Idaho Risk Evaluation Manual

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Department of Environmental Quality

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ACRONYMS AND ABBREVIATIONS

ALM	Adult Lead Methodology
AST	Above Ground Storage Tank
ASTM	American Society for Testing and Materials
BHC	Benzene Hexachloride
BTEX	Benzene, Toluene, Ethyl Benzene, and Xylene
CAL-EPA	California Environmental Protection Agency
CAS	Chemical Abstract Service
cc	Cubic Centimeter
CLP	Contract Laboratory Program
COC	Chemical of Concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C_{cw}	Concentration in Ground Water (Between Source and Surface Water) at Alternate Point of Compliance
cm^2	Square Centimeter
C_{soil}	Source Area Concentration in Soil
C_{swpoe}	Point of Exposure Concentration in Surface Water
DAFs	Dilution Attenuation Factors
DEQ	State of Idaho, Department of Environmental Quality
DDD	1,1-dichloro-2,2-bis(p-chlorophenyl)ethane
DDE	1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene
DDT	1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane
DOE	U.S. Department of Energy
DNAPL	Dense Non-Aqueous Phase Liquid
DQO	Data Quality Objective

Eh	Redox Potential
EM	Exposure Model
EPA	U.S. Environmental Protection Agency
EU	Exposure Unit
ft	foot
gm	gram
GW	Ground Water
GWP	Ground Water Protection
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
HWMA	Hazardous Waste Management Act
IDTL	Initial Default Target Level
IDWR	Idaho Department of Water Resources
IELCR	Individual Excess Lifetime Cancer Risk
IEUBK	Integrated Exposure Uptake Biokinetic Model
ILRA	Idaho Land Remediation Act
IRIS	Integrated Risk Information System
ISCE	Initial Site Characterization and Evaluation
IUPAC	International Union of Pure and Applied Chemists
kg	kilogram
L	liter
LNAPL	Light Non-Aqueous Phase Liquid
m^3/hr	Cubic Meters per Hour
MCL	Maximum Contaminant Level
mg	milligram

MS	Microsoft
MTBE	Methyl Tertiary Butyl Ether
NA	Natural Attenuation
NAPL	Non-Aqueous Phase Liquid
NCEA	National Center for Environmental Assessment
NFA	No Further Action
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic Aromatic Hydrocarbons
PbB	Blood Lead
PCB	Polychlorinated Biphenyls
PCE	Perchloroethylene
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
POC	Point of Compliance
POE	Point of Exposure
PPRTV	Provisional Peer Reviewed Toxicity Value
PSC	Petition for Site Closure
PST	Petroleum Storage Tank
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Relative Absorption
RATL-1	Remedial Action Target Level-1
RATL-2	Remedial Action Target Level-2
RBCA	Risk-Based Corrective Action
REM	Risk Evaluation Manual

RE-1	Risk Evaluation-1
RE-2	Risk Evaluation-2
RF	Reduction Factor
RMP	Risk Management Plan
RNA	Remediation by Natural Attenuation
ROE	Route of Exposure
SAB	EPA's Science Advisory Board
SCM	Site Conceptual Model
Servitude	Equitable Servitude and Conservation Easement
SNL	Sandia National Laboratory
SVOC	Semi-Volatile Organic Chemical
STATECOM	State Communications Center
SW	Surface Water
TCDD	2,3,7,8-tetrachloro-dibenzo-p-dioxin
TEQ	Total Toxic Equivalency
TEF	Toxic Equivalency Factors
TNRCC	Texas Natural Resource Conservation Commission
TP	4,5-trichlorophenoxy propionic acid (Silvex)
TSD	(Hazardous Waste) Transportation, Storage, and Disposal Facility
UCL	Upper Confidence Limit
USACE	United States Army Corps of Engineers
VOC	Volatile Organic Compound

1.0 BACKGROUND AND OBJECTIVE

DEQ will use this document as a guideline to evaluate the need for investigation or remedial actions to address releases and threatened releases of contaminants under DEQ statutory authorities (such as the Idaho eEnvironmental Protection and Health Act (EPHA), the Hazardous Waste Management Act of 1983 (HWMA), and the Idaho Solid Waste Facilities Act (SWFA)) and administrative rules promulgated thereunder; and to evaluate the scope and nature of such investigations or actions. These procedures are not exclusive and do not have the force and effect of law. DEQ may use other procedures to evaluate the need for or adequacy of response actions under its statutory authorities and may act at variance with the procedures contained in this document. The final standard for all DEQ evaluations is compliance with DEQ's mission to protect human health and the environment.

1.1 INTRODUCTION

The Department of Environmental Quality (DEQ) is faced with the task of selecting and overseeing the most appropriate response actions at hundreds of contaminated sites across the state. These sites are managed under a variety of regulatory programs. Whereas the primary objective of each program is to protect human health and the environment, the specific evaluation process used to achieve this objective varies from program to program.

Thus, there is a need to develop a consistent agency-wide evaluation process for contaminated sites that can accommodate the unique requirements of the various regulatory programs. Such a process has the potential to streamline the process of site cleanup and closure, focus finite resources on sites with the highest current and/or potential future risks, and reduce the overall cost of cleanups. Although the DEQ will not allow cost considerations to compromise public health or the environment, it recognizes the need to promote cost-effective site activities (characterization and remediation) that are protective of human health, the environment, and natural resources.

In response to this need, DEQ has developed an integrated risk evaluation process for managing contaminated sites, termed *Idaho Risk Evaluation Manual (REM).* This document presents the process, methodologies, and key elements of the risk evaluation process. This process is similar to the *Idaho Risk Based Corrective Action Guidance* Document for Petroleum Releases (DEQ, 1996). This document is currently used to manage petroleum releases regulated under the Petroleum Release Reporting, Investigation, and Confirmation and Petroleum Release Response and Corrective Action sections (IDAPA 58.01.02.851 and 58.01.02.852) of the Idaho Water Quality Standards and Wastewater Treatment Requirements.

1.2 OBJECTIVE OF THIS DOCUMENT

The objective of this document is to describe the risk-based evaluation process for use in managing a variety of contaminated sites. This process and the associated policies will evolve as the various stakeholders (DEQ, consultants, responsible parties, etc.) gain experience with its application. Thus, DEQ anticipates revising and updating this document as appropriate.

This document has been developed for environmental professionals with working knowledge and experience in the areas of site assessment, site investigation, risk assessment, and remedial actions. Technical information is included that describes the risk evaluation process and its elements, including data needs and the development of target levels. However, this manual is not intended as a general guide to every aspect of site management, nor is it a substitute for the individual administrative requirements of the various programs. This document's use is limited to establishing the procedures, processes, and methodologies that can be used to develop risk-based cleanup levels. Prior experience or training will be necessary for an individual to correctly implement this process as a part of the overall site management process.

1.3 APPLICABILITY AND PURPOSE

The risk evaluation process does not in any way replace or supercede DEQ's enforcement or permitting authority, notification requirements, or other applicable requirements, nor does it reduce any of a responsible party's obligations under other regulations. Once a site has been identified as requiring corrective action, the REM describes a process to determine site-specific cleanup levels protective of human health and the environment. These cleanup levels will determine the nature and extent of corrective action that would be required to restore contaminated sites to a condition that is protective of human health and the environment.

The risk evaluation process is not intended for use at permitted facilities such as those regulated under the Land Application of Water and Wastewater, National Pollutant Discharge Elimination System (NPDES), or Air Quality programs. The risk evaluation process is applicable to numerous programs under which the DEQ oversees corrective actions. The following sections present a brief overview of several of these programs.

It is not the intent of DEQ to use the REM to reopen sites previously closed based on the RBCA process. The guidance may be applied at new releases discovered at previously closed sites. The REM is intended to replace the existing *Idaho Risk Based Corrective Action Guidance document for Petroleum Releases*. Petroleum release sites discovered after the issuance of the REM will be required to use these procedures while sites discovered prior to it's issuance will have the option of following either guidance.

1.4 ORGANIZATION OF THIS DOCUMENT

This document consists of 12 sections and 14 appendices. Section 2.0 presents a brief description of the steps in the risk evaluation process. Sections 3.0 and 4.0 present general information related to the implementation of the risk evaluation process. The next seven sections present details of each of the steps in the process. The final section provides a list of references cited and additional useful references.

1.5 OVERVIEW OF DEQ'S CORRECTIVE ACTION PROGRAMS

This section discusses the various DEQ release reporting, corrective action, and public involvement requirements.

1.5.1 Release Reporting Provisions

Various DEQ authorities require responsible parties, owners, and operators to immediately report to DEQ any suspected or confirmed release of a substance with the potential to impact human health or the environment. By acting immediately, responsible parties assist DEQ in protecting human health and the environment. Taking immediate action also acts to reduce the cost of investigation into and, if necessary, remediation of, any resulting contamination. Specific DEQ authorities are listed below.

1.5.1.1 Water Quality Standards and Wastewater Treatment Requirements, IDAPA 58.01.02

- **Section 850.03:** "In the case of a release of hazardous materials to state waters or to land such that there is a likelihood that it will enter state waters, the responsible persons in charge must immediately notify the Department or designated agent of the spill." To date, the DEQ has not assigned a designated agent; thus, notice must be to the DEQ.

- **Section 851.01:** "Owners and operators of any petroleum storage tank (PST) systems [aboveground or underground] shall report to the Department within twenty-four (24) hours" any suspected release of petroleum from the PST system, as defined by IDAPA 58.01.02.851.01 a. through c.

