | 7440-41-7 | 63,000 | 100<br>100 | 6010B[G]<br>6020A[1b,G] | 500[C] | ILM04.0/200.7 CLP-M | 4.0 | 0.3<br>0.3 | 6010B<br>6020A[1b,G] | 0.2 | ILM04.0/**210.2**<br>CLP-M ***(furnace)*** | 0.7 200.7[5]<br>0.3 200.8[5] |

| RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC (September 15, 2000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CAS No. | RESIDENTIAL SOIL (µg/kg) | | | | RESIDENTIAL GROUND WATER (µg/L) | | | | | |
| | | Default Closure Level[a], µg/kg | SW-846[1a] | | CLP[2,3] | | Default Closure Level[b], µg/L | SW-846[1a] | | CLP[2,3] | | EPA Drinking & Waste Water[4-12] | |
| Analyte | | | EQL | Method | CR(Q/D)L | Method | | EQL | Method | CR(Q/D)L | Method | MDL | Method |
| Bis(2-chloroethyl)ether *syn: 1,1'-Oxybis(2-chloroethane)* | 111-44-4 | 0.70 | 0.5 | 8410[E,L] | 330 | OLM04.2-D/SVOA | 0.15* | 0.3 | 8111[F,I,X] | 10 | OLM04.2-D/SVOA | 0.3 | 611[7,X] |
| Bis(2-chloroisopropyl)ether *syn: 2,2'-Oxybis(1-chloropropane)* | 108-60-1 | 27 | 0.5 | 8410[E,L] | 330 | OLM04.2-D/SVOA | 4.2 | 0.8 | 8111[F,I] | 10 | OLM04.2-D/SVOA | 0.8 | 611[7] |
| Bis(2-ethylhexyl)phthalate *syn.: Di(2-ethylhexyl)phthalate* | 117-81-7 | 300,000 | 625<br>2700 | 8270C<br>8061A[N,R] | 330 | OLM04.2-D/SVOA | 6.0 | 2.7 | 8061A[N] | 10 | OLM04.2-D/SVOA | 0.8 | 525.2[4] |
| Bromodichloromethane | 75-27-4 | 630 | 5<br>25 | 8260B[E]<br>8021B[N] | 10 | OLM04.2-D/VOA | 100 | 5<br>0.2 | 8260B<br>8021B[N] | 10 | OLM04.2-D/VOA | 0.02<br>0.08 | 502.2[4]<br>524.2[4] |
| Bromoform *synonym: Tribromomethane* | 75-25-2 | 750 | 5<br>16 | 8260B[E]<br>8021B[E,N] | 10 | OLM04.2-D/VOA | 100 | 5<br>1.6 | 8260B<br>8021B[N] | 10 | OLM04.2-D/VOA | 1.6<br>0.12 | 502.2[4]<br>524.2[4] |
| n-Butanol *syn.: n-butyl alcohol, 1-butanol* | 71-36-3 | 16,000 | 625<br>2300 | 8260B[R,U]<br>8015B[Q,U] | --- | --- | 3,700 | 5<br>140 | 8260B[U]<br>8015B[U] | --- | --- | 500 | 1666[12] |
| Butyl benzyl phthalate | 85-68-7 | 930,000 | 660 | 8270C[R] | 330 | OLM04.2-D/SVOA | 2,700 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 0.5 | 525.2[4] |
| Cadmium | 7440-43-9 | 7,500 | 300<br>200 | 6010B[G]<br>6020A[1b,G] | 500[C] | ILM04.0/200.7<br>CLP-M | 5.0 | 0.1<br>5 | 7131A<br>6020 | 5 | ILM04.0/200.7<br>CLP-M | 1<br>0.5 | 200.7[5]<br>200.8[5] |
| Carbazole | 86-74-8 | 5,900 | [ 660<br>[1000 | 8270C][W]<br>8275A][P,W] | 330 | OLM04.2-D/SVOA | 43 | [ 10 | 8270C] | 330 | OLM04.2-D/SVOA | 20 | 1625C[8] |
| Carbon disulfide | 75-15-0 | 10,000 | 50 | 8260B[K] | 10 | OLM04.2-D/VOA | 1,300 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.09 | 524.2[4] |
| Carbon tetrachloride | 56-23-5 | 66 | 5<br>13 | 8260B[E]<br>8021B[N] | 10 | OLM04.2-D/VOA | 5.0 | 1<br>0.1 | 8260B[D]<br>8021B[N] | 10 | OLM04.2-D/VOA | 0.01<br>0.21 | 502.2[4]<br>524.2[4] |
| Chlordane | 57-74-9 | 9,600 | 370 (() | 8081B[M,R] | 1.7 | OLM04.2-D/PEST | 2.0 | 0.37(() | 8081B[M] | 0.05 | OLM04.2-D/PEST | 0.0015 | 508[4] |
| p-Chloroaniline *synonym: 4-Chloroaniline* | 106-47-8 | 970 | 440<br>1300 | 8131[E,N]<br>8270C[E,V] | 330 | OLM04.2-D/SVOA | 150 | 46<br>20 | 8131<br>8270C | 10 | OLM04.2-D/SVOA | 20 | 1625C[8] |
| Chlorobenzene | 108-90-7 | 1,300 | 13<br>625 | 8021B[N,R]<br>8260B[N] | 10 | OLM04.2-D/VOA | 100 | 0.1<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.01<br>0.04 | 502.2[4]<br>524.2[4] |

| RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC (September 15, 2000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAS No.** | **RESIDENTIAL SOIL (µg/kg)** | | | | | **RESIDENTIAL GROUND WATER (µg/L)** | | | | |
| | | Default Closure Level[a], µg/kg | **SW-846**[1a] | | **CLP**[2,3] | | Default Closure Level[b], µg/L | **SW-846**[1a] | | **CLP**[2,3] | | **EPA Drinking & Waste Water**[4-12] | |
| **Analyte** | | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | **MDL** | **Method** |
| Chloroethane | 75-00-3 | 260 | 1<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 50 | 1<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.1<br>0.1 | 502.2[4]<br>524.2[4] |
| Chloroform<br>*synonym: Trichloromethane* | 67-66-3 | 590 | 25<br>5 | 8021B[N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 100 | 0.2<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.02<br>0.03 | 502.2[4]<br>524.2[4] |
| 2-Chlorophenol | 95-57-8 | 750 | 660<br>210 | 8270C[E]<br>8041[E,M] | 330 | OLM04.2-D/SVOA | 38 | 10<br>3.1 | 8270C<br>8041 | 10 | OLM04.2-D/VOA | 3.3<br>0.58 | 625[7]<br>604[7] |
| Total Chromium[T] | 7440-47-3 | 38,000 | 500<br>400 | 6010B[G]<br>6020A[1b,G] | 1000[C] | ILM04.0/200.7 CLP-M | 100 | 10<br>0.9 | 6010B<br>6020 | 10 | ILM04.0/200.7 CLP-M | 4<br>0.9 | 200.7[5]<br>200.8[5] |
| Chromium III *(trivalent)*[S] | 16065-83-1 | 10,000,000 | *Calculate as difference: Total - hexavalent = tri (or use:)*<br>80 | 6020-SIM[S] | --- | — | 2,000 | *Calculate as difference: Total - hexavalent=tri (or use:)*<br>0.08 | 6020-SIM[S] | --- | — | *Calculate as difference: Total - hexavalent=tri (or use:)*<br>0.2<br>0.9 | 1639[8]<br>200.8-SIM[5] |
| Chromium VI *(hexavalent)*[S] | 18540-29-9 | 38,000 | **Alkaline Digestion (Method 3060A)** + *one of the following*:<br>20000<br>12<br>80 | 7196A[G]<br>7199[G]<br>6020A-SIM[S] | --- | --- | 100 | **Alkaline Preservation** + *one of the following* 5<br>10<br>0.3<br>0.08 | 7195<br>7198<br>7199<br>6020A-SIM[S] | --- | --- | **Alkaline Preservation *( See Method 1669)*[8]** +<br>10<br>5<br>0.4<br>0.5 | 218.4[9]<br>218.5[9]<br>218.6[10]<br>1636[8] |
| Chrysene | 218-01-9 | 25,000 | 660<br>1500 | 8270C<br>8310[N] | 330 | OLM04.2-D/SVOA | 1.6 | 1.5 | 8310 | 10 | OLM04.2-D/SVOA | 0.3 | 525.2[4] |
| Copper | 7440-50-8 | 580,000 | 400<br>200 | 6010B[G]<br>6020A[1b,G] | 2500[C] | ILM04.0/200.7 CLP-M | 1,300 | 3<br>0.5 | 6010B<br>6020 | 25 | ILM04.0/200.7 CLP-M | 3<br>0.5 | 200.7[5]<br>200.8[5] |
| Cyanide, free | 57-12-5 | 150,000 | 1000<br>2500 | 9014 *(free)*<br>9213 *(free)* | 2500[C] | ILM04.0/**335.2** CLP-M *(total CN-)* | | 20<br>50 | 9014 *(free)*<br>9213 *(free)* | 10 | ILM04.0/335.2 CLP-M *(total CN-)*[Y] | 5 | 335.4[6,Y] *(total CN-)* |
| 4,4'-DDD *(DDD)* | 72-54-8 | 28,000 | 500 | 8081B[M] | 3.3 | OLM04.2-D/PEST | 3.5 | 0.50 | 8081B[M] | 0.10 | OLM04.2-D/PEST | 0.01 | 508[4] |

| RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC (September 15, 2000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CAS No. | RESIDENTIAL SOIL (µg/kg) | | | | | RESIDENTIAL GROUND WATER (µg/L) | | | | |
| | | Default Closure Level[a], µg/kg | SW-846[1a] | | CLP[2,3] | | Default Closure Level[b], µg/L | SW-846[1a] | | CLP[2,3] | | EPA Drinking & Waste Water[4-12] | |
| Analyte | | | EQL | Method | CR(Q/D)L | Method | | EQL | Method | CR(Q/D)L | Method | MDL | Method |
| 4,4'-DDE *(DDE)* | 72-55-9 | 20,000 | 580 | 8081B[M] | 3.3 | OLM04.2-D/PEST | 2.5 | 0.58 | 8081B[M] | 0.10 | OLM04.2-D/PEST | 0.02 | 508[4] |
| 4,4'-DDT *(DDT)* | 50-29-3 | 20,000 | 810 | 8081B[M] | 3.3 | OLM04.2-D/PEST | 2.5 | 0.81 | 8081B[M] | 0.10 | OLM04.2-D/PEST | 0.06 | 508[4] |
| Dibenz[a,h]anthracene | 53-70-3 | 500 | 20 | 8310[E,N] | 330 | OLM04.2-D/SVOA | 0.12 | 0.03[F] | 8310 | 10 | OLM04.2-D/SVOA | 0.1 | 525.2[4] |
| Di-n-butyl phthalate | 84-74-2 | 2,000,000 | 3300<br>660 | 8061A[N,R]<br>8270C | 330 | OLM04.2-D/SVOA | 3,700 | 3.3<br>10 | 8061A<br>8270C | 10 | OLM04.2-D/SVOA | 4 | 525.2[4] |
| 1,2-Dichlorobenzene | 95-50-1 | 17,000 | 0.5<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 600 | 2.7<br>5 | 8121<br>8260B | 10 | OLM04.2-D/SVOA | 0.04<br>0.05 | 502.2[4]<br>524.2[4] |
| 1,3-Dichlorobenzene | 541-73-1 | 130 | 0.2<br>5 | 8021B[N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 6.9 | 2.5<br>5 | 8121<br>8260B | 10 | OLM04.2-D/SVOA | 0.07<br>0.05 | 502.2[4]<br>524.2[4] |
| 1,4-Dichlorobenzene | 106-46-7 | 2,200 | 0.1<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 75 | 8.9<br>5 | 8121<br>8260B | 10 | OLM04.2-D/SVOA | 0.04<br>0.04 | 502.2[4]<br>524.2[4] |
| 3,3'-Dichlorobenzidine | 91-94-1 | 62 | 62 | 1625C[O,8] | 330 | OLM04.2-D/SVOA | 1.9 | 1.4[F] | 8325 | 10 | OLM04.2-D/SVOA | 0.13 | 605[7] |
| 1,1-Dichloroethane | 75-34-3 | 5,600 | 0.7<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 990 | 0.7<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.03<br>0.04 | 502.2[4]<br>524.2[4] |
| 1,2-Dichloroethane | 107-06-2 | 24 | 0.3<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 5.0 | 0.3<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.03<br>0.06 | 502.2[4]<br>524.2[4] |
| 1,1-Dichloroethylene<br>*synonym: 1,1-Dichloroethene* | 75-35-4 | 58 | 0.7<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 7.0 | 0.7<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.04<br>0.12 | 502.2[4]<br>524.2[4] |
| cis-1,2-Dichoroethene<br>*syn.: cis-1,2-Dichloroethylene* | 156-59-2 | 400 | 0.2<br>5 | 8021B[N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 70 | 0.2<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.05<br>0.12 | 502.2[4]<br>524.2[4] |
| trans-1,2-Dichoroethene<br>*syn.: trans-1,2-Dichloroethylene* | 156-60-5 | 680 | 0.5<br>5 | 8021B[N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 100 | 0.5<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.05<br>0.06 | 502.2[4]<br>524.2[4] |
| 2,4-Dichlorophenol | 120-83-2 | 1,100 | 660<br>260 | 8270C[E]<br>8041[E,N] | 330 | OLM04.2-D/SVOA | 110 | 10<br>3.9 | 8270C<br>8041 | 10 | OLM04.2-D/SVOA | 0.39<br>2.7 | 604[7]<br>625[7] |
| 1,2-Dichloropropane | 78-87-5 | 30 | 0.06<br>5 | 8021B[N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 5.0 | 0.06<br>1 | 8021B[N]<br>8260B[D] | 10 | OLM04.2-D/VOA | 0.03<br>0.04 | 502.2[4]<br>524.2[4] |

**RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC** (September 15, 2000)

| Analyte | CAS No. | RESIDENTIAL SOIL (µg/kg) | | | | | RESIDENTIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| 1,3-Dichloropropene (cis- and trans-) | 542-75-6 | 40 | 0.3<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 5.6 | 0.3<br>1 | 8021B[N]<br>8260B[D] | 10 | OLM04.2-D/VOA | 0.1 / 502.2[4]<br>0.1 / 524.2[4] |
| Dieldrin | 60-57-1 | 46 | 30 | 8081B[E,M] | 3.3 | OLM04.2-PEST | 0.053 | 0.044 | 8081B[F,M] | 0.10 | OLM04.2-PEST | 0.02 / 508[4] |
| Diethylphthalate | 84-66-2 | 450,000 | 660<br>2500 | 8270C<br>8061A[N,R] | 330 | OLM04.2-D/SVOA | 29,000 | 10<br>2.5 | 8270C<br>8061A | 10 | OLM04.2-D/SVOA | 0.8 / 525.2[4] |
| Dimethylphthalate | 131-11-3 | 1,400,000 | 660<br>6400 | 8270C<br>8061A[N,R] | 330 | OLM04.2-D/SVOA | 370,000 | 10<br>6.4 | 8270C<br>8061A | 10 | OLM04.2-D/SVOA | 0.14 / 525.2[4]<br>1.1 / 506[4] |
| 2,4-Dimethylphenol | 105-67-9 | 9,000 | 660<br>220 | 8270C<br>8041[E,M] | 330 | OLM04.2-D/SVOA | 730 | 10<br>3.2 | 8270C<br>8041 | 10 | OLM04.2-D/SVOA | 2.4 / 625[7] |
| Dimethylphthalate | 131-11-3 | 1,400,000 | 660<br>6400 | 8270C<br>8061A[N,R] | 330 | OLM04.2-D/SVOA | 370,000 | 10<br>6.4 | 8270C<br>8061A | 10 | OLM04.2-D/SVOA | 1.1 / 506 |
| 2,4-Dinitrophenol | 51-28-5 | 290 | 13 | 8041[F] | 830 | OLM04.2-D/SVOA | 73 | 50 | 8270C[V] | 25 | OLM04.2-D/SVOA | 42 / 625[7] |
| Dinitrotoluene mixture | 25321-14-6 | 8.5 | 1 | 8410[L] | 330 | OLM04.2-D/SVOA | 1.3 | 0.31 | 8330 | 10 | OLM04.2-D/SVOA | 0.02 / 609[7] |
| Di-n-octyl phthalate | 117-84-0 | 2,000,000 | 660<br>490 | 8270C<br>8061A[N,R] | 330 | OLM04.2-D/SVOA | 20 | 10<br>0.5 | 8270C<br>8061A | 10 | OLM04.2-D/SVOA | 2.5 / 625[7] |
| Endosulfan | 115-29-7 | 20,000 | 400 | 8081B[M] | 3.3 | OLM04.2-D/PEST | 220 | 0.4 | 8081B[M] | 0.10 | OLM04.2-PEST | 0.015 / 508[4] |
| Endrin | 72-20-8 | 990 | 390 | 8081B[M] | 3.3 | OLM04.2-D/PEST | 2.0 | 0.39 | 8081B[M] | 0.10 | OLM04.2-PEST | 0.015 / 508[4] |
| Ethylbenzene | 100-41-4 | 13,000 | 5<br>0.05 | 8260B<br>8021B[N] | 10 | OLM04.2-D/VOA | 700 | 5<br>0.05 | 8260B<br>8021B[N] | 10 | OLM04.2-D/VOA | 0.002 / 503.1[4]<br>0.06 / 524.2[4] |
| Fluoranthene | 206-44-0 | 880,000 | 660<br>2100 | 8270C<br>8310[N] | 330 | OLM04.2-D/SVOA | 210 | 10<br>2.1 | 8270C<br>8310 | 10 | OLM04.2-D/SVOA | 0.21 / 610[7]<br>2.2 / 625[7] |
| Fluorene | 86-73-7 | 170,000 | 660<br>2,100 | 8270C<br>8310[N] | 330 | OLM04.2-D/SVOA | 310 | 10<br>2.1 | 8270C<br>8310 | 10 | OLM04.2-D/SVOA | 0.21 / 610[7]<br>1.9 / 625[7] |
| Heptachlor | 76-44-8 | 540 | 27 | 8081B[E,M] | 1.7 | OLM04.2-D/PEST | 0.40 | 0.40 | 8081B[M] | 0.050 | OLM04.2-D/PEST | 0.01 / 508[4] |
| Heptachlor epoxide | 1024-57-3 | 470 | 21 | 8081B[E,M] | 1.7 | OLM04.2-D/PEST | 0.20 | 0.032 | 8081B[F,M] | 0.050 | OLM04.2-D/PEST | 0.015 / 508[4] |

| RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC (September 15, 2000) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAS No.** | **RESIDENTIAL SOIL (µg/kg)** | | | | | | **RESIDENTIAL GROUND WATER (µg/L)** | | | | | |
| | | Default Closure Level[a], µg/kg | **SW-846**[1a] | | **CLP**[2,3] | | | Default Closure Level[b], µg/L | **SW-846**[1a] | | **CLP**[2,3] | | **EPA Drinking & Waste Water**[4-12] |
| **Analyte** | | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | **MDL** / **Method** |
| Hexachlorobenzene | 118-74-1 | 2,200 | 660<br>56 | 8270C[E]<br>8121[N,R] | 330 | OLM04.2-D/SVOA | | 1.0 | 0.056 | 8121[N] | 10 | OLM04.2-D/SVOA | 0.1 / 525.2[4] |
| Hexachloro-1,3-butadiene | 87-68-3 | 16,000 | 660<br>14 | 8270C<br>8121[N,R] | 330 | OLM04.2-D/SVOA | | 7.3 | 0.014 | 8121[N] | 10 | OLM04.2-D/SVOA | 0.05 / 502.2[4]<br>0.11 / 524.2[4] |
| ∀-HCH *(∀-BHC)* | 319-84-6 | 7.2 | 1.9<br>7.4 | 8081B[F,M]<br>8121[E,N] | 1.7 | OLM04.2-D/PEST | | 0.14 | 0.04<br>0.11 | 8081B[F]<br>8121[N] | 0.050 | OLM04.2-D/PEST | 0.025 / 508[4] |
| ∃-HCH *(∃-BHC)* | 319-85-7 | 26 | 15<br>21 | 8081B[E,M]<br>8121[E,N] | 1.7 | OLM04.2-D/PEST | | 0.47 | 0.23<br>0.31 | 8081B[M]<br>8121[N] | 0.050 | OLM04.2-D/PEST | 0.01 / 508[4] |
| (-HCH *((-BHC)*<br>*synonym: Lindane* | 58-89-9 | 9.4 | 2<br>15 | 8081B[F,M]<br>8121[E,N] | 1.7 | OLM04.2-D/PEST | | 0.20 | 0.02<br>0.2 | 8081B[F]<br>8121[N] | 0.050 | OLM04.2-D/PEST | 0.015 / 508[4] |
| Hexachlorocyclopentadiene | 77-47-4 | 400,000 | 660<br>2400 | 8270C<br>8121[N,R] | 330 | OLM04.2-D/SVOA | | 50 | 10<br>2.4 | 8270C<br>8121[N] | 10 | OLM04.2-D/SVOA | 0.1 / 525.2[4] |
| Hexachloroethane | 67-72-1 | 2,800 | 660<br>16 | 8270C[E]<br>8121[N] | 330 | OLM04.2-D/SVOA | | 37 | 10<br>0.016 | 8270C<br>8121[N] | 10 | OLM04.2-D/SVOA | 0.03 / 612[7] |
| Indeno[1,2,3-cd]pyrene | 193-39-5 | 3,100 | 660<br>29 | 8270C[E]<br>8310[N] | 330 | OLM04.2-D/SVOA | | 0.022 | 0.043 | 8310[F,X] | 10 | OLM04.2-D/SVOA | 0.02 / 525.2[4] |
| Isophorone | 78-59-1 | 5,300 | 660 | 8270C[E] | 330 | OLM04.2-D/SVOA | | 900 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 2.2 / 625[7] |
| Lead | 7439-92-1 | 81,000 | 2800<br>300 | 6010B[G]<br>6020A[1b,G] | 4200[C] | ILM04.0/200.7 | CLP-M | 15 | 1<br>0.6 | 7421<br>6020 | 3 | ILM04.0/200.7 CLP-M | 10 / 200.7[5]<br>0.6 / 200.8[5] |
| Mercury | 7439-97-6 | 2,100 | 200<br>200 | 7470/1A[G]<br>6020A[1b,G] | 200[C] | ILM04.0/**245.5** | CLP-M | 2.0 | 0.2<br>0.1 | 7470<br>7472 | 0.2 | ILM04.0/**245.1** or **245.2** CLP-M | 0.2 / 245.1[6] |
| Methoxychlor | 72-43-5 | 160,000 | 120 | 8081B[M] | 17 | OLM04.2-D/PEST | | 40 | 0.9 | 8081B[M] | 0.50 | OLM04.2-D/PEST | 0.05 / 508[4] |
| Methyl bromide<br>*synonym: Bromomethane* | 74-83-9 | 52 | 11<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | | 11 | 5<br>11 | 8260B<br>8021B[N] | 10 | OLM04.2-D/VOA | 0.19 / 502.2[4]<br>0.11 / 524.2[4] |
| Methylene chloride | 75-09-2 | 23 | 0.2<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | | 5.0 | 0.2<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.01 / 502.2[4]<br>0.03 / 524.2[4] |
| Methyl ethyl ketone<br>*(MEK)*<br>*synonym: 2-Butanone* | 78-93-3 | 12,000 | 2700<br>50 | 8015B[Q]<br>8260B[K] | 10 | OLM04.2-D/VOA | | 2,500 | 500<br>50 | 8015B[K,N]<br>8260B[K] | 10 | OLM04.2-D/VOA | 0.48 / 524.2[4]<br>50 / 1624C[8] |

| RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC (September 15, 2000) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAS No.** | **RESIDENTIAL SOIL (µg/kg)** | | | | | | **RESIDENTIAL GROUND WATER (µg/L)** | | | | | | | |
| | | Default Closure Level[a], µg/kg | **SW-846**[1a] | | **CLP**[2,3] | | | Default Closure Level[b], µg/L | **SW-846**[1a] | | **CLP**[2,3] | | | **EPA Drinking & Waste Water**[4-12] | |
| **Analyte** | | | **EQL** | **Method** | **CR(Q/D)L** | | **Method** | | **EQL** | **Method** | **CR(Q/D)L** | | **Method** | **MDL** | **Method** |
| 4-Methyl-2-pentanone *(MIBK) synonym: Methyl isobutyl ketone* | 108-10-1 | 990 | 200<br>50 | 8015B[K,N]<br>8260B[E,K] | 10 | | OLM04.2-D/VOA | 210 | 200<br>50 | 8015B[K,N]<br>8260B[E,K] | 10 | | OLM04.2-D/VOA | 0.09<br>50[H] | 524.2[4]<br>1624C[8] |
| 2-Methylphenol *synonym: o-Cresol* | 95-48-7 | 14,000 | 660<br>220 | 8270C<br>8041[H,M] | 330 | | OLM04.2-D/SVOA | 1,800 | 10<br>3.2 | 8270C<br>8041[H,M] | 10 | | OLM04.2-D/SVOA | 10[H] | 1625C[8] |
| 3-Methylphenol *synonym: m-Cresol* | 108-39-4 | 11,000 | 660<br>220 | 8270C<br>8041[H,M] | [ 330 | | OLM04.2-D/SVOA] | 1,800 | 10<br>3.2 | 8270C<br>8041[H,M] | [10 | | OLM04.2-D/SVOA][W] | [10 | 1625C][W] |
| 4-Methylphenol *synonym: p-Cresol* | 106-44-5 | 1,100 | 660<br>220 | 8270C[E]<br>8041[H,M] | 330 | | OLM04.2-D/SVOA | 180 | 10<br>3.2 | 8270C<br>8041[H,M] | 10 | | OLM04.2-D/SVOA | 10[H] | 1625C[8] |
| Methyl-t-butyl ether *(MTBE)* *syn.: Methyl tertiary-butyl ether* | 1634-04-4 | 350 | 5 | 8260B[E] | 10 | | OLM04.2-D/VOA | 45 | 5 | 8260B | 10 | | OLM04.2-D/VOA | 1.2 | 524.2[4] |
| Naphthalene | 91-20-3 | 700 | 5<br>660 | 8260B<br>8270C[E] | 330 | | OLM04.2-D/SVOA | 8.3 | 5<br>0.6 | 8260B<br>8021B[E,N] | 10 | | OLM04.2-D/SVOA | 0.04<br>1.6 | 524.2[4]<br>625[7] |
| Nickel | 7440-02-0 | 130,000 | 1000<br>200 | 6010B[G]<br>6020A[1b,G] | 4000[C] | | ILM04.0/200.7 CLP-M | 100 | 10<br>0.5 | 6010B[G]<br>6020A[1b,G] | 40 | | ILM04.0/200.7 CLP-M | 5<br>0.5 | 200.7[5]<br>200.8[5] |
| 2-Nitroaniline | 88-74-4 | 41 | 2 | 8410[L] | 830 | | OLM04.2-D/SVOA | 2.1 | 1.0 | 8131[F] | 25 | | OLM04.2-D/SVOA | 10 | 1625C |
| Nitrobenzene | 98-95-3 | 120 | 1.3 | 8410[L] | 330 | | OLM04.2-D/SVOA | 18 | 6.4 | 8330 | 10 | | OLM04.2-D/SVOA | 1.9 | 625[7] |
| N-Nitrosodiphenylamine | 86-30-6 | 9,700 | 550<br>660 | 8070A[E,N]<br>8270C | 330 | | OLM04.2-D/SVOA | 170 | 8.1<br>10 | 8070A[N]<br>8270C | 10 | | OLM04.2-D/SVOA | 0.8<br>1.9 | 607[7]<br>625[7] |
| N-Nitroso-di-n-propylamine | 621-64-7 | 0.60 | 0.25 | 8410[L] | 330 | | OLM04.2-D/SVOA | 0.12* | 0.46 | 8070A[F,X] | 10 | | OLM04.2-D/SVOA | 0.46 | 607[X,7] |
| Polychlorinated biphenyl compounds *(PCBs)* | 1336-36-3 | 1,800 | 600 | 8082[M] | 67 | | OLM04.2-D/PEST | 0.50 | 0.054 *to* 0.90[X]<br>8082[F,P]<br>*(as Aroclors)* | | 1.0 *to* 2.0 | | OLM04.2-D/PEST | 0.065<sub>1242</sub><br>0.15 | 608[7]<br>1656 |
| Pentachlorophenol | 87-86-5 | 28 | 1.6<br>13 | 8151A[Q]<sub>GC/ECD</sub><br>8151A[Q]<sub>GC/MS</sub> | 830 | | OLM04.2-D/SVOA | 1.0 | 0.76 | 8151A[N] | 25 | | OLM04.2-D/SVOA | 0.076 | 515.1[4] |
| Phenol | 108-95-2 | 110,000 | 660 | 8270C | 330 | | OLM04.2-D/SVOA | 22,000 | 10 | 8270C | 10 | | OLM04.2-D/SVOA | 2.2 | 604[7] |

| RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC (September 15, 2000) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAS No.** | **RESIDENTIAL SOIL (µg/kg)** | | | | | **RESIDENTIAL GROUND WATER (µg/L)** | | | | | | |
| | | Default Closure Level[a], µg/kg | **SW-846**[1a] | | **CLP**[2,3] | | Default Closure Level[b], µg/L | **SW-846**[1a] | | **CLP**[2,3] | | **EPA Drinking & Waste Water**[4-12] | |
| **Analyte** | | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | **MDL** | **Method** |
| Pyrene | 129-00-0 | 570,000 | 660<br>2700 | 8270C<br>8310 | 330 | OLM04.2-D/SVOA | 140 | 10<br>2.7 | 8270C<br>8310 | 10 | OLM04.2-D/SVOA | 0.16 | 525.2[4] |
| Selenium | 7782-49-2 | 5,200 | 5000<br>3200 | 6010B[G]<br>6020A[1b,G] | 500[C] | ILM04.0/**270.2**<br>CLP-M ***(furnace)*** | 50 | 2<br>8 | 7740<br>6020A | 2 | ILM04.0/**270.2**<br>CLP-M ***(furnace)*** | 20<br>7.9 | 200.7[5]<br>200.8[5] |
| Silver | 7440-22-4 | 31,000 | 500<br>50 | 6010B[G]<br>6020A[1b,G] | 1000[C] | ILM04.0/200.7 CLP-M | 180 | 10<br>60 | 6010B<br>7760A | 10 | ILM04.0/200.7<br>CLP-M | 2<br>0.1 | 200.7[5]<br>200.8[5] |
| Styrene | 100-42-5 | 3,500 | 13<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 100 | 0.1<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.06 | 524.2[4] |
| 1,1,1,2-Tetrachloroethane | 630-20-6 | 50 | 6<br>5 | 8021B[N]<br>8260B[E] | --- | — | 6.9 | 0.05 | 8021B[N] | --- | --- | 0.05 | 524.2[4] |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 7.0 | 0.1<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 0.90 | 0.1 | 8021B[N] | 10 | OLM04.2-D/VOA | 0.02<br>0.20 | 502.2[4]<br>524.2[4] |
| Tetrachloroethylene *(PCE)* *synonym: Tetrachloroethene* | 127-18-4 | 58 | 0.5<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 5.0 | 0.5<br>1 | 8021B[N]<br>8260B[D] | 10 | OLM04.2-D/VOA | 0.02<br>0.14 | 502.2[4]<br>524.2[4] |
| Thallium | 7440-28-0 | 2,800 | 2700<br>100 | 6020A[G]<br>6010B[1b,G] | 500[C] | ILM04.0/**279.2**<br>CLP-M ***(furnace)*** | 2.0 | 0.3<br>1 | 6020A[G]<br>7841 | 1 | ILM04.0/**279.2**<br>CLP-M *(furnace)* | 0.3 | 200.8[5] |
| Toluene | 108-88-3 | 12,000 | 13<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 1,000 | 0.1<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.11 | 524.2[4] |
| Toxaphene | 8001-35-2 | 3,900 | 860 | 8081B[M,R] | 170 | OLM04.2-D/PEST | 3.0 | 0.9 | 8081B[M] | 5.0 | OLM04.2-D/PEST | 1.0 | 505[4] |
| 1,2,4-Trichlorobenzene | 120-82-1 | 5,300 | 38<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 70 | 0.3<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/SVOA | 0.08<br>0.20 | 502.2[4]<br>524.2[4] |
| 1,1,1-Trichloroethane | 71-55-6 | 1,900 | 38<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 200 | 0.3<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.01<br>0.08 | 502.2[4]<br>524.2 |
| 1,1,2-Trichloroethane | 79-00-5 | 30 | 0.5<br>5 | 8021B[E,H]<br>8260B[E] | 10 | OLM04.2-D/VOA | 5.0 | 0.5<br>1 | 8021B[H,N]<br>8260B | 10 | OLM04.2-D/VOA | 0.04<br>0.10 | 502.2[4]<br>524.2[4] |
| Trichloroethylene *(TCE)* *synonym: Trichloroethene* | 79-01-6 | 57 | 0.2<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA | 5.0 | 0.2<br>1 | 8021B[N]<br>8260B[D] | 10 | OLM04.2-D/VOA | 0.06<br>0.19 | 502.2[4]<br>524.2[4] |
| 2,4,5-Trichlorophenol | 95-95-4 | 250,000 | 660<br>430 | 8270C<br>8041[H,M] | 830 | OLM04.2-D/SVOA | 3,700 | 10<br>6.4 | 8270C<br>8041 | 25 | OLM04.2-D/SVOA | 10 | 1625C[8] |
| 2,4,6-Trichlorophenol | 88-06-2 | 1,500 | 660<br>430 | 8270C[E]<br>8041[M] | 330 | OLM04.2-D/SVOA | 77 | 10<br>6.4 | 8270C<br>8041 | 10 | OLM04.2-D/SVOA | 2.7 | 625[7] |

| RESIDENTIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC (September 15, 2000) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAS No.** | **RESIDENTIAL SOIL (µg/kg)** | | | | | **RESIDENTIAL GROUND WATER (µg/L)** | | | | |
| | | Default Closure Level[a], µg/kg | **SW-846**[1a] | | **CLP**[2,3] | | Default Closure Level[b], µg/L | **SW-846**[1a] | | **CLP**[2,3] | | **EPA Drinking & Waste Water**[4-12] | |
| **Analyte** | | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | | **EQL** | **Method** | **CR(Q/D)L** | **Method** | **MDL** | **Method** |
| Vinyl acetate | 108-05-4 | 2,300 | 5 | 8260B | — | — | 550 | 5 | 8260B | --- | --- | 10 | 1624C[8,H] |
| Vinyl chloride | 75-01-4 | 13 | 5<br>0.2 | 8260B[E]<br>8021B[E,N] | 10 | OLM04.2-D/VOA | 2.0 | 1<br>0.2 | 8260B[D]<br>8021B[N] | 10 | OLM04.2-D/VOA | 0.18<br>0.17 | 502.2[4]<br>524.2[4] |
| Xylene mixture *(o-, m-, p-)* | 1330-20-7 | 190,000 | 5<br>25 | 8260B<br>8021B[N] | 10 | OLM04.2-D/VOA | 10,000 | 0.2<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.02<br>0.11 | 502.2[4]<br>524.2[4] |
| Zinc | 7440-66-6 | 10,000,000 | 200<br>700 | 6010B[G]<br>6020A[1b,G] | 2000[C] | ILM04.0/200.7 CLP-M | 11,000 | 2 | 6010B[G] | 20 | ILM04.0/200.7 CLP-M | 2<br>1.8 | 200.7[5]<br>200.8[5] |

**NOTES**
**Table Information**

10 OLM04.2-D/VOA Shaded cell with light print indicates quantitation limit exceeds Default Closure Level. Method will not meet DQO without analytical modification.

***** Asterisk indicates that no standard EPA method is available with a detection or quantitation limit able to meet the Default Closure Level for that matrix without modification. For some methods, modifications to lower detection limits may be as simple as using a larger sample size, extra concentration of extracts, use of an alternate extraction method, or use of an alternate detector. Consult your laboratory and your IDEM chemist.

[a] Default Closure Level for RESIDENTIAL soil in units of µg/kg.

[b] Default Closure Level for RESIDENTIAL groundwater in units of µg/L.

[C]The CLP SOW does not list CRDLs for soil samples. Soil CRDLs have been estimated as follows. **Note: Detection limits will be higher for samples with dry weight < 100%.**

***** **metals by ICP** - formula on page D-13 of ILM04.0 assuming 100% dry weight, 0.5 g sample size, 50 mL final volume of digestate, and the aqueous CRDL from page C-2 as the concentration in the digestate. If the estimated ICP detection limit on page D-25 exceeds the aqueous CRDL, the ICP detection limit is substituted as the concentration in digestate. If the calculation using the CRDL on page C-2 exceeds the RISC closure level and the ICP estimated detection limit on page D-25 is lower than the CRDL, the ICP detection limit is substituted for the concentration in the digestate.

***** **metals when the ICP estimated detection limit will not meet the RISC closure level** - formula on page D-13 of ILM04.0 assuming 100% dry weight, 0.5 g sample size, 50 mL final volume of digestate, and the lowest concentration of the optimum range for the furnace method as the concentration in the digestate. (Notation ***furnace*** added after method number.)

***** **mercury** - the formula on page D-59 of ILM04.0 assuming 100% dry weight, a 0.2 gram sample, 200 mL final volume after preparation, and the aqueous CRDL as the concentration read from the standard curve.

***** **cyanide** - the formula on page D-76 of ILM04.0 assuming a 1 gram sample, 100% dry weight, and the aqueous CRDLas the concentration read from the standard curve.

[D] EQL obtained by purging 25 mL aqueous sample instead of 5 mL aqueous sample. (See SW-846 Method 8260B, Table 3, page 8260B-35, December 1996.)

[E] EQL or CRQL for **low level** soil procedure (required). Methods for semivolatile and nonvolatile compounds assume a Gel Permeation Chromatography (GPC) clean up of extract prior to analysis.

[F]Method Detection Limit (MDL) is listed rather than EQL.

[G] SW-846 metals methods reference instrument detection limits (IDLs) instead of quantitation limits. Therefore, a detection limit is listed rather than an EQL.
For **6010B**: (1) Aqueous detection limits are taken from the IDL table on page 6010B-19. (2) Soil detection limits have been calculated using the equation on page 6020A-9, assuming a 1gram sample (dry weight), 100 mL as the final digestate volume, and the aqueous IDLas the concentration in the digestate. All are rounded up to the next 100 µg/L or /kg.
For **6020A**: Method 6020A does not provide a table of IDLs. MDLs taken from the analogous EPA water method (200.8, Rev. 5.5) for the appropriate matrix are listed.

[H] Compound is listed in the method, but no MDL is provided. The MDL is estimated based on compounds of similar properties for which the method does provide a MDL.

[I] EQL or MDL for SW-846 method estimated by using MDL for analogous waste water method using same instrumentation. EQLs were calcualted by multiplying the MDL by standard SW-846 EQL matrix factors: (a) 10 for ground water, (b) 10 for low level soils in volatile organics methods, and (c) 670 for low level soils with GPC cleanup in semivolatile and nonvolatile organics methods. The analogous waste water method for SW-846 Method 8111 is 611.

[J] MCL for arsenic is scheduled to be changed to 5 µg/L (0.005 mg/L) from 50 µg/L (0.050 mg/L) on January 1, 2001.

[K] EQL multiplied a factor of 10 above method default EQL for matrix because of poor purging efficiency.

**NOTES,** continued
**Table Information,** continued

[L] Methods utilizing Fourier Transform-Infrared Spectroscopy (FT-IR) for detection reference identification limits instead of EQLs; therefore identification limit is listed instead of EQL. For soil and sediment samples the identification limit has been calculated from the aqueous identification limit listed in Table 1, page 8410-11, assuming a 10 gram sample, a 1mL final extract volume prior to drying, and 100% dry weight. For analytes with two identification limits listed, the value in parenthesis has been used.

[M] EQLs for Methods 8081B (01/98) and 8082 (12/96) are calculated using 8081 (09/94) MDLs multiplied by 8081B or 8082 matrix factors. (No MDLs in Methods 8081B and 8082.)
EQLs for Method 8041 (12/96) are calculated using MDLs and matrix factors from Method 8040A (07/92), an earlier form of the same method. (Method 8041 does not provide MDLs).

[N] EQL calculated by multiplying aqueous MDL (µg/L) by matrix factors listed in the method. If no table of EQL matrix factors is provided in the method, the aqueous MDLs have been multiplied by the following standard SW-846 EQL matrix factors: (a) Volatile organics methods - (i)10 for ground water, (ii) 10 for low level soils, and (iii) 1250 for high level soils; (b) Semivolatile organics methods - (i) 10 for ground water, (ii) 670 for low level soils with GPC cleanup, and (iii)10,000 for high level soils.

[O] No SW-846 method meets required detection limit for solid matrices. Method referenced is an EPA Office of Water sediment method.

[P] EQL(or MDL) is taken from text in the Scope and Application and/or Method Performance section of the method. (No MDL or EQL listed in tables for compound.)

[Q] EQL is calculated by multiplying MDL or EDL for solid matrix times 10.

[R] EQL or CRQL listed is for the high level (SW-846) or medium level (CLP) soils procedure: **If analytes requiring the low level soil procedure are also contaminants of concern for the method in question, the low level procedure should be run instead.** If a sample contains a mixture of high concentration and low concentration contaminants of concern, the low level soil procedure should be used to quantitate the low concentration analytes and, as needed, dilutions analyzed to quantitate the high concentration analytes.
**SW-846:** For methods other than 8260 and 8270, the high level EQL is the aqueous MDL times the high level soils factor. For 8260 and 8270, the high level EQL is the EQL for low level soils multiplied by: (a) 125 for volatiles (8260), or (b) 7.5 for semivolatiles (8270).
**CLP:** The medum level CRQL is the medium soil value listed in OLM04.2, Exhibit C.

[S] If speciated Chromium will be analyzed, a separate sample must be taken for hexavalent chromium analysis. Although ICP-MS in selective ion monitoring (SIM) mode should be able to distinguish between Cr(VI) and Cr(III), method development would be necessary at most laboratories (requiring much additional time and expense). Therefore, In most cases the easiest way to determine separate concentrations for hexavalent chromium and trivalent chromium will be to analyze for total chromium, do a special preparation and analysis for hexavalent chromium on a separate sample, and determine trivalent chromium by difference:
(1) For water samples, the sample for analysis of hexavalent chromium must be preserved with *sodium hydroxide*. **This will increase the holding time from 24 hours to 30 days.** (See EPA Method 1669, Section 8.4.5for instructions.) The sample to be analyzed for all other metals (except mercury), including total chromium (or trivalent, if a method is available) should be acid preserved.
b. For soil samples, the sample for hexavalent chromium must be digested by *Method 3060A*, and digestion must occur *within 30 days of sampling*. The sample to be analyzed for other metals can also be analyzed for total chromium (or trivalent chromium, if a method is available); this sample will undergo acid digestion, and the holding time is the usual six months

[T] If only total chromium will be run (i.e., hexavalent and/or trivalent chromium will not be analyzed for specifically), the default closure levels for hexavalent chromium will apply.

[U] Requires heated purge (80EC).

[V] The EQL listed for this analyte in Method 8270C is higher than the default 10µg/L (water) and 660 µg/kg (soil).

[W] [*EQL Method No.*] Analyte is not explicitly listed in method but is amenable to analysis by method. Analyte was listed in a previous version of the method, or analytes with similar properties are listed for the method.

[X] EQL or MDL exceeds closure level but is in within an order of magnitude. Method may be acceptable for use without modification. Consult the IDEM project chemist.

Notes continued

Table information Continued

[Y] Includes measurement of complexed cyanides. The CLP SOW and the EPA water methods do not include methods specifically for free cyanide. Measurement of total cyanide may lead to artificially high results.