- **Section 852.01.c:** Owners and operators of any PST system (aboveground or underground) shall report to DEQ within 24 hours any confirmed release of petroleum from the PST system.

1.5.1.2 Rules and Standards for Hazardous Waste, IDAPA 58.01.05 – Transfer, Storage, and Disposal Facility Requirements (Section 008).

Section 008 of the Idaho Rules and Standards for Hazardous Waste incorporates by reference 40 CFR 264.98, which states that the owner or operator of a hazardous waste transportation, storage, and disposal facility (TSD) must notify DEQ in writing within seven days of finding statistically significant evidence of contamination by chemical parameters or hazardous constituents specified in the facility permit. Section 008 also incorporates by reference the TSD imminent or actual emergency procedures contained in 40 CFR 264.50 through 56. Following is a brief summation of the reporting requirements of these provisions. This summation does not encompass all relevant requirements of these provisions; in case of an imminent or actual emergency situation, refer to 40 CFR 264.55 and 56 to ascertain all regulatory requirements.

These provisions provide that each TSD owner or operator must, at all times, have at least one employee at the TSD or on call with the responsibility of coordinating emergency response measures to develop and maintain on-site a facility contingency plan. The provisions further require each TSD owner or operator to maintain on-site a contingency plan designed to minimize hazards to human health and the environment from fires, explosions and unplanned sudden or non-sudden release of hazardous waste constituents to air, soil, or surface water. The contingency plan describes those actions facility personnel must take to comply with emergency procedures. Among other responsibilities, whenever there is an imminent or actual emergency situation, the coordinator must immediately notify State or local agencies (the Department) with designated response roles if their help is needed.

If the coordinator determines the TSD has had a release, fire or explosion, the coordinator must immediately notify either the government official designated as the on-scene coordinator or the National Response Center. These provisions enumerate the information the coordinator must report. See 40 CFR 264.56(d)(2)(i-vi). Finally, the coordinator must notify the Department, among other parties, that the TSD is in compliance with 40 CFR 264.56(h) before resuming operations in the affected areas of the TSD.

1.5.1.3 Idaho Solid Waste Facilities Act (Section 39-7414)

This provision incorporates by reference 40 CFR 258.55, which states that the owner or operator of a municipal solid waste landfill (MSWLF) must, within 14 days of finding statistically significant levels of a listed constituent (see 40 CFR 258, Appendix I) above applicable ground water protection standards, place a notice in the operating record identifying the elevated constituent(s) and notify DEQ and all appropriate local government officials that the notice has been placed in the operating record.

1.5.1.4 Hazardous Substance Emergency Response Act (Section 39-7108)

This provision requires any person who has the responsibility for reporting a release under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 103, to report said release to the military division, Bureau of Hazardous Material, office of the governor, as soon as practicable after he has knowledge of any such reportable release. In turn, the military division shall immediately notify DEQ of any reported release. Permitted releases and those releases exempted by Section 39-7108(3) of the act are not subject to this provision.

1.5.2 Corrective Action Provisions

The risk evaluation process establishes a procedure by which DEQ determines cleanup levels necessary to assure protection of human health and the environment at a given site (risk-based cleanup levels). Below is a discussion of specific DEQ authorities under which DEQ requires responsible parties to conduct investigations into, and remediation of, environmental contamination. As discussed below, each authority allows DEQ to take the risk-based approach contained in this REM.

1.5.2.1 Water Quality Standards and Wastewater Treatment Requirements, IDAPA 58.01.02

The water quality standards were promulgated pursuant to Idaho Code Sections 39-105, 39-107, and 39-3601 et seq. and safeguard the quality of the waters of the state including the enforcement of standards relating to the discharge of effluent into the waters of the state. The water quality standards designate uses that are to be protected in the waters of the state and establish standards of water quality protective of those uses. Restrictions are placed on the discharge of wastewaters and on human activities that may adversely affect water quality in the waters of the state.

In addition, unique and outstanding waters of the state are recognized.

DEQ may require a responsible party to conduct corrective action to resolve a violation of Sections 800 or 850-852 of the water quality standards.

Section 800 prohibits any person from storing, disposing of, or accumulating adjacent to or in the immediate vicinity of state waters, any hazardous or deleterious material, unless adequate measures and controls are provided to ensure that those materials will not enter state waters as a result of high water, precipitation runoff, wind, storage facility failure, accidents in operation, or unauthorized third party activities. Thus, DEQ may require the removal of any hazardous or deleterious materials stored, disposed of, or accumulated in a manner violating this provision.

Section 850 provides that in the case of an unauthorized release of hazardous materials to state waters or to land such that there is a likelihood that it will enter state waters, the responsible persons in charge must: make every reasonable effort to abate and stop a continuing spill; make every reasonable effort to contain spilled material in such a manner that it will not reach surface or ground waters of the state; immediately notify DEQ or a designated agent of the spills; and collect, remove, and dispose of the spilled material in a manner approved by DEQ.

Sections 851 and 852 contain DEQ authorities addressing petroleum release reporting, investigation, confirmation, and response and corrective action requirements for releases from above and below ground petroleum storage tank systems. Section 852.06 contains "corrective action plan" provisions, requiring that responsible parties submit and implement a plan that "provides for adequate protection of human health and the environment as determined by the Department."

1.5.2.2 Ground Water Quality Rule, IDAPA 58.01.011

The Board of Environmental Quality promulgated the Ground Water Quality Rule in 1997 pursuant to Idaho Code Sections 39-105, 39-107, 39-120, and 39-126. The rule contains ambient ground water quality standards and incorporates the *Idaho Ground Water Plan* (Groundwater Quality Council, 1996) into the administration of DEQ programs. Various plan provisions provide that in determining when remediation should be initiated, the extent of remediation needed, and how to select the appropriate remedy, DEQ should consider site-specific risks to health and the environment, in addition to the cost of the remediation and technological limitations (see *Idaho Ground Water Plan* Executive Summary, pages 9 and 10; Preamble, page 21; and Remediation of Contamination, page 45). The Idaho Ground Water Quality Rule establishes minimum requirements for protection of ground water quality through standards and an aquifer categorization process. The requirements of this rule serve as a basis for the administration of programs that address ground water quality.

DEQ may require a responsible party to conduct corrective action to resolve a violation of Section 400.03 of the Ground Water Quality Rule. Section 400.03 provides that the discovery of any contamination exceeding a ground water standard that poses a threat to existing or projected future beneficial uses of ground water shall require appropriate actions, as determined by DEQ, to prevent further contamination. These actions may consist of investigation and evaluation, or enforcement actions if necessary, to stop further contamination or clean up existing contamination, as required under the Environmental Protection and Health Act, Section 39-108, Idaho Code.

Should DEQ determine cleanup of contamination is appropriate, the Ground Water Quality Rule provides authority for DEQ to develop site-specific ground water quality levels above (or below) established ground water standards for remediation conducted under DEQ's oversight. (see Section 400.05.a. of the Ground Water Quality Rule.) The enumerated factor for consideration when developing any site-specific "remediation" level is that the level be based on "consideration of effects to human health and the environment," (Section 400.05).

1.5.2.3 The Idaho Hazardous Waste Management Act of 1983, Idaho Code Sections 39-4401 et seq.

The Idaho Hazardous Waste Management Act (HWMA) protects public health and safety, the health of living organisms, and the environment from the effects of improper, inadequate, or unsound management of hazardous waste.

DEQ may require a responsible party to conduct remediation to resolve a violation of Section 39-4408 of the HWMA. This provision provides that no person shall treat or store hazardous waste, nor shall any person discharge, incinerate, release, spill, place, or dispose of any hazardous waste in such a manner that the waste, or any constituent thereof, may enter the environment, unless DEQ has issued a permit or variance as required for the specific activity involved or exempted the activity from permit requirements.

In addition, DEQ may require action under the Standards for Hazardous Waste, IDAPA 58.01.05, which incorporate into Idaho law standards for owners and operators of TSD facilities (see IDAPA 58.01.05.008.). Section 008 incorporates requirements for TSD owners and operators to perform certain investigatory and/or corrective actions upon the discovery of the release of a hazardous constituent (see 40 CFR 264.90 through 264.101). Federal regulations (40 CFR 264.100) specifically require TSD owners and operators to establish a corrective action program.

1.5.2.4 The Idaho Land Remediation Act, Idaho Code Section 39-7201 et seq.

The Idaho Land Remediation Act (ILRA) establishes a voluntary program for the remediation of hazardous substance or petroleum contaminated sites. The Idaho Land Remediation Rules detail the voluntary remediation program and are located at IDAPA 58.01.18. The ILRA's legislative findings, Idaho Code Section 39-7202, refers to conducting remediation for the "minimization of risk to human health and the environment," and the ILRA's implementing regulations provide detailed mechanisms for conducting remediation using risk-based cleanup criteria. In turn, Section 023 of the Idaho Land Remediation Rules, entitled Remediation Standards, provides that "all hazardous substance or petroleum concentrations in media which exceed the health-based and environmental remediation standards shall be addressed through appropriate remediation and in accordance with the appropriate technical standards based upon site characteristics, hazardous substances or petroleum, and technical guidance approved by DEQ".

1.5.2.5 The Idaho Solid Waste Facilities Act, Idaho Code Sections 39-7401 et seq.

The Idaho Solid Waste Facilities Act regulates municipal solid waste landfills in Idaho. Section 39-7414 incorporates into Idaho law federal regulations outlining the assessment, monitoring, and corrective action required of a municipal solid waste landfill responsible party whenever a statistically significant increase over background for a listed constituent is detected (see 40 CFR 258, Appendix A.; corrective action requirements are located in Section 258, Subpart E, at 258.55 through 58).

1.5.2.6 Compliance Schedules, Idaho Code Section 39-116

This statutory provision provides the DEQ's director the authority to issue compliance schedule orders to any person who is the source of any health hazard, air contaminant, water pollution, or solid waste for which any regulatory standards have been established. The purpose of a compliance schedule order is to identify and establish appropriate acts and time schedules for interim actions by those persons who are or who will be affected by regulatory standards. The acts and schedules are designed to assure timely compliance.

2.0 OVERVIEW OF RISK EVALUATION PROCESS

2.1 INTRODUCTION

As discussed in Section 1.0, the risk evaluation process is applicable to a variety of sites that are managed by DEQ under a number of different regulatory and statutory programs. These programs may impose program-specific administrative and notification requirements on the responsible party. However, it is anticipated that the identification of the nature and extent of risk management actions required to restore sites to chemical levels protective of human health and the environment will be based on the process described in this guidance document. Key steps in this process are described below. Software has also been developed that complements the process described. The software is intended to perform most of the calculations for steps 5 and 6 (RE-1 and RE-2 evaluations) but not the initial screening or emergency response steps. Appendix M is a user's guide for this software.

2.2 STEPS IN THE RISK EVALUATION PROCESS

The overall evaluation process for a site where contamination is discovered and reported to DEQ is illustrated in Figure 2-1. The process consists of seven steps, each of which is briefly discussed below. In some cases, when adequate data are available concerning a release, the RP may proceed directly to a more detailed level of evaluation, such as RE-1 or RE-2, without formally completing the intermediate steps. DEQ should be notified in these instances.

2.2.1 Step 1: Site Discovery

The risk-based site management process begins with the discovery of a contaminated site. A contaminated site may be discovered and reported to DEQ under a variety of circumstances. These include, but are not limited to, citizen complaints, investigations conducted as a part of real estate transactions, environmental impacts observed in surface waterbodies, and notification of accidents and spills. It is the responsible party's responsibility to perform the initial notification as per the requirements of each program mentioned in Section 1.5.1, or any other applicable federal, state, or local regulatory requirement. **Further details of this step are provided in Section 5.0.**

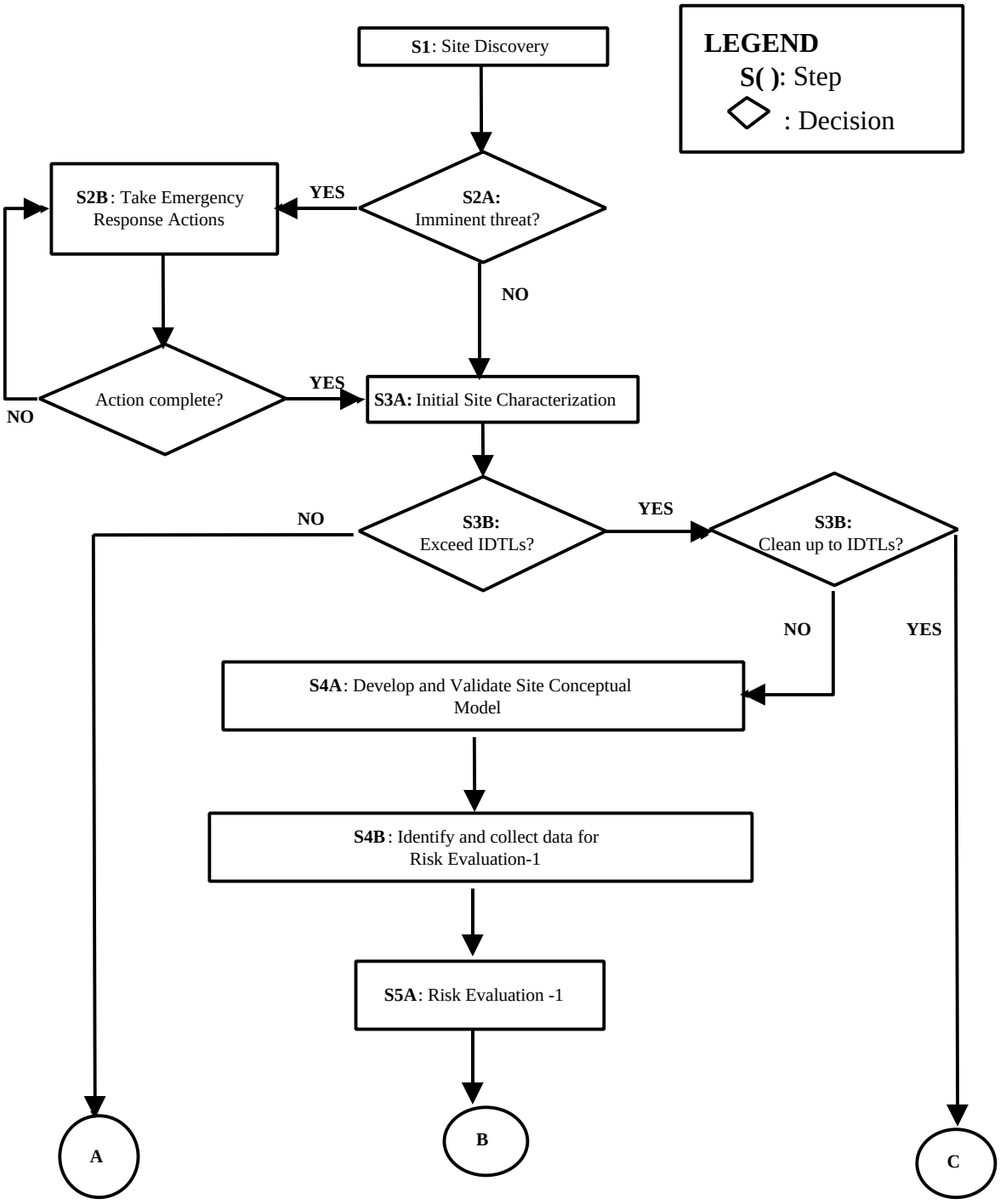

Figure 2-1. Idaho Risk Evaluation Process Flowchart (page 1 of 2)

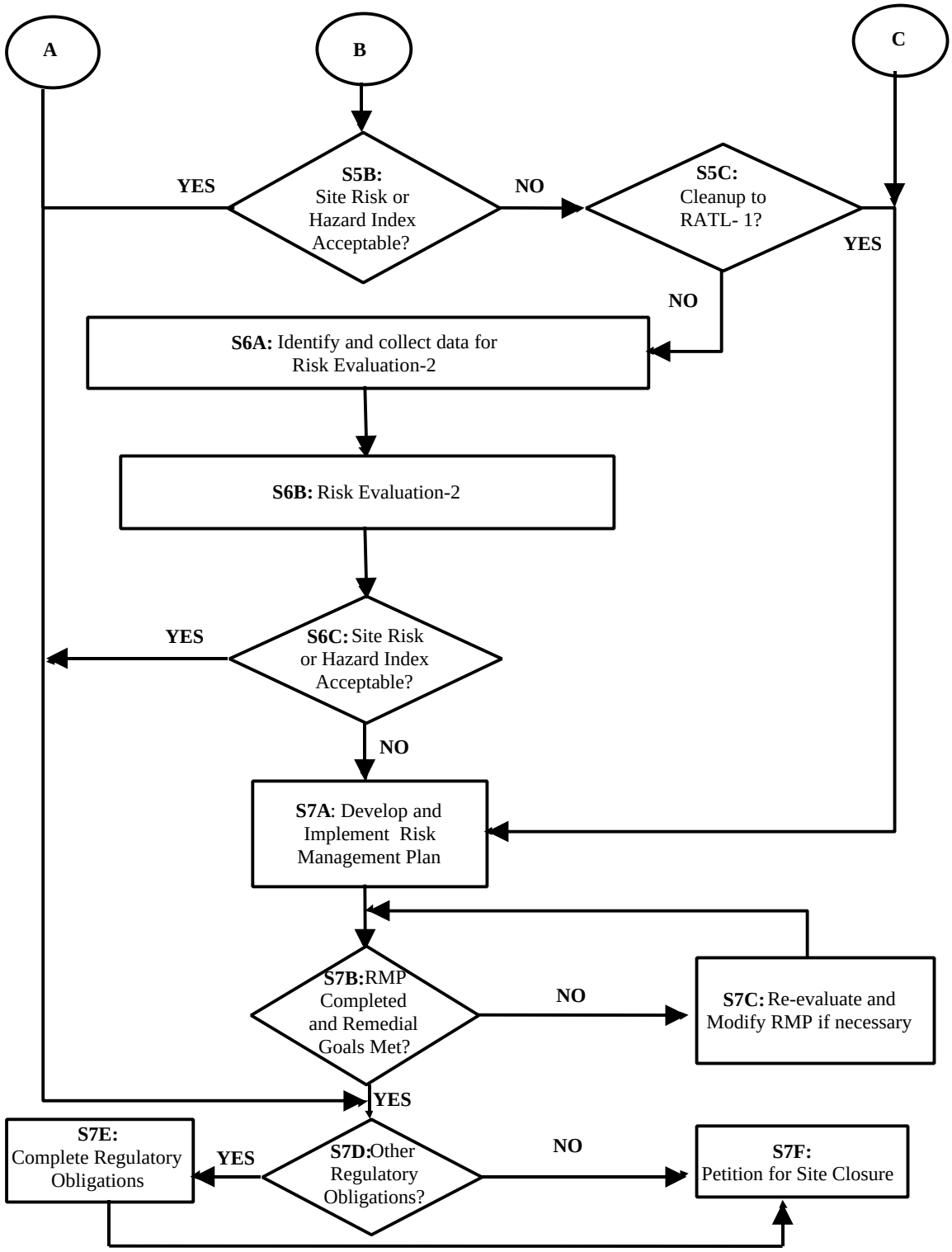

Figure 2-1. Idaho Risk Evaluation Process Flowchart (page 2 of 2)