**NOTES**, continued
**References: Methods Manuals**

[1a]*Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, USEPA Publication SW-846, Third edition, Final Update III, [NTIS#: PB97-156111 (integrated 3rd edition through Update III)], June 1997 ***(unless otherwise noted)***.

[1b]*Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, USEPA Publication SW-846, Third edition, Update IVA: Notice of Data Availability (NODA), published in the Federal Register on May 8, 1998 (63 FR 25430).

[2]*USEPA Contract Laboragory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration*, OLM04.2, [EPA web site: http://www.epa.gov/superfund/programs/clp/methods.htm], August 1994

[3]*USEPA Contract Laboragory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration*, ILM04.0, [NTIS#: PB95-963545], July 1995

[4]*Methods for the Determination of Organic Compounds in Drinking Water - Supplement III*, EPA/600/R-95/131, August 1995

[5]*Methods for the Determination of Metals in Environmental Samples*, EPA/6000/4-91/010, June 1991

[6]*Methods for the Determination o f Inorganic Substances in Environmental Samples*, EPA/600/R-93/100, August 1993

[7]Code of Federal Regulations, 40 CFR 136 - Revised as of July 1, 1995, Appendix A to Part 136 - "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater"

[8]Stand Alone Method (EPA Office of Water method that is not part of a compendium). Referenced from CD-ROM, "EPA Methods and Guidance for Analysis of Water" (1999), prepared for the USEPA Office of Water by DynCorp Consulting Services Division under EPA Contract 68-C3-0337.

[9]*Methods for Chemical Analysis of Water and Wastes* (MCAWW) EPA/600/4-79-020 - Revised March 1983

[10]*Methods for the Determination of Metals in Environmental Samples - Supplement I* - EPA/600/R-94-111- May 1994

[11]*Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater - Vol.I* - EPA-821-R-93-010-A August 1993, Revision 1

[12]*Analytical Methods for the Determination of Pollutants in Pharmaceutical Manufacturing Industry Wastewater, Revision A*, EPA-821-B-98-016 - July 1998

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| Acenaphthene | 83-32-9 | 1,200,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 4,200 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 1.9 / 625[7] |
| Acetone<br>*synonym: 2-Propanone* | 67-64-1 | 41,000 | 625<br>20000 | 8260B[R]<br>8015B[N,R] | 1200 | OLM04.2-D/VOA[R] | 10,000 | 50<br>160 | 8260B[K]<br>8015B[N] | 10 | OLM04.2-D/VOA | 50 / 1624C[8] |
| Acrolein<br>*synonym: 2-Propenal* | 107-02-8 | 220 | 50 | 8260B[E,K] | — | --- | 2,000 | 5 | 8260B | — | — | 50 / 1624C[8] |
| Aldrin | 309-00-2 | 800 | 340 | 8081B[M,R] | 1.7 | OLM04.2-D/PEST | 0.17 | 0.034 | 8081B[F] | 0.050 | OLM04.2-D/PEST | 0.007 / 505[4]<br>0.045 / 525.2[4] |
| Anthracene | 120-12-7 | 51,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 43 | 10 | 8270C | 10 | OLM04.2-D/VOA | 0.18 / 525.2[4] |
| Antimony | 7440-36-0 | 37,000 | 2100 | 6010B[G] | 3200[C] | ILM04.0/200.7 CLP-M | 41 | 3<br>21 | 7041 (7010[1b])<br>6010B[G] | 3 | ILM04.0/**204.2** CLP-M ***(furnace)*** | 3 / 204.2[5]<br>8 / 200.7[5] |
| Arsenic | 7440-38-2 | 20,000 | 3500 | 6010B[G] | 5300[C] | ILM04.0/200.7 CLP-M | 50 | 1<br>1.4 | 7060A(7010[1b])<br>6020A[1b,G] | 1 | ILM04.0/**206.2** CLP-M ***(furnace)*** | 1 / 206.2[5]<br>8 / 200.7[5] |
| Barium | 7440-39-3 | 5,900,000 | 100 | 6010B[G] | 20000[C] | ILM04.0/200.7 CLP-M | 7,200 | 1 | 6010B[G] | 200 | ILM04.0/200.7 CLP-M | 1 / 200.7[5]<br>0.8 / 200.8[5] |
| Benz[a]anthracene | 56-55-3 | 15,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 3.9 | 0.13 | 8310 | 10 | OLM04.2-D/SVOA | 0.20 / 525.2[4] |
| Benzene | 71-43-2 | 670 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 99 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.02 / 502.2[4]<br>0.04 / 524.2[4] |
| Benzo[b]fluoranthene | 205-99-2 | 15,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 1.5 | 0.18 | 8310 | 10 | OLM04.2-D/SVOA | 0.3 / 525.2[4] |
| Benzo[k]fluoranthene | 207-08-9 | 39,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 0.80 | 0.17 | 8310 | 10 | OLM04.2-D/SVOA | 0.3 / 525.2[4] |
| Benzoic acid | 65-85-0 | 1,600,000 | 25000 | 8270C[R,V] | — | — | 410,000 | 50 | 8270C[V] | — | — | 50[H] / 1625C[8] |
| Benzo[a]pyrene | 50-32-8 | 1,500 | 660 | 8270C[E] | 330 | OLM04.2-D/SVOA[E] | 0.39 | 0.23 | 8310 | 10 | OLM04.2-D/SVOA | 0.1 / 525.2[4] |
| Benzyl alcohol | 100-51-6 | 140,000 | 9800 | 8270C[R,V] | — | — | 31,000 | 20 | 8270C[V] | — | — | 50[H] / 1625C[8] |
| Beryllium | 7440-41-7 | 2,300,000 | 200 | 6010B[G] | 500[C] | ILM04.0/200.7 CLP-M | 200 | 0.2 | 6010B[G] | 5 | ILM04.0/200.7 CLP-M | 0.7 / 200.7[5]<br>0.3 / 200.8[5] |
| Bis(2-chloroethyl)ether<br>*syn: 1,1'-Oxybis(2-chloroethane)* | 111-44-4 | 12 | 3.5 | 8410[L] | 330 | OLM04.2-D/SVOA | 2.6 | 3 | 8111[I,X] | 10 | OLM04.2-D/SVOA | 0.3 / 611[7] |

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| Bis(2-chloroisopropyl)ether *syn: 2,2'-Oxybis(1-chloropropane)* | 108-60-1 | 260 | 2.5 | 8410[L] | 330 | OLM04.2-D/SVOA | 41 | 8<br>25 | 8111B[I]<br>8410[L] | 10 | OLM04.2-D/SVOA | 0.8 / 611[7] |
| Bis(2-ethylhexyl)phthalate *syn.: Di(2-ethylhexyl)phthalate* | 117-81-7 | 980,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 200 | 2.7 | 8061A | 10 | OLM04.2-D/SVOA | 0.8 / 525.2[4] |
| Bromodichloromethane | 75-27-4 | 630 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 100 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.08 / 524.2[4] |
| Bromoform *synonym: Tribromomethane* | 75-25-2 | 2,700 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 360 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.12 / 524.2[4] |
| n-Butanol *syn.: n-butyl alcohol, 1-butanol* | 71-36-3 | 44,000 | 625<br>9400 | 8260B[R,U]<br>8015B[U] | --- | — | 10,000 | 5<br>140 | 8260B<br>8015B[N] | --- | --- | 500 / 1666[12] |
| Butyl benzyl phthalate | 85-68-7 | 930,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 2,700 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 0.5 / 525.2[4] |
| Cadmium | 7440-43-9 | 77,000 | 300 | 6010B[G] | 500[C] | ILM04.0/200.7 CLP-M | 51 | 0.1<br>5 | 7131A<br>6020A | 5 | ILM04.0/200.7 CLP-M | 1 / 200.7[5]<br>0.5 / 200.8[5] |
| Carbazole | 86-74-8 | 20,000 | [ 5000<br>[1000 | 8270C][R,W]<br>8275A][P,W] | 10000 | OLM04.2-D/SVOA[R] | 140 | [ 10 | 8270C] | 330 | OLM04.2-D/SVOA | 20 / 1625C[8] |
| Carbon disulfide | 75-15-0 | 82,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 10,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.09 / 524.2[4] |
| Carbon tetrachloride | 56-23-5 | 290 | 5<br>13 | 8260B[E]<br>8021B[N] | 10 | OLM04.2-D/VOA[E] | 22 | 1<br>0.1 | 8260B[D]<br>8021B[N] | 10 | OLM04.2-D/VOA | 0.01 / 502.2[4]<br>0.21 / 524.2[4] |
| Chlordane | 57-74-9 | 39,000 | 370 (() | 8081B[M,R] | 1.7 | OLM04.2-D/PEST | 0.082 | 0.37(() | 8081B[M] | 0.05 | OLM04.2-D/PEST | 0.0015 / 508[4] |
| p-Chloroaniline *synonym: 4-Chloroaniline* | 106-47-8 | 2,700 | 440<br>1300 | 8131[E,N]<br>8270C[E,V] | 330 | OLM04.2-D/SVOA[E] | 410 | 46<br>20 | 8131<br>8270C | 10 | OLM04.2-D/SVOA | 20 / 1625C[8] |
| Chlorobenzene | 108-90-7 | 27,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 2,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.04 / 524.2[4] |
| Chloroethane | 75-00-3 | 5,200 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 990 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.1 / 524.2[4] |
| Chloroform *synonym: Trichloromethane* | 67-66-3 | 1,200 | 625 | 8260B[R] | 10 | OLM04.2-D/VOA[E] | 470 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.03 / 524.2[4] |
| 2-Chlorophenol | 95-57-8 | 10,000 | 5000 | 8270C[R] | 330 | OLM04.2-D/SVOA[E] | 510 | 10 | 8270C | 10 | OLM04.2-D/VOA | 3.3 / 625[7] |
| Total Chromium[T] | 7440-47-3 | 38,000 | 500 | 6010B[G] | 1000[C] | ILM04.0/200.7 CLP-M | 100 | 10 | 6010B | 10 | ILM04.0/200.7 CLP-M | 4 / 200.7[5] |

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL | EPA Drinking & Waste Water[4-12] Method |
| Chromium III *(trivalent)*[S] | 16065-83-1 | 10,000,000 | *Calculate as difference: Total - hexavalent = tri (or use:)* 80 | 6020-SIM[S] | --- | — | 150,000 | *Calculate as difference: Total - hexavalent=tri (or use:)* 0.08 | 6020-SIM[S] | --- | — | *Calculate as difference: Total - hexavalent=tri (or use:)* 0.2 | 1639[8] |
| | | | | | | | | | | | | 0.9 | 200.8-SIM[5] |
| Chromium VI *(hexavalent)*[S] | 18540-29-9 | 38,000 | **Alkaline Digestion (Method 3060A)** *plus one of:* 20000 | 7196A | --- | --- | 100 | **Alkaline Preservation *(See Method 1669[8])*** *plus one of:* 5 | 7195 | --- | --- | **Alkaline Preservation *(See Method 1669 [8])*** *plus one of:* 10 | 218.4[9] |
| | | | 12 | 7199 | | | | 10 | 7198 | | | 5 | 218.5[9] |
| | | | 80 | 6020-SIM[S] | | | | 0.3 | 7199 | | | 0.4 | 218.6[10] |
| | | | | | | | | 0.08 | 6020-SIM[S] | | | 0.5 | 1636[8] |
| Chrysene | 218-01-9 | 25,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 1.6 | 1.5 | 8310 | 10 | OLM04.2-D/SVOA | 0.3 | 525.2[4] |
| Copper | 7440-50-8 | 1,700,000 | 400 | 6010B[G] | 2500[C] | ILM04.0/200.7 CLP-M | 3,800 | 3 | 6010B | 25 | ILM04.0/200.7 CLP-M | 3 | 200.7[5] |
| Cyanide, free | 57-12-5 | 410,000 | 1000 | 9014 *(free)* | 2500[C] | ILM04.0/**335.2** CLP-M *(total CN-)*[Y] | 2,000 | 20 | 9014 *(free)* | 10 | ILM04.0/335.2 CLP-M *(total CN-)*[Y] | 5 | 335.4[6] *(total CN-)*[Y] |
| | | | 2500 | 9213 *(free)* | | | | 50 | 9213 *(free)* | | | | |
| 4,4'-DDD *(DDD)* | 72-54-8 | 120,000 | 500 | 8081B[M,R] | 3.3 | OLM04.2-D/PEST | 12 | 0.50 | 8081B[M] | 0.10 | OLM04.2-D/PEST | 0.01 | 508[4] |
| 4,4'-DDE *(DDE)* | 72-55-9 | 86,000 | 580 | 8081B[M,R] | 3.3 | OLM04.2-D/PEST | 8.4 | 0.58 | 8081B[M] | 0.10 | OLM04.2-D/PEST | 0.02 | 508[4] |
| 4,4'-DDT *(DDT)* | 50-29-3 | 86,000 | 810 | 8081B[M,R] | 3.3 | OLM04.2-D/PEST | 8.4 | 0.81 | 8081B[M] | 0.10 | OLM04.2-D/PEST | 0.06 | 508[4] |
| Dibenz[a,h]anthracene | 53-70-3 | 1,500 | 660 | 8270C[E] | 330 | OLM04.2-D/SVOA[E] | 0.39 | 0.03[F] | 8310 | 10 | OLM04.2-D/SVOA | 0.1 | 525.2[4] |
| Di-n-butyl phthalate | 84-74-2 | 2,000,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 10,000 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 4 | 525.2[4] |
| 1,2-Dichlorobenzene | 95-50-1 | 270,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 9,200 | 5 | 8260B | 10 | OLM04.2-D/SVOA | 0.05 | 524.2[4] |
| 1,3-Dichlorobenzene | 541-73-1 | 1,800 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 92 | 5 | 8260B | 10 | OLM04.2-D/SVOA | 0.05 | 524.2[4] |
| 1,4-Dichlorobenzene | 106-46-7 | 3,400 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 120 | 5 | 8260B | 10 | OLM04.2-D/SVOA | 0.04 | 524.2[4] |

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| 3,3'-Dichlorobenzidine | 91-94-1 | 210 | 62 | 1625C[O,8] | 330 | OLM04.2-D/SVOA | 6.4 | 1.4[F] | 8325 | 10 | OLM04.2-D/SVOA | 0.13 / 605[7] |
| 1,1-Dichloroethane | 75-34-3 | 58,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 10,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.04 / 524.2[4] |
| 1,2-Dichloroethane | 107-06-2 | 150 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 31 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.06 / 524.2[4] |
| 1,1-Dichloroethylene *synonym: 1,1-Dichloroethene* | 75-35-4 | 58 | 0.7<br>5 | 8021B[E,N]<br>8260B[E] | 10 | OLM04.2-D/VOA[E] | 7.0 | 0.7<br>5 | 8021B[N]<br>8260B | 10 | OLM04.2-D/VOA | 0.12 / 524.2[4] |
| cis-1,2-Dichoroethene *syn.: cis-1,2-Dichloroethylene* | 156-59-2 | 5,800 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 1,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.12 / 524.2[4] |
| trans-1,2-Dichoroethene *syn.: trans-1,2-Dichloroethylene* | 156-60-5 | 14,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 2,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.06 / 524.2[4] |
| 2,4-Dichlorophenol | 120-83-2 | 3,000 | 660 | 8270C[E] | 330 | OLM04.2-D/SVOA[E] | 310 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 2.7 / 625[7] |
| 1,2-Dichloropropane | 78-87-5 | 250 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 42 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.04 / 524.2[4] |
| 1,3-Dichloropropene (cis- and trans-) | 542-75-6 | 200 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 29 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.1 / 524.2[4] |
| Dieldrin | 60-57-1 | 150 | 30 | 8081B[E,M] | 3.3 | OLM04.2-PEST | 0.18 | 0.044 | 8081B[F,M] | 0.10 | OLM04.2-PEST | 0.02 / 508[4] |
| Diethylphthalate | 84-66-2 | 1,300,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 82,000 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 0.8 / 525.2[4] |
| Dimethylphthalate | 131-11-3 | 1,400,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 1,000,000 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 0.14 / 525.2[4] |
| 2,4-Dimethylphenol | 105-67-9 | 25,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 2,000 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 2.4 / 625[7] |
| 2,4-Dinitrophenol | 51-28-5 | 820 | 220<br>3300 | 8041[M]<br>8270C[V] | 830 | OLM04.2-D/SVOA[E,X] | 200 | 50 | 8270C[V] | 25 | OLM04.2-D/SVOA | 42 / 625[7] |
| Dinitrotoluene mixture | 25321-14-6 | 28 | 1[L] | 8410 | 330 | OLM04.2-D/SVOA | 4.2 | 0.31 | 8330 | 10 | OLM04.2-D/SVOA | 0.02 / 609[7] |
| Di-n-octyl phthalate | 117-84-0 | 2,000,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 20 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 2.5 / 625[7] |
| Endosulfan | 115-29-7 | 46,000 | 400 | 8081B[M] | 3.3 | OLM04.2-D/PEST | 510 | 0.4 | 8081B[M] | 0.10 | OLM04.2-PEST | 0.015 / 508[4] |
| Endrin | 72-20-8 | 15,000 | 390 | 8081B[M] | 3.3 | OLM04.2-D/PEST | 31 | 0.39 | 8081B[M] | 0.10 | OLM04.2-PEST | 0.015 / 508[4] |

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| Ethylbenzene | 100-41-4 | 200,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 10,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.06 / 524.2[4] |
| Fluoranthene | 206-44-0 | 880,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 210 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 2.2 / 625[7] |
| Fluorene | 86-73-7 | 1,100,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 2,000 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 1.9 / 625[7] |
| Heptachlor | 76-44-8 | 1,200 | 400 | 8081B[M,R] | 1.7 | OLM04.2-D/PEST | 0.64 | 0.40 | 8081B[M] | 0.050 | OLM04.2-D/PEST | 0.01 / 508[4] |
| Heptachlor epoxide | 1024-57-3 | 1,000 | 320 | 8081B[M,R] | 1.7 | OLM04.2-D/PEST | 0.31 | 0.3 | 8081B[M] | 0.050 | OLM04.2-D/PEST | 0.015 / 508[4] |
| Hexachlorobenzene | 118-74-1 | 3,900 | 660 | 8270C[E] | 330 | OLM04.2-D/SVOA[E] | 1.8 | 0.056 | 8121[N] | 10 | OLM04.2-D/SVOA | 0.1 / 525.2[4] |
| Hexachloro-1,3-butadiene | 87-68-3 | 44,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 20 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 0.9 / 625[7] |
| ∀-HCH *(∀-BHC)* | 319-84-6 | 24 | 23 | 8081B[E,M] | 1.7 | OLM04.2-D/PEST | 0.45 | 0.35 | 8081B[M] | 0.050 | OLM04.2-D/PEST | 0.025 / 508[4] |
| ∃-HCH *(∃-BHC)* | 319-85-7 | 86 | 15 | 8081B[E,M] | 1.7 | OLM04.2-D/PEST | 1.6 | 0.23 | 8081B[M] | 0.050 | OLM04.2-D/PEST | 0.01 / 508[4] |
| (-HCH *((-BHC)* *synonym: Lindane* | 58-89-9 | 100 | 17 | 8081B[E,M] | 1.7 | OLM04.2-D/PEST | 2.2 | 0.25 | 8081B[M] | 0.050 | OLM04.2-D/PEST | 0.015 / 508[4] |
| Hexachlorocyclopentadiene | 77-47-4 | 2,000,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 720 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 0.1 / 525.2[4] |
| Hexachloroethane | 67-72-1 | 7,700 | 5000 | 8270C[R] | 330 | OLM04.2-D/SVOA[E] | 100 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 0.03 / 612[7] |
| Indeno[1,2,3-cd]pyrene | 193-39-5 | 3,100 | 660 | 8270C[E] | 330 | OLM04.2-D/SVOA[E] | 0.022 | 0.043 | 8310[F,X] | 10 | OLM04.2-D/SVOA | 0.02 / 525.2[4] |
| Isophorone | 78-59-1 | 18,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 3,000 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 2.2 / 625[7] |
| Lead | 7439-92-1 | 230,000 | 2800 | 6010B[G] | 4200[C] | ILM04.0/200.7 CLP-M | 42 | 1<br>28 | 7421<br>6010B[G] | 3 | ILM04.0/200.7 CLP-M | 10 / 200.7[5] |
| Mercury | 7439-97-6 | 32,000 | 2000<br>200 | 6010B[G]<br>7471A | 200[C] | ILM04.0/**245.5** CLP-M | 31 | 0.2<br>0.2 | 7470<br>6020A[1b,G] | 0.2 | ILM04.0/**245.1** or **245.2** CLP-M | 0.2 / 245.1[6] |
| Methoxychlor | 72-43-5 | 180,000 | 860 | 8081B[M] | 17 | OLM04.2-D/PEST | 45 | 0.9 | 8081B[M] | 0.50 | OLM04.2-D/PEST | 0.05 / 508[4] |