2.2.2 Step 2A: Determination of Imminent Threat

Upon site discovery, the responsible party should carefully evaluate the available information to determine whether the site poses any imminent threat to human health or safety, or to the environment. Threats include, but are not limited to, impacts to water wells; vapors or odors in residential and commercial structures; concentrations approaching explosive levels; visual impacts to a surface waterbody; and impacts to wildlife, vegetation, or endangered species. If any imminent threats are identified, the responsible party should notify DEQ immediately and take immediate steps to abate the threat (Step 2B). **Further details of this step are provided in Section 6.0.**

2.2.3 Step 2B: Initial Abatement/Emergency Response Actions

The responsible party should immediately initiate abatement actions if a site causes an immediate threat to human health and safety or the environment. Examples of abatement measures include taking action to prevent further release into the environment, provision of alternate water supply if drinking water wells are impacted, evacuation of residents/commercial workers if exposed to vapors at high concentrations, installation of booms on surface waterbodies with a sheen, or ventilation of utilities with vapors. Documentation of abatement activities and confirmation that imminent threats have been removed should be provided to DEQ. **Further details of this step are provided in Section 6.0.**

2.2.4 Step 3A: Initial Site Characterization and Evaluation

Upon completion of the emergency response action, if any, it is necessary to perform an Initial Site Characterization and Evaluation (ISCE). As a part of the ISCE, media-specific (soil, surface water, and ground water) data should be collected to characterize the source. This step is intended to identify the maximum soil and ground water contaminant concentrations. Since a site may be granted no further action after the ISCE, it is very important that the data collected in Step 3A identify the maximum media-specific concentrations. **Further details of this step are provided in Section 7.0.**

2.2.5 Step 3B: Comparison with Initial Default Target Levels

This step involves the comparison of maximum, media-specific contaminant concentrations, identified in the ISCE, with the Initial Default Target Levels (IDTLs) developed by DEQ and presented in Appendix A. If the maximum media-specific concentrations at a site do not exceed the IDTLs, the site may be a candidate for closure, or perhaps limited monitoring. The specific DEQ program overseeing the site will make the final determination on site status. If the maximum soil or ground water concentrations exceed the IDTLs, the responsible party may either adopt the IDTLs as cleanup levels and develop a risk management plan (RMP) (Step 7) to achieve these levels or perform a Risk Evaluation-1 (RE-1) (Steps 4 and 5). **Further details of this step are provided in Section 8.0.**

2.2.6 Step 4A: Development and Validation of a Site Conceptual Model

If the IDTLs are exceeded and are not selected as the cleanup levels, it is necessary to develop and validate a site conceptual model (SCM). A SCM provides the framework for the overall management of the site and should help guide data collection and risk management activities. The key elements of the SCM are the release scenario(s) and chemicals of concern (COCs); the exposure model (EM) that focuses on the receptors, pathways, and routes of exposure (ROE); the site stratigraphy and hydrogeology; and the spatial and temporal distribution of the COCs. An important part of this step is the validation of the SCM based on the collection of site-specific data. **Further details of this step are provided in Section 9.0.**

2.2.7 Step 4B: Identify and Collect Data for Risk Evaluation-1

Depending on the site-specific conditions, the RE-1 evaluation may require the collection of additional site-specific data. In preparation for a RE-1 evaluation, the SCM developed in Step 4A should be reviewed, data requirements to fill gaps identified, and additional data collected, if necessary. This data will be used to develop estimates of representative concentrations, site-specific cumulative risk and, potentially, to develop remedial action target levels-1 (RATL-1) using the guidance provided in this document (Step 5A). **Further details of this step are provided in Section 9.0.**

2.2.8 Step 5A: Risk Evaluation-1

Risk Evaluation-1 requires the development of site-specific estimates of representative concentrations for soil and ground water, the estimation of site-specific cumulative risk, and, if necessary, the development of remedial action target levels-1 (RATL-1). These levels will be developed for each COC and each media identified in the EM developed as a part of Step 4. **Further details of this step are provided in Section 9.0.**

2.2.9 Steps 5B and 5C: Comparison with Target Risk Levels and Decision Making

The estimated site-specific cumulative risk from Step 5A is compared to target risk levels. If target risk levels are not exceeded, the site may be a candidate for closure or reduced levels of monitoring. If the target risk levels are exceeded, cleanup levels (RATL-1 values) are calculated. After RATL-1 values are calculated two options are available:

- Adopt RATL-1 values as cleanup levels and subsequently develop and implement a RMP to achieve these levels, as per Step 7A below.
- Evaluate the site under Risk Evaluation-2 (RE-2) option, Step 6.

Upon completion of the RE-1 evaluation, the responsible party should provide recommendations to DEQ. In most cases it is anticipated that DEQ and the responsible party will work together to identify the best alternative. **Further details of this step are provided in Section 9.0.**

2.2.10 Step 6A: Identification and Collection of Data for Risk Evaluation-2

Depending on the site-specific conditions, RE-2 evaluation may require the collection of additional site-specific data. In preparation for a RE-2 evaluation, the SCM developed in Step 4 should be revised as appropriate and additional data collected, if necessary. This data will be used to revise estimates of representative concentrations and site-specific cumulative risk and, potentially, to develop remedial action target levels-2 (RATL-2) using the guidance provided in this document. Prior to collection of these data, a work plan should be developed outlining additional data needs and the overall approach for RE-2 evaluation. The plan should be approved by DEQ prior to proceeding with RE-2 evaluation**. Details of this step including the basic contents of a work plan are included in Section 10.0.**

2.2.11 Step 6B: Risk Evaluation-2

This step involves recalculating representative chemical concentrations and estimates of site-specific cumulative risk and, if necessary, developing RATL-2 levels for all the complete pathways, media, and COCs identified in the previous steps. The responsible party will be expected to provide justification of the data used to develop the RATL-2 levels. **Details of this step are included in Section 10.0.**

2.2.12 Step 6C: Comparison with Target Risk Levels

The estimated site-specific cumulative risk from Step 6B is compared to target risk levels. If target risk levels are not exceeded, the site may be a candidate for closure or reduced levels of monitoring. If the target risk levels are exceeded, then cleanup levels (RATL-2 values) are calculated.

The RATL-2 levels are adopted as cleanup levels, and a RMP is developed and implemented, as per Step 7. **Details of this step are included in Section 10.0.**

2.2.13 Step 7A: Development and Implementation of a Risk Management Plan

This step requires the development and implementation of a RMP to achieve the cleanup levels. In the risk evaluation process, the responsible party has to select either the IDTLs, RATL-1, or RATL-2 as the cleanup levels and prepare an RMP to achieve the selected levels in each media. The RMP may include a combination of active and passive remedial options and activity and land use restrictions assumed in the risk evaluation step. The plan should include the type of technology to be used, any institutional controls, the time it may take to implement the RMP, and data that will be collected to monitor the effectiveness of the RMP. It is important that during the implementation of the RMP sufficient data be collected and analyzed to evaluate the performance of the plan. The RMP should not be implemented until approved by DEQ. The performance evaluation data should be collected as per the RMP presented to and approved by DEQ. **Details of this step are included in Section 11.0.**

2.2.14 Step 7B and 7C: Evaluation of Progress Towards Remedial Goals and Modification of the Risk Management Plan

The data collected in Step 7A must be carefully evaluated by both the responsible party and DEQ and a determination must be made whether the RMP is progressing as anticipated. In the event that significant deviations, or unacceptable risk levels to receptors, are identified, appropriate modifications to the RMP should be determined and approved by DEQ. In particular, the RMP should be revised if the data indicate that site cleanup is not progressing at the rate anticipated. The specific modification will vary from site to site. **Details of this step are included in Section 11.0.**

2.2.15 Steps 7D, E, and F: Site Closure

The primary objective of the RMP at any site is to ensure the long-term protection of human health, the environment, and natural resources under current and reasonable future conditions. When DEQ is satisfied that the site concentrations meet the specified target risk levels or the IDTLs, RATL-1, or RATL-2, the site may be eligible for closure or the level of remediation/ corrective action at the site may be reduced (e.g., continued monitoring may be required, but other activities can be discontinued). Closure typically involves a request by the responsible party for termination of a consent order that is in place governing remediation. There may be other activities or conditions associated with the site, not directly related to the achievement of target levels, that are specified in the consent order that must also be met. Specific DEQ or Federal programs (RCRA, CERCLA, etc.) may also have additional requirements prior to issuance of a no further action determination for the site.

2.3 RATIONALE AND CHARACTERISTICS OF A TIERED APPROACH

In the risk evaluation process, a site may be eligible for closure or a reduced level of activity if DEQ target risk goals are achieved or the contaminant concentrations are below one of the three target levels developed based on these risk goals (IDTL, RATL-1 or RATL-2). A brief discussion of these levels is presented below:

2.3.1 Initial Default Target Levels

Initial default target levels are the most conservative medium-specific levels and meeting these levels allows unrestricted (residential) use of the property. Since exposure to these low levels of contaminants does not pose a threat to human health, their application does not require the evaluation of site-specific exposure pathways, the development of a site conceptual model, or any land use restrictions.

2.3.2 Remedial Action Target Levels-1

Remedial action target levels-1 are target levels developed by the responsible party using a combination of conservative default and site-specific parameters. These levels depend on the receptor, media, pathway, and the ROE and are discussed in Section 9.0. Use of RATL-1 may require land use restrictions.

2.3.3 Remedial Action Target Levels-2

Remedial action target levels-2 are site-specific levels based on data collected at the site and the guidelines included in this document. These levels have to be developed by the responsible party using site-specific data and represent the most detailed and comprehensive evaluation of site conditions in the risk evaluation process.

It is important to note that although IDTL, RATL-1, and RATL-2 may be different, they all meet DEQ specified acceptable risk levels. Table 2-1 presents the differences between the three risk evaluation options. Subsequent sections of this document discuss the options in further detail. Note that all complete ROE and COCs must be evaluated in both RE-1 and RE-2. Despite the differences among the three levels, there is one very significant similarity. Each level will result in an equally acceptable level of protection for the site-specific human and environmental receptors.

Table 2-1. Comparison Of Risk Evaluation Options

FACTORS	IDTL[a]	RE-1[b]	RE-2[c]
Exposure Factors	Default	Default	Site-specific/default
Toxicity Factors	Default	Default	Default or DEQ accepted values
Physical and Chemical Properties	Default	Default	Default or DEQ accepted values
Fate and Transport Parameters	Default	Default/limited site-specific	Site-specific
Unsaturated Zone Attenuation	None	None/site-specific	Site-specific
Fate and Transport Models	Default	Default	Other models acceptable to DEQ
Representative Concentrations	Maximum	95% Upper Confidence Limit of Mean/ statistical evaluation	95 % Upper Confidence Limit of Mean/ statistical evaluation.
IELCR[d]	1×10^{-6}	Cumulative effects considered T arget of 1×10^{-5}	Cumulative effects considered Target of 1×10^{-5}
Hazard Quotient (HQ)/Hazard Index (HI)	HQ = 1	Cumulative effects considered HI Target of 1	Cumulative effects considered HI Target of 1
Ground Water Protection	MCL[e]	MCL or target levels based on classification described in Section 3.8	MCL or target levels based on classification described in Section 3.8
Ecological Risk	None	Screening evaluation	Detailed evaluation
Outcome of Evaluation	PSC[f], RE-1, RMP[g]	PSC, RE-2, RMP	PSC, RMP
Soil Concentration Protective of Ground Water	Default model with POE[h] at source	Default model with POE determined as per Section 3.6	Same as RE-1 with flexibility in model used
Surface Water Classification	See Section 3.10	See Section 3.10	See Section 3.10
Point of Exposure	Source	See Section 3.6	See Section 3.6
Institutional Controls	None	See Section 3.15	See Section 3.15

a IDTL: Initial Default Target Level
b RE-1: Risk Evaluation-1
c RE-2: Risk Evaluation-2
d IELCR: Individual Excess Lifetime Cancer Risk
e MCL: Maximum Contaminant Level
f PSC: Petition for Site Closure
g RMP: Risk Management Plan
h POE: Point of Exposure

3.0 RISK-BASED EVALUATION: GENERAL CONSIDERATIONS

The risk evaluation process requires the consideration of numerous policy issues and technical factors in order to develop sound estimates of site-specific risk and target levels. Policy issues that need to be evaluated include, but are not limited to, land use, identification of on-site and off-site receptors, evaluation of exposure pathways, development of exposure models, determination of points of compliance and exposure, evaluation of ground and surface water use, nuisance conditions, and target risk levels. Technical factors that must be evaluated include the physical, chemical, and toxicological properties of the COCs; exposure factors; fate and transport parameters; and fate and transport models. Guidance related to these issues and factors is presented in this section.

3.1 LAND USE

Evaluating current and reasonably likely future land uses at and adjacent to the release site is a critical component of this process when determining cleanup target levels and potential exposure points, exposure pathways, and exposure factors because target levels vary depending on whether the land use is residential or nonresidential.

Residential land use generally requires lower target levels. Cleanup to residential standards will usually allow unrestricted land use. Whenever land use is considered nonresidential, and cleanup is not to residential standards, DEQ may require that a remedial action institutional control be imposed on the land. An example of such an institutional control mechanism is included in Appendix B.

For the risk evaluation process, examples of residential and nonresidential land use include:

- **Residential -** Includes, but is not limited to dwellings, homes, hospitals, nursing homes, schools, childcare centers, farms with houses, and any other areas/structures with sensitive human activity. Typically, residential land uses are those where someone is present at a location for more than 8 hours per day, seven days per week.

- **Nonresidential -** Includes, but is not limited to, gas stations, industrial operations, stores, businesses, fleet operations etc., where employees work but do not reside on a continuing basis. Typically, nonresidential land uses are those where someone is at a location less than 10 hours a day and absent on weekends or holidays. Hotels, motels, and similar businesses are considered nonresidential unless it is documented that the proprietor, or another person, lives on-site.

The responsible party should submit to DEQ illustrated land use maps clearly identifying current land uses at the site and the adjacent properties. One map should clearly show the area within 0.5 miles of the known or likely extent of contamination.

3.1.1 Determine Current Land Use

Current land use refers to land use as it exists today and can be readily determined by a site visit. Thus, there should be no ambiguity about current land use.

A site visit should identify homes, playgrounds, parks, businesses, industries, or other land uses at, and in close proximity of, the release site. As appropriate, state or local zoning boards; the U.S. Bureau of the Census; zoning, topographic, land use, housing and other types of maps; and aerial photographs can provide information for determining land use.

Undeveloped land should be characterized by the most likely future use of that property, considering current zoning restrictions. If the undeveloped parcel is located in a predominantly nonresidential area, nonresidential classification may be appropriate. However, if the setting is more rural or land-use is mixed, the undeveloped land should be considered residential unless the responsible party develops and implements an institutional control as a part of the Risk Management Plan acceptable to DEQ.

3.1.2 Determine Reasonably Likely Future Land Use(s)

Knowledge about reasonably likely future use(s) of the site and adjacent properties is necessary to identify potential exposure points, exposure pathways, and exposure factors. Consideration of these factors ensures that the site-specific decisions are protective of likely future site conditions. The exposures to be evaluated in a human health or environmental risk assessment depend upon the activities that could occur under likely future uses of land and ground water at the site. The future ground water use should be consistent with the most likely future land use.

For example, consider property that is currently used as farmland. If the impacted farmland includes a residence, the current land use is residential. However, if the responsible party provides information establishing clear plans to develop the residence into a nonresidential building in the near future, the likely future use may be evaluated as nonresidential.

While evaluating likely future land use(s) presents uncertainties, DEQ has identified certain factors that assist in this evaluation. These factors include, but are not limited to, local zoning ordinances; knowledge of current land use and changing land use patterns; zoning decisions; community master plans; interviews with current property owners; nonresidential appraisal reports; proximity to wetlands, critical habitat, and other environmentally sensitive areas, such as source water protection areas; and the use of remedial action institutional controls at a site.

Nonresidential use designations must be justified and there should be a high likelihood that the land will be used for nonresidential purposes. Absent such a justification, DEQ will consider the residential land use scenario as the default future land use.

3.2 IDENTIFICATION OF ON-SITE AND OFF-SITE IMPACTS

Within the risk evaluation process, the impact of the COCs to potential on-site and off-site receptors should be considered. Thus, the EM discussed in Section 3.5 must clearly identify all complete pathways, ROEs, and receptors that may be impacted by COCs located on-site and off-site. Chemicals of concern released at a site may impact multiple land uses and multiple receptors. For example, a plume may migrate off site below a residential and a nonresidential area. In this case, both off-site residential and nonresidential receptors must be considered while developing the EM. For simplification, the following definitions should be used:

- On-Site - The area located within the legal property boundaries within which the source of the release is located. This includes soil, ground water, surface water, and air within those boundaries. Adjacent property purchased subsequent to the release will be considered off-site.
- Off-Site - The areas of concern located outside the boundaries of the property where the release source is located. This includes soil, ground water, surface water, and air located outside the property boundaries.

Site characterization will include a determination of the on-site and off-site areas of impact. These areas are considered in determining the pathway-specific exposure domain of the receptor(s). The exposure unit for a pathway is the area over which the receptor may be exposed to the contaminated medium. Determining the exposure unit is critical in developing representative concentrations separately for ground water and soil for on-site and off-site properties. An impacted site may have multiple exposure units: one for each receptor and for each complete ROE.

3.3 RECEPTORS

The objective of a risk assessment is to quantify the adverse health effects to the current and potential future receptors. For residential conditions, risk to both adults and children, as well as age-adjusted individuals are evaluated. An age-adjusted individual represents a composite receptor potentially exposed as a child, adolescent, and adult. For nonresidential conditions, risk to adults is considered. Finally, under the construction scenario adult construction workers are considered. Thus, the human receptors considered within this process include:

Residential – Children, adults, and age-adjusted individuals

Nonresidential Workers - Adults Construction Workers – Adults

Typically, the individuals described above represent the human receptors subject to the highest potential exposures. Other human receptors, e.g. visitors, trespassers on the property, will generally have less exposure and therefore their risk need not be quantified.

The default exposure duration for construction workers is 30 days. This exposure duration is considered a subchronic, rather than a chronic exposure. Most chemical toxicity values, including the ones listed in this manual, are based on chronic exposure. However, subchronic toxicity values are available for some chemicals. For situations in which the construction worker is the only receptor estimated to have unacceptable risk, DEQ can be consulted for guidance regarding the use of subchronic toxicity information.