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| Methyl bromide *synonym: Bromomethane* | 74-83-9 | 700 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 140 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.11 524.2[4] |
| Methylene chloride | 75-09-2 | 1,800 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 380 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.03 524.2[4] |
| Methyl ethyl ketone *(MEK)* *synonym: 2-Butanone* | 78-93-3 | 260,000 | 6250 | 8260B[R,K] | 1200 | OLM04.2-D/VOA[R] | 61,000 | 50 | 8260B[K] | 10 | OLM04.2-D/VOA | 0.28 524.2[4] |
| 4-Methyl-2-pentanone*(MIBK)* *syn.: Methyl isobutyl ketone* | 108-10-1 | 39,000 | 6250 | 8260B[R,K] | 1200 | OLM04.2-D/VOA[R] | 8,200 | 50 | 8260B[K] | 10 | OLM04.2-D/VOA | 0.09 524.2[4] |
| 2-Methylphenol *synonym: o-Cresol* | 95-48-7 | 39,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 5,100 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 10[H] 1625C[8] |
| 3-Methylphenol *synonym: m-Cresol* | 108-39-4 | 30,000 | 5000 | 8270C[R] | [10000 | OLM04.2-D/SVOA[R]] | 5,100 | 10 | 8270C | [10 | OLM04.2-D/SVOA][W] | [10 1625C[8]][W] |
| 4-Methylphenol *synonym: p-Cresol* | 106-44-5 | 3,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 510 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 10[H] 1625C[8] |
| Methyl-t-butyl ether *(MTBE)* *syn.: Methyl tertiary-butyl ether* | 1634-04-4 | 5,600 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 720 | 5 | 8260B | 10 | OLM04.2-D/VOA | 1.2 524.2[4] |
| Naphthalene | 91-20-3 | 170,000 | 625<br>5000 | 8260B[R]<br>8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 2,000 | 5<br>10 | 8260B<br>8270 | 10 | OLM04.2-D/SVOA | 1.6 625[7] |
| Nickel | 7440-02-0 | 2,700,000 | 1000 | 6010B[G] | 4000[C] | ILM04.0/200.7 CLP-M | 2,000 | 10 | 6010B[G] | 40 | ILM04.0/200.7 CLP-M | 5 200.7[5] |
| 2-Nitroaniline | 88-74-4 | 110 | 2 | 8410[L] | 830 | OLM04.2-D/SVOA | 5.8 | 1 | 8131[F] | 25 | OLM04.2-D/SVOA | 10 1625C[8] |
| Nitrobenzene | 98-95-3 | 340 | 260 | 8330[Q] | 330 | OLM04.2-D/SVOA | 51 | 6.4 | 8330 | 10 | OLM04.2-D/SVOA | 1.9 625[7] |
| N-Nitrosodiphenylamine | 86-30-6 | 32,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 580 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 1.9 625[7] |
| N-Nitroso-di-n-propylamine | 621-64-7 | 2.0 | 0.25 | 8410[L] | 330 | OLM04.2-D/SVOA | 0.41* | 0.46 | 8070A[X] | 10 | OLM04.2-D/SVOA | 0.46 607[X,7] |
| Polychlorinated biphenyl compounds *(PCBs)* | 1336-36-3 | 5,300 | 600<br>660 | 8082[M]<br>8270C[E] | 67 | OLM04.2-D/PEST | 1.4 | 0.90 | 8082[M] | 1.0 *to* 2.0[X] | OLM04.2-D/PEST | 0.065[1242] 608[7]<br>0.15 1656 |
| Pentachlorophenol | 87-86-5 | 660 | 51<br>3300 | 8151A[N]<br>8270C[V] | 830 | OLM04.2-D/SVOA | 24 | 0.76<br>50 | 8151A[N]<br>8270C[V] | 25 | OLM04.2-D/SVOA | 3.6 625[7] |
| Phenol | 108-95-2 | 320,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 61,000 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 3.0 625[7] |
| Pyrene | 129-00-0 | 570,000 | 5000 | 8270C[R] | 10000 | OLM04.2-D/SVOA[R] | 140 | 10 | 8270C | 10 | OLM04.2-D/SVOA | 1.9 625[7] |

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | Default Closure Level[b], µg/L | SW-846[1a] EQL | SW-846[1a] Method | CLP[2,3] CR(Q/D)L | CLP[2,3] Method | EPA Drinking & Waste Water[4-12] MDL / Method |
| Selenium | 7782-49-2 | 53,000 | 5000 | 6010B[G] | 7500[C] | ILM04.0/200.7 CLP-M | 510 | 50 | 6010B[G] | 75 | ILM04.0/200.7 CLP-M | 20 / 200.7[5] |
| Silver | 7440-22-4 | 87,000 | 500 | 6010B[G] | 1000[C] | ILM04.0/200.7 CLP-M | 510 | 5 | 6010B[G] | 10 | ILM04.0/200.7 CLP-M | 2 / 200.7[5] |
| Styrene | 100-42-5 | 720,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 20,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.06 / 524.2[4] |
| 1,1,1,2-Tetrachloroethane | 630-20-6 | 790 | 5 | 8260B | --- | — | 110 | 5 | 8260B | --- | --- | 0.05 / 524.2[4] |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | 110 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 14 | 5 | 8260B | 10 | OLM04.2-D/VOA | 6.9 / 624[7] |
| Tetrachloroethylene *(PCE)* *synonym: Tetrachloroethene* | 127-18-4 | 640 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 55 | 5 | 8260B | 10 | OLM04.2-D/VOA | 4.1 / 624[7] |
| Thallium | 7440-28-0 | 13,000 | 2700 | 6010B[G] | 4000[C] | ILM04.0/200.7 CLP-M | 9.2 | 0.3<br>1 | 6020A[1b,G]<br>7841 | 1 | ILM04.0/**279.2** CLP-M *(furnace)* | 1 / 200.7[5] |
| Toluene | 108-88-3 | 240,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 20,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 6.0 / 624[7] |
| Toxaphene | 8001-35-2 | 12,000 | 860 | 8081B[M,R] | 170 | OLM04.2-D/PEST | 3.0 | 0.9 | 8081B[M] | 5.0 | OLM04.2-D/PEST | 1.0 / 505[4] |
| 1,2,4-Trichlorobenzene | 120-82-1 | 77,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 1,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 1.9 / 625[7] |
| 1,1,1-Trichloroethane | 71-55-6 | 35,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 3,600 | 5 | 8260B | 10 | OLM04.2-D/VOA | 3.8 / 624[7] |
| 1,1,2-Trichloroethane | 79-00-5 | 300 | 5 | 8260B[E] | 10 | OLM04.2-D/VOA[E] | 50 | 5 | 8260B | 10 | OLM04.2-D/VOA | 5.0 / 624[7] |
| Trichloroethylene *(TCE)* *synonym: Trichloroethene* | 79-01-6 | 3,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 260 | 5 | 8260B | 10 | OLM04.2-D/VOA | 1.9 / 624[7] |
| 2,4,5-Trichlorophenol | 95-95-4 | 690,000 | 5000 | 8270C[R] | 25000 | OLM04.2-D/SVOA[R] | 10,000 | 10<br>6.4 | 8270C<br>8041 | 25 | OLM04.2-D/SVOA | --- / --- |
| 2,4,6-Trichlorophenol | 88-06-2 | 5,000 | 660 | 8270C[E] | 10000 | OLM04.2-D/SVOA[R] | 260 | 10<br>6.4 | 8270C<br>8041 | 10 | OLM04.2-D/SVOA | 2.7 / 625[7] |
| Vinyl acetate | 108-05-4 | 430,000 | 625 | 8260B[R] | — | — | 100,000 | 5 | 8260B | --- | --- | 10 / 1624C[8,H] |
| Vinyl chloride | 75-01-4 | 13 | 5<br>0.2 | 8260B[E]<br>8021B[E,N] | 10 | OLM04.2-D/VOA[E] | 2.0 | 1<br>0.2 | 8260B[D]<br>8021B[N] | 10 | OLM04.2-D/VOA | 0.18 / 502.2[4]<br>0.17 / 524.2[4] |

## INDUSTRIAL CLOSURE - ANALYTICAL METHODS WITH REPORTING LIMITS FOR RISC

| Analyte | CAS No. | INDUSTRIAL SOIL (µg/kg) | | | | | INDUSTRIAL GROUND WATER (µg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Default Closure Level[a], µg/kg | SW-846[1a] | | CLP[2,3] | | Default Closure Level[b], µg/L | SW-846[1a] | | CLP[2,3] | | EPA Drinking & Waste Water[4-12] | |
| | | | EQL | Method | CR(Q/D)L | Method | | EQL | Method | CR(Q/D)L | Method | MDL | Method |
| Xylene mixture *(o-, m-, p-)* | 1330-20-7 | 410,000 | 625 | 8260B[R] | 1200 | OLM04.2-D/VOA[R] | 180,000 | 5 | 8260B | 10 | OLM04.2-D/VOA | 0.11 | 524.2[4] |
| Zinc | 7440-66-6 | 10,000,000 | 200 | 6010B | 2000[C] | ILM04.0/200.7 CLP-M | 31,000 | 2 | 6010B | 20 | ILM04.0/200.7 CLP-M | 2 | 200.7[5] |

**NOTES**
**Table Information**

10 OLM04.2-D/VOA Shaded cell with light print indicates quantitation limit exceeds Default Closure Level. Method will not meet DQO without analytical modification.

***** Asterisk indicates that no standard EPA method is available with a detection or quantitation limit able to meet the Default Closure Level for that matrix without modification. For some methods, modifications to lower detection limits may be as simple as using a larger sample size, extra concentration of extracts, use of an alternate extraction method, or use of an alternate detector. Consult your laboratory and your IDEM chemist.

[a] Default Closure Level for RESIDENTIAL soil in units of µg/kg.

[b] Default Closure Level for RESIDENTIAL groundwater in units of µg/L.

[C] The CLP SOW does not list CRDLs for soil samples. Soil CRDLs have been estimated as follows. **Note: Detection limits will be higher for samples with dry weight < 100%.**
***metals by ICP** - formula on page D-13 of ILM04.0 assuming 100% dry weight, 0.5 g sample size, 50 mL final volume of digestate, and the aqueous CRDL from page C-2 as the concentration in the digestate. If the estimated ICP detection limit on page D-25 exceeds the aqueous CRDL, the ICP detection limit is substituted as the concentration in digestate. If the calculation using the CRDL on page C-2 exceeds the RISC closure level and the ICP estimated detection limit on page D-25 is lower than the CRDL, the ICP detection limit is substituted for the concentration in the digestate.
***metals when the ICP estimated detection limit will not meet the RISC closure level** - formula on page D-13 of ILM04.0 assuming 100% dry weight, 0.5 g sample size, 50 mL final volume of digestate, and the lowest concentration of the optimum range for the furnace method as the concentration in the digestate. (Notation ***furnace*** added after method number.)
***mercury** - the formula on page D-59 of ILM04.0 assuming 100% dry weight, a 0.2 gram sample, 200 mL final volume after preparation, and the aqueous CRDL as the concentration read from the standard curve.
***cyanide** - the formula on page D-76 of ILM04.0 assuming a 1 gram sample, 100% dry weight, and the aqueous CRDLas the concentration read from the standard curve.

[D] EQL obtained by purging 25 mL aqueous sample instead of 5 mL aqueous sample. (See SW-846 Method 8260B, Table 3, page 8260B-35, December 1996.)

[E] EQL or CRQL for **low level** soil procedure (required). Methods for semivolatile and nonvolatile compounds assume a Gel Permeation Chromatography (GPC) clean up of extract prior to analysis.

[F] Method Detection Limit (MDL) is listed rather than EQL.

[G] SW-846 metals methods reference instrument detection limits (IDLs) instead of quantitation limits. Therefore, a detection limit is listed rather than an EQL. For Method 6010B, detection limits were determined as follows: (1) Aqueous detection limits are taken from the IDL table on page 6010B-19. (2) Soil detection limits have been calculated using the equation on page 6020A-9, assuming a 1gram sample (dry weight), 100 mL as the final digestate volume, and the aqueous IDLas the concentration in the digestate. All are rounded to the nearest 100 µg/L or µg/kg. Method 6020A may be run instead of Method 6010B.