There are certain sites, such as conservation and sensitive resource areas, where wildlife may be the potential receptors. In these areas, ecological exposure of wetlands, sensitive environments, wildlife, and threatened and endangered species should be thoroughly evaluated. Section 3.13 addresses concerns regarding ecological risks. The potential risk to these receptor types should be evaluated under RE-2. Contact DEQ to obtain additional guidance on these issues.

3.4 EXPOSURE PATHWAYS

A receptor comes in contact with COCs through a complete exposure pathway. For a pathway to be complete, there must be (1) a source of chemical, (2) a mechanism by which the chemical is released, (3) a medium through which a chemical travels from the point of release to the receptor location, and (4) a ROE by which the chemical enters the receptor's body. Items (1), (2), and (3) are critical in determining the exposure domain of the receptor(s). DEQ has identified the most commonly encountered exposure pathways for which an evaluation must be conducted. These pathways are discussed below. At sites where receptors, exposure pathways, or ROE other than those discussed below are important, the responsible party must identify them and discuss their quantitative evaluation with DEQ.

3.4.1 Pathways for Inhalation

For the inhalation pathway, chemical intake occurs by the inhalation of vapors or particulates either indoors or outdoors. In most cases, the source of these vapors is volatile chemicals in soil and/or ground water. Chemicals may volatilize from the soil and/or ground water and diffuse and/or advect through the overlying capillary fringe, unsaturated zone, and cracks in the floor/foundation to indoor or outdoor air where the exposure occurs. Inhalation of particulates (and their associated absorbed chemicals) may be important at sites where fugitive dust is prominent.

Past evaluation of indoor and outdoor inhalation ROE from subsurface soil and ground water indicates that outdoor inhalation is rarely a critical ROE. Hence the outdoor inhalation pathway is only quantitatively evaluated via the surficial soil direct contact pathway.

Appendix C of this document, entitled, "Evaluation of the Indoor Air Inhalation Pathway" describes in detail the process used to evaluate potential exposure via the indoor air pathway.

3.4.2 Pathways for Surficial Soils (0 - 1 foot below ground surface)

Surficial soils are defined as soils extending from the surface to 1 foot below ground surface. The exposure pathways associated with impacted surficial soils include:

- Ground water protection (leaching to ground water and subsequent potential ingestion of ground water),
- Surface water protection (leaching to ground water and subsequent migration to a surface waterbody), and
- Ingestion of soil, outdoor inhalation of vapors and particulate emissions from soil, and dermal contact with soil.

3.4.3 Pathways for Subsurface Soils (1 foot below ground surface to the water table)

Subsurface soils are defined as soils extending from 1 foot below the ground surface to the water table. The exposure pathways associated with subsurface soils include:

- Indoor inhalation of vapor emissions,
- Ground water protection (leaching to ground water and subsequent potential ingestion of ground water or other use of ground water), and
- Surface water protection (leaching to ground water and subsequent migration to a surface waterbody).

Evaluation of impacts from these pathways may include testing soils located below the water table. This may be necessary where significant fluctuation of the water table occurs.

3.4.4 Pathways for Ground Water

Potentially complete exposure pathways for impacted ground water include:

- Indoor inhalation of vapor emissions, and
- Current and/or future ingestion of water on or off site.

3.4.5 Pathways for Surface Water and Sediments

Depending on the beneficial use designation of impacted surface waters, complete pathways for surface water include:

- Intentional ingestion of surface water (i.e., surface water used as a drinking water supply),
- Contact with surface water during recreational activities (ingestion, inhalation of vapors, and dermal contact),
- Ingestion of fish, and
- Contact with sediments.

Section 3.10 provides additional information regarding the evaluation and protection of surface waterbodies.

3.4.6 Other Pathways and Routes of Exposure

Other complete or potentially complete exposure pathways, such as ingestion of produce grown in impacted soils, ingestion of fish, contact with contaminated sediments, or use of ground water for irrigation purposes, should be evaluated under RE-2 on a case-by-case basis. The responsible party should contact DEQ for further guidance.

The responsible party must evaluate all complete exposure pathways as part of the exposure assessment. However, in some cases it may be determined by DEQ that one or more of the ROEs are incomplete or insignificant and, therefore will not need to be quantitatively evaluated.

3.5 EXPOSURE MODEL

Information obtained during the site assessment is used to develop an EM for the site, identifying potentially complete exposure pathways. The EM shows the media from which COCs are released (surficial soils, subsurface soils, ground water, surface water, etc.), transport mechanisms for the COCs from each media (leaching, ground water transport, volatilization, etc.), receptors of concern (residents, nonresidential individuals, ecological), and routes of exposure (inhalation, ingestion, dermal contact, etc.) that are complete.

The EM requires a basic understanding of the following characteristics:

- Chemical concentrations and distribution of the COCs,
- Factors affecting chemical transport, and
- Potential for a chemical to reach a receptor.

When conducting a site-specific evaluation under this process, a qualitative evaluation must be performed by the responsible party to identify the mechanisms by which COCs will move from affected source media to the point of exposure (POE) where contact with the receptor occurs. If this migration or contact is not possible (e.g., due to engineering controls such as a paved site that will prevent human contact with contaminated soil) under current and most likely future land use conditions, the site-specific COC concentrations may not pose risk. The exposure unit of all receptors must be considered. The exposure unit, or spatial area over which a given receptor is likely to be exposed, must be established for the on-site scenario as well as any off-site impacted or potentially impacted properties. The same site may have different exposure units for current and future scenarios.

An EM is required for RE-1 and RE-2. At sites where multiple off site properties are impacted, more than one EM must be developed.

Throughout this process, the EM should be evaluated and revised to accurately reflect site conditions. Figure 3-1 is a graphical presentation that may be used as a worksheet to develop an EM.

The responsible party must clearly document all the source-pathway-receptor-route combinations nd present clear justification when pathways are determined to be complete or not complete.

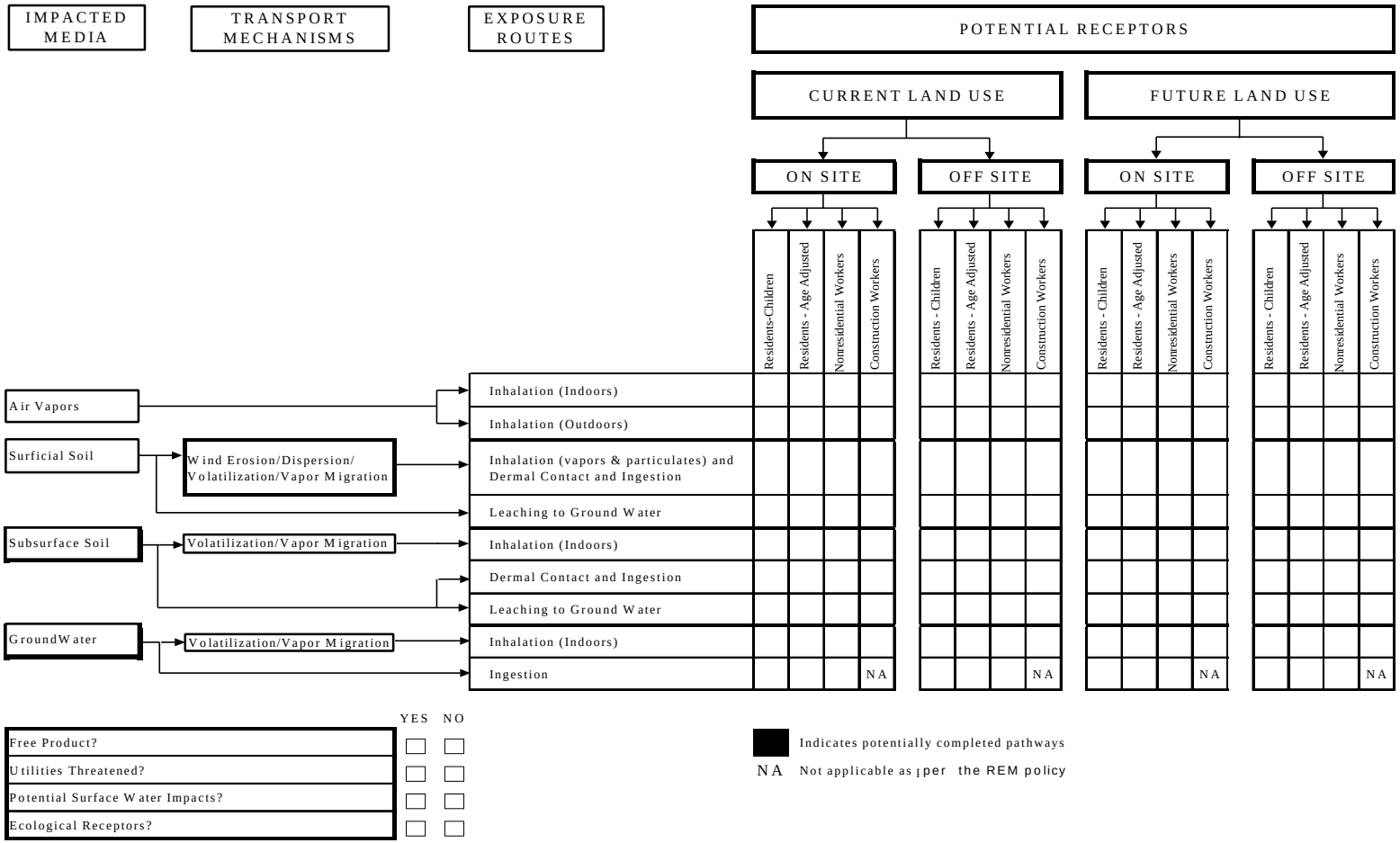

Figure 3-1. Graphical Display of a Site Conceptual Exposure Model

3.6 POINT OF EXPOSURE AND POINT OF COMPLIANCE

The POE is the location where a receptor comes in contact with COCs under current and likely future conditions. A separate POE is associated with each complete exposure pathway combination identified in the EM (see Section 3.5). For direct exposure pathways, the POE is located at the source of the COCs. For example, for the ingestion of surface soil, the POE is at the same location as the soil source. For indirect exposure pathways, the POE and the source of COCs are physically separate. For example, for the case of indoor inhalation of vapors from soil, the POE is inside the building (the breathing space) whereas the source is the soil below and adjacent to the building. The POE location for the protection of the ground water for ground water ingestion is discussed in Section 3.8.

Thus, for each complete exposure pathway, the responsible party must identify the source, exposure unit, and the POE.

A point of compliance (POC) is a location where concentrations are measured to determine if compliance with remedial goals has been achieved. Concentration measurements at the POC may be in any media (e.g., soil, ground water, soil vapor, etc.). The location of a POC may be identical to the POE or may be located between the source and the POE. In the latter case, the target levels at the POC are back-calculated to ensure that the concentrations at the POE do not exceed the target level at the POE. For example, for the protection of the ground water pathway, the POC well may serve as a sentry well for protection of the POE. The calculated target levels for the POC are then compared to measured concentrations. POC locations may be predetermined based on program-specific requirements. Most sites, particularly those involving ground water impacts, will have multiple POC locations. All POC locations must be approved by DEQ.

3.7 CALCULATION OF RISK-BASED TARGET LEVELS

The procedure used to calculate risk-based target levels requires quantitative values of target risk levels, chemical-specific toxicological factors, receptor-specific exposure factors, fate and transport parameters, physical and chemical properties of the COCs, and mathematical models. Each of these factors is discussed below. For the screening level evaluation, DEQ has calculated IDTLs for each COC (see Section 4.2), each receptor (see Section 3.3), and the commonly encountered complete ROEs (see Section 3.4) using conservative assumptions applicable to most sites in Idaho. This screening level evaluation is discussed in Section 8.0.

For RE-1, the responsible party will calculate the target levels using technically justifiable site-specific data and DEQ-selected pathway-specific models, as described in Section 9.0. For RE-2, the same models used for developing the RE-1 levels may be used. In addition, other models may be used if desired. If different models are proposed by the responsible party, they must be approved by DEQ (see Section 10.0).

3.7.1 Target Risk Level

A risk-based decision-making process requires the specification of target or acceptable risk levels for both carcinogenic and non-carcinogenic health effects. For carcinogenic effects, risk is quantified using the individual excess lifetime cancer risk (IELCR) that represents an increase in the probability of an individual developing cancer due to exposure to a specific COC through a specific exposure pathway. Since a receptor may be exposed to multiple chemicals through multiple ROEs, the acceptable risk level should account for the effect of simultaneous exposure to multiple chemicals and multiple ROEs. For non-carcinogenic effects, risk is quantified using a hazard quotient (HQ) that represents the ratio of the estimated dose of a chemical for a ROE to the reference or allowable dose. When a receptor is exposed to multiple chemicals and multiple ROEs, individual HQs may be added together to estimate the Hazard Index (HI).

Within the risk evaluation process, DEQ calculated the IDTLs using an IELCR of 1×10^{-6} for each chemical and each pathway and a HQ of 1. In the development of IDTLs, DEQ did not consider the cumulative effect of multiple COCs and multiple ROEs because IDTLs are based on very conservative assumptions.

For RE-1 and RE-2 the following target risk criteria must be satisfied:

- **Site-wide IELCR**: The sum of IELCR for each COC that has carcinogenic health effects and each complete ROE must be less than or equal to 1×10^{-5}.
- **Site-wide HI:** The sum of HQs for each COC that has non-carcinogenic health effects and each ROE must be less than or equal to 1.0.

The above target risk levels must be met for each current and potential future receptor at the site. In addition to the target risk levels, DEQ requires that maximum contaminant levels (MCLs), or comparable risk-based values for ground water ingestion, be met at the POE when there is a high probability of ground water use. When there is a low probability of ground water use for drinking water, alternate risk-based groundwater target levels, based on the other potentially complete exposure pathways identified for the site, must be met at the POE (see Section 3.9). Similarly, for impacts to surface waterbodies, target concentrations, as discussed in Section 3.10, must be met.

The target risk level of 1×10^{-5} was selected since it is within the risk range for carcinogens (1×10^{-4} to 1×10^{-6}) generally used to evaluate CERCLA actions. The 1×10^{-5} level is protective based on the overall conservative nature of exposure scenarios used in this process and the underlying health criteria.

This process uses specified target risk levels rather than ranges to streamline the decision-making process, while remaining protective of human health and the environment. While the selection of specified target risk levels minimizes some of the flexibility of having a target risk range, its use is a key component of streamlining this process and provides a consistent risk target for developing cleanup levels.

3.7.2 Chemical-Specific Toxicological Factors

The toxicity of chemicals is quantified using slope factors (or potency values) for chemicals with carcinogenic adverse health effects. For chemicals that cause non-carcinogenic health effects, toxicity is typically quantified by reference dose and reference concentrations. The primary source of information for toxicity factors is the U.S. Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) (EPA, 2002a).

Toxicity factors selected by DEQ for the COCs are presented in Appendix D. DEQ requires that these toxicity factors be used in the risk evaluation process and will periodically update Appendix D to ensure the most current, defensible toxicity values are used. In selecting toxicity factors for the COCs, the following sources are consulted in the order listed:

- IRIS.
- EPA Provisional Peer Reviewed Toxicity Values (PPRTVs).
- Health Effects Assessment Summary Tables (HEAST).
- State-approved or recommended values.
- Values withdrawn from IRIS and HEAST and values under review.

3.7.3 Receptor-Specific Exposure Factors

Exposure factors describe the physiological and behavioral characteristics of the receptor. These factors include the following:

- Water ingestion rate,
- Body weight,
- Exposure duration for each ROE,
- Exposure frequency,
- Soil ingestion rate,
- Hourly inhalation rates,
- Exposure times for indoor/outdoor inhalation,

- Dermal relative absorption factor,
- Skin surface area for dermal contact with soil,
- Soil-skin adherence factor, and
- Oral relative absorption factor.

A list of default exposure factors used to compute the IDTLs and RE-1 levels are presented in Table 3-1. Appendix E provides justification for these default values. For RE-2, site-specific values of exposure factors, other than default values, may be used. However, the responsible party must submit a proposal for the use of alternative values to DEQ for approval prior to their use.

Table 3-1. Initial Default Target Level And Risk Evaluation –1
Default Exposure Factors

EXPOSURE PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
Averaging Time - Carcinogen	AT_c	years	70	HHEM
Averaging Time - Noncarcinogen (equals exposure duration)	AT_{nc}	years	Receptor dependent = ED	HHEM
Body Weight (BW)				
Child	BW_c	kg	15	EFH
Adolescent	BW_{as}	kg	55	EFH
Adult	BW_a	kg	70	SDEF
Exposure Duration (ED)				
Resident (child)	ED_c	years	6	PJ
Resident (adolescent)	ED_{as}	years	9	PJ
Resident (adult)	ED_a	years	15	PJ
Nonresidential Worker	ED	years	6.6	SDEF
Construction Worker	ED	years	1	PJ
Exposure Frequency (EF)				
Resident (child)	EF_c	days/yr	350	SDEF
Resident (adolescent)	EF_{as}	days/yr	350	SDEF
Resident (adult)	EF_a	days/yr	350	SDEF
Nonresidential Worker	EF	days/yr	250	SDEF
Construction Worker	EF	days/yr	30	SDEF
Resident (child)	EF_{d-c}	days/yr	270	PJ

Table 3-1. (continued)

EXPOSURE PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
Exposure Frequency for Direct Contact Pathways (EF)				
Resident (adolescent)	EF_{d-as}	days/yr	270	PJ
Resident (adult)	EF_{d-a}	days/yr	270	PJ
Nonresidential Worker	EF_d	days/yr	180	PJ
Construction Worker	EF_d	days/yr	30	PJ
Soil Ingestion Rate (IR)				
Resident (child)	IR_{s-c}	mg/day	200	EFH
Resident (adolescent)	IR_{s-as}	mg/day	100	PJ
Resident (adult)	IR_{s-a}	mg/day	100	EFH
Nonresidential Worker	IR_s	mg/day	100	EFH
Construction Worker	IR_s	mg/day	480	RBCA
Daily Water Ingestion Rate (IRW)				
Resident (child)	IR_{w-c}	L/day	1.5	EFH
Resident (adolescent)	IR_{w-as}	L/day	1.7	EFH
Resident (adult)	IR_{w-a}	L/day	2	SDEF
Nonresidential Worker	IR_w	L/day	1	SDEF
Hourly Indoor Inhalation Rate (IR)				
Resident (child)	IR_{ai-c}	m^3/hr	0.7	EFH, PJ
Resident (adolescent)	IR_{ai-as}	m^3/hr	0.7	EFH, PJ
Resident (adult)	IR_{ai-a}	m^3/hr	0.7	EFH, PJ
Nonresidential Worker	IR_{ai}	m^3/hr	1.0	EFH, PJ
Construction Worker	IR_{ai}	m^3/hr	NA	