[H] Compound is listed in the method, but no MDL is provided. The MDL is estimated based on compounds of similar properties for which the method does provide a MDL.

[I] EQL or MDL for SW-846 method estimated by using MDL for analogous waste water method using same instrumentation. EQLs were calcualted by multiplying the MDL by standard SW-846 EQL matrix factors: (a) 10 for ground water, (b) 10 for low level soils in volatile organics methods, and (c) 670 for low level soils with GPC cleanup in semivolatile and nonvolatile organics methods. The analogous waste water method for SW-846 Method 8111 is 611.

[J] MCL for arsenic is scheduled to be changed to 5 µg/L (0.005 mg/L) from 50 µg/L (0.050 mg/L) on January 1, 2001.

[K] EQL multiplied a factor of 10 above method default EQL for matrix because of poor purging efficiency.

[L] Methods utilizing Fourier Transform-Infrared Spectroscopy (FT-IR) for detection reference identification limits instead of EQLs; therefore identification limit is listed instead of EQL. For soil and sediment samples the identification limit has been calculated from the aqueous identification limit listed in Table 1, page 8410-11, assuming a 10 gram sample, a 1mL final extract volume prior to drying, and 100% dry weight. For analytes with two identification limits listed, the value in parenthesis has been used.

Notes Continued
Table Information Continued

M EQLs for Methods 8081B (01/98) and 8082 (12/96) are calculated using 8081 (09/94) MDLs multiplied by 8081B or 8082 matrix factors. (No MDLs in Methods 8081B and 8082.). EQLs for Method 8041 (12/96) are calculated using MDLs and matrix factors from Method 8040A (07/92), an earlier form of the same method. (Method 8041 does not provide MDLs).

N EQL calculated by multiplying aqueous MDL (µg/L) by matrix factors listed in the method. If no table of EQL matrix factors is provided in the method, the aqueous MDLs have been multiplied by the following standard SW-846 EQL matrix factors: (a) Volatile organics methods - (i)10 for ground water, (ii) 10 for low level soils, and (iii) 1250 for high level soils; (b) Semivolatile organics methods - (i) 10 for ground water, (ii) 670 for low level soils with GPC cleanup, and (iii)10,000 for high level soils.

O No SW-846 method meets required detection limit for solid matrices. Method referenced is an EPA Office of Water sediment method.

P EQL is taken from text in the Scope and Application and/or Method Performance section of the method. (No MDL or EQL listed in tables for compound.)

Q EQL is calculated by multiplying MDL or EDL for solid matrix times 10.

R EQL or CRQL listed is for the high level (SW-846) or medium level (CLP) soils procedure: **If analytes requiring the low level soil procedure are also contaminants of concern for the method in question, the low level procedure should be run instead.** If a sample contains a mixture of high concentration and low concentration contaminants of concern, the low level soil procedure should be used to quantitate the low concentration analytes and, as needed, dilutions analyzed to quantitate the high concentration analytes.
**SW-846:** For methods other than 8260 and 8270, the high level EQL is the aqueous MDL times the high level soils factor. For 8260 and 8270, the high level EQL is the EQL for low level soils multiplied by: (a) 125 for volatiles (8260), or (b) 7.5 for semivolatiles (8270).
**CLP:** The medum level CRQL is the medium soil value listed in OLM04.2, Exhibit C.

S If speciated Chromium will be analyzed, a separate sample must be taken for hexavalent chromium analysis. Although ICP-MS in selective ion monitoring (SIM) mode should be able to distinguish between Cr(VI) and Cr(III), method development would be necessary at most laboratories (requiring much additional time and expense). Therefore, In most cases the easiest way to determine separate concentrations for hexavalent chromium and trivalent chromium will be to analyze for total chromium, do a special preparation and analysis for hexavalent chromium on a separate sample, and determine trivalent chromium by difference:
(1) For water samples, the sample for analysis of hexavalent chromium must be preserved with *sodium hydroxide*. **This will increase the holding time from 24 hours to 30 days.** (See EPA Method 1669, Section 8.4.5for instructions.) The sample to be analyzed for all other metals (except mercury), including total chromium (or trivalent, if a method is available) should be acid preserved.
b. For soil samples, the sample for hexavalent chromium must be digested by *Method 3060A*, and digestion must occur *within 30 days of sampling*. The sample to be analyzed for other metals can also be analyzed for total chromium (or trivalent chromium, if a method is available); this sample will undergo acid digestion, and the holding time is the usual six months

T If only total chromium will be run (i.e., hexavalent and/or trivalent chromium will not be analyzed for specifically), the default closure levels for hexavalent chromium will apply.

U Requires heated purge (80EC).

V The EQL listed for this analyte in Method 8270C is higher than the default 10 µg/L (water) and 660 µg/kg (soil).

W [*EQL Method No.*] Analyte is not explicitly listed in method but is amenable to analysis by method. Analyte was listed in a previous version of the method, or analytes with similar properties are listed for the method.

X EQL or MDL exceeds closure level but is in within an order of magnitude. Method may be acceptable for use without modification. Consult the IDEM project chemist.

Y Includes measurement of complexed cyanides. The CLP SOW and the EPA water methods do not include methods specifically for free cyanide. Measurement of total cyanide may lead to artificially high results.

NOTES, continued

**References: Methods Manuals**

[1a]*Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, USEPA Publication SW-846, Third edition, Final Update III, [NTIS#: PB97-156111 (integrated 3rd edition through Update III)], June 1997 ***(unless otherwise noted)***.

[1b]*Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, USEPA Publication SW-846, Third edition, Update IVA: Notice of Data Availability (NODA), published in the Federal Register on May 8, 1998 (63 FR 25430).

[2]*USEPA Contract Laboragory Program Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration*, OLM04.2, [EPA web site: http://www.epa.gov/superfund/programs/clp/methods.htm ], May 1999

[3]*USEPA Contract Laboragory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration*, ILM04.0, [NTIS#: PB95-963545], July 1995

[4]*Methods for the Determination of Organic Compounds in Drinking Water - Supplement III*, EPA/600/R-95/131, August 1995

[5]*Methods for the Determination of Metals in Environmental Samples*, EPA/6000/4-91/010, June 1991

[6]*Methods for the Determination o f Inorganic Substances in Environmental Samples*, EPA/600/R-93/100, August 1993

[7]Code of Federal Regulations, 40 CFR 136 - Revised as of July 1, 1995, Appendix A to Part 136 - "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater"

[8]Stand Alone Method (EPA Office of Water method that is not part of a compendium). Referenced from CD-ROM, "EPA Methods and Guidance for Analysis of Water" (1999), prepared for the USEPA Office of Water by DynCorp Consulting Services Division under EPA Contract 68-C3-0337.

[9]*Methods for Chemical Analysis of Water and Wastes* (MCAWW) EPA/600/4-79-020 - Revised March 1983

[10]*Methods for the Determination of Metals in Environmental Samples - Supplement I* - EPA/600/R-94-111- May 1994

[11]*Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater - Vol.I - Revision 1*, EPA-821-R-93-010-A, August 1993

[12]*Analytical Methods for the Determination of Pollutants in Pharmaceutical Manufacturing Industry Wastewater, Revision A*, EPA-821-B-98-016 - July 1998

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# APPENDIX E

# MINIMUM DATA DOCUMENTATION REQUIREMENTS

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# IDEM Minimum Data Documentation Requirements

## Leaking Underground Storage Tank Sites

**February 13, 2003**

General requirements applicable to all samples are followed by requirements specific to analysis type.

## GENERAL REQUIREMENTS FOR ALL SAMPLES

***Sampling Quality Control Data and Information:***

- Chain-of-Custody
- Date and time each sample was taken
- Map or diagram indicating sample locations
- Any notable observations *(*color, clarity, texture, reaction with preservatives, etc.)
- Trip blank (or field blank)
- Equipment blank (rinsate blank)
- Identity of field duplicates (a minimum of one duplicate for every 20 or fewer samples)
- Sample for site specific MS/MSD

***Laboratory Quality Control Data and Information:***

- Completed Chain-of-Custody
- Date and time of receipt at the laboratory
- Condition of samples upon receipt at the laboratory
- Sample identification number or designation
- Sample preparation, extraction, cleanup, or digestion method(s) and date(s)
- Analytical method (name, number, and source) and date of analysis
- Final analytical results
- Case narrative (Includes deviations from standard analytical or preparatory procedure(s); quality control problems encountered--whether stemming from system, instrumentation, analyst error, or sample matrix; corrective measures taken; if corrective measures as called for in the method were not taken; results of corrective measures taken; etc.)

## SPECIFIC REQUIREMENTS BY ANALYSIS TYPE

***Organic Analyses***

VOLATILE ORGANIC ANALYSIS (VOA) and SEMIVOLATILE ORGANIC ANALYSIS (SVOA) BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

- Method blank summary sheet with results, including detections
- Detection/quantitation limit for each compound
- Internal standards summary
- Surrogate (System Monitoring Compound) results (concentration of surrogate spikes added, measured concentrations, and % Recoveries of all surrogates) for each sample
- Matrix Spike/Matrix Spike Duplicate (MS/MSD) results (sample concentration for analyte, concentration of spike added, results, % Recovery for each compound, and Relative Percent Difference between MS and MSD for each compound)
- Laboratory Control Sample results

ANALYSIS OF VOLATILE ORGANIC COMPOUNDS and SEMIVOLATILE ORGANIC COMPOUNDS BY

GAS CHROMATOGRAPHY (GC) Using Method-Specified Detectors (FID, PID, HECD, etc.) and ANALYSIS OF SEMIVOLATILE AND NONVOLATILE ORGANIC COMPOUNDS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC)

- Method of sample introduction (direct injection or purge-and-trap)
- Detection/quantitation limit for each compound
- Method blank summary
- Surrogate recoveries for samples, blanks, and spikes
- Matrix spike/matrix spike duplicate (MS/MSD) analysis or lab duplicates
- Laboratory Control Sample results

ANALYSIS OF PCBS BY GAS CHROMATOGRAPHY (GC) WITH ELECTRON CAPTURE DETECTOR (ECD) OR ELECTROLYTIC CONDUCTIVITY DETECTOR (ELCD OR HECD)

- Method blank summary
- Detection/quantitation limit for each compound (in each sample)
- Surrogate recoveries for samples, blanks, and spikes
- Matrix spike/matrix spike duplicate (MS/MSD) analysis or laboratory duplicates
- Laboratory Control Sample results

***Metals and General Chemistry Analyses***

TOTAL AND DISSOLVED METALS by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) or Atomic Absorption Spectroscopy (AA) and GENERAL CHEMISTRY ANALYSES

- Method/sample quantitation limits
- Instrument detection limits
- Blank results
- Matrix spike (sample number of sample spiked, sample concentration for analyte, concentration of spike added, results and % Recovery)
- Matrix spike duplicate or laboratory duplicate (results and Relative Percent Difference [RPD]; if matrix spike duplicate, also report %Recovery)
- Laboratory control sample (QC standard or lab-fortified blank: results and %Recovery).

## ADDITIONAL INFORMATION

If full QA/QC documentation is requested, the requirements can be found in Appendix 2 of the Risk Integrated System of Closure (RISC) Technical Guide, pages 8-11.