Table 3-1. (continued)

EXPOSURE PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
Exposure Time for Indoor Inhalation (ET)				
Resident (child)	ET_{i-c}	hr/day	21	EFH
Resident (adolescent)	ET_{i-as}	hr/day	15.8	EFH
Resident (adult)	ET_{i-a}	hr/day	15	EFH
Nonresidential Worker	ET_i	hr/day	7.5	EFH
Hourly Outdoor Inhalation Rate (IR)				
Resident (child)	IR_{ao-c}	m^3/hr	1.1	EFH
Resident (adolescent)	IR_{ao-as}	m^3/hr	1.3	EFH
Resident (adult)	IR_{ao-a}	m^3/hr	1.3	EFH
Nonresidential Worker	IR_{ao}	m^3/hr	1.6	EFH
Construction Worker	IR_{ao}	m^3/hr	2.4	EFH
Exposure Time for Outdoor Inhalation (ET)				
Resident (child)	ET_{o-c}	hr/day	2	PJ
Resident (adolescent)	ET_{o-as}	hr/day	2	PJ
Resident (adult)	ET_{o-a}	hr/day	2	PJ
Nonresidential Worker	ET_o	hr/day	6	PJ
Construction Worker	ET_o	hr/day	10	PJ
Oral Relative Absorption Factor (RAF)	RAF_o	---	Assume 100%	PJ
Dermal Relative Absorption Factor (RAF_d)				
Volatiles*	RAF_d	---	0.0005	EPA Region III
Volatiles**	RAF_d	---	0.03	EPA Region III
Arsenic	RAF_d	---	0.032	EPA Region III
PAHs	RAF_d	---	0.10	EPA Region III
SVOCs and Pesticides	RAF_d	---	0.10	EPA Region III

Table 3-1. (continued)

EXPOSURE PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
Pentachlorophenol	RAF_d	---	0.25	SGDRA
PCB	RAF_d	---	0.14	SGDRA
Chlordane	RAF_d	---	0.04	SGDRA
Cadmium	RAF_d	---	0.001	SGDRA
Metals	RAF_d	---	0.01	EPA Region III
Soil-to-Skin Adherence Factor (M)				
Residential (child)	M_c	mg/cm^2	1.0	MDEP
Residential (adolescent)	M_{as}	mg/cm^2	0.3	MDEP
Residential (adult)	M_a	mg/cm^2	0.3	MDEP
Nonresidential Worker	M	mg/cm^2	0.1	MDEP
Construction Worker	M	mg/cm^2	0.5	MDEP
Skin Surface Area for Dermal Contact with Soil (SA)				
Child Receptors	SA_c	cm^2/d	2434	MDEP
Adolescent Receptors	SA_{as}	cm^2/d	2434	MDEP
Adult Receptors	SA_a	cm^2/d	5657	MDEP
Nonresidential Worker Receptors	SA	cm^2/d	3477	MDEP
Construction Worker Receptors	SA	cm^2/d	3477	MDEP

* Chemicals with vapor pressures less than benzene
** Chemicals with vapor pressure greater than benzene
Note: Exposure factors for the age-adjusted resident are calculated from the values listed for child, adolescent, and adult receptors using the equations in Appendix H.

Reference Abbreviations
EFH – EPA Exposure Factors Handbook
EPA Region III – Technical Guidance Manual, Assessing Dermal Exposure from Soil
HHEM – Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual
MDEP – Massachusetts Department of Environmental Protection, Weighted Skin-Soil Adherence Factors
PJ – Professional Judgement
RBCA – Idaho Risk-Based Corrective Action Guidance for Petroleum Releases
SDEF – EPA Standard Default Exposure Factors
SGDRA – EPA RAGS Volume I: HHEM, Part E, Supplemental Guidance for Dermal Risk Assessment

Other Abbreviations
PAH – Polycyclic Aromatic Hydrocarbons
SVOC – Semi-Volatile Organic Chemical
PCB – Polychlorinated Biphenyl

3.7.4 Fate and Transport Parameters

Fate and transport parameters are necessary to estimate target levels for indirect ROEs. These factors characterize the physical site properties such as depth to ground water, soil porosity, and infiltration rate at a site. For calculating the IDTLs, DEQ has selected the conservative default values listed in Table 3-2. Justification for these parameters is included in Appendix F. For RE-1 and RE-2, a combination of site-specific and default values for these parameters is used. However, the value of each parameter used, whether site-specific or default, must be justified based on site-specific conditions. For RE-2, the specific fate and transport parameters required to calculate the target levels might vary depending on the choice of models.

Table 3-2. Default Fate and Transport Parameters

PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
SOIL PARAMETERS				
Unsaturated Zone Soil				
Source-building separation	L_{Ts}	cm	30	PJ
Source bottom-building separation	L_{TSB}	cm	183	PJ
Vapor permeability	kv	cm2	5.0E-9	Calculated
Mean particle diameter	D	cm	0.030	EPA, 2003
Van Genuchten curve shape parameter	N	-	1.449	EPA, 2003
Thickness of capillary fringe zone	h_{cap}	cm	25	EPA, 2003
DAF in the unsaturated zone (user-defined)	DAF_{unsat}	--	1	PJ
Total soil porosity in the vadose zone	θ_T	cm^3/cm^3-soil	0.39	EPA, 2003
Volumetric water content in vadose zone	θ_{ws}	cm^3/cm^3	0.17	PJ
Volumetric air content in vadose zone	θ_{as}	cm^3/cm^3	0.22	Calculated
Dry soil bulk density	ρ_s	g/cm^3	1.64	PJ
Fractional organic carbon content in the vadose zone	foc	g-C/g-soil	0.001	PJ
Volumetric water content in the foundation/wall cracks	θ_{wcrack}	cm^3/cm^3	0.17	PJ
Volumetric air content in the foundation/wall cracks	θ_{acrack}	cm^3/cm^3	0.22	Calculated
Volumetric water content in capillary fringe zone	θ_{wcap}	cm^3/cm^3	0.32	EPA, 2003
Volumetric air content in capillary fringe zone	θ_{acap}	cm^3/cm^3	0.07	EPA, 2003
Saturated Zone Soil				
Dry soil bulk density	ρ_{ss}	g/cm^3	1.64	PJ
Fractional organic carbon content	foc_s	g-C/g-soil	0.001	PJ
Total soil porosity	θ_{Ts}	cm^3/cm^3-soil	0.39	PJ

PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
Volumetric water content	θ_{wss}	cm^3/cm^3	0.39	PJ
Volumetric air content	θ_{ass}	cm^3/cm^3	0.0	PJ
AIR PROPERTY				
Viscosity of air	μ	g/cm-s	1.8E-4	
GROUND WATER PARAMETERS				
Water table-building separation	L_{Tgw}	cm	30	PJ
Ground water darcy velocity	U_{gw}	cm/year	3340	DEQ, 1996
Ground water mixing zone thickness	δ_{gw}	cm	153	DEQ, 1996
Length of ground water source parallel to ground water flow direction	L_{mz}	cm	1220	PJ
Width of ground water source perpendicular to ground water flow direction	W_{gw}	cm	1220	PJ
Infiltration rate	I	cm/year	25	PJ
ENCLOSED SPACE PARAMETERS				
Area of the Enclosed Space Below Grade				
Residential	A_B	cm^2	1561600	Calculated
Nonresidential	A_B	cm^2	4782069	Calculated
Enclosed Space Foundation/Wall Thickness				
Residential	L_{crack}	cm	15	EPA, 2003
Nonresidential	L_{crack}	cm	15	EPA, 2003
Total area of Cracks				
Residential	A_{crack}	cm^2	484	Calculated
Non-residential	A_{crack}	cm^2	861	Calculated
Number of Air Exchanges per Second				
Residential	ER	1/s	2.78E-4	MDEQ, 1998
Nonresidential	ER	1/s	5.56E-4	MDEQ, 1998

PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
Length of Enclosed Space				
Residential	L_B	cm	1220	DOE, 1995
Nonresidential	L_B	cm	2157	DOE, 2001
Width of Enclosed Space				
Residential	W_B	cm	1220	DOE, 1995
Nonresidential	W_B	cm	2157	DOE, 2001
Height of Enclosed Space				
Residential	H_B	cm	244	PJ
Nonresidential	H_B	cm	244	PJ
Floor-Wall Seam Perimeter				
Residential	X_{crack}	cm	4880	Calculated
Nonresidential	X_{crack}	cm	8628	Calculated
Crack depth below grade	Z_{crack}	cm	15	Calculated
Equivalent crack radius	r_{crack}	cm	0.1	EPA, 2003
Pressure differential between enclosed space and soil surface beneath	ΔP	$g/cm\text{-}s^2$	40	EPA, 2003
COWHERD PARTICULATE EMISSION MODEL				
Inverse of the mean concentration at the center of a square source	Q/C	$(g/m^2\text{-}s)/(kg/m^3)$	69.41	EPA, 1996
Fractional vegetative cover	V	m^2/m^2	0.5	EPA, 1996
Mean annual wind speed	U_m	m/s	3.98	EPA, 1996
Equivalent threshold value of wind speed at 7 m	U_t	m/s	11.32	EPA, 1996
Wind speed distribution function from Cowherd et. al, 1985	F(x)	--	4.95E-2	EPA, 1996
AVERAGING TIME FOR VAPOR FLUX				
Resident child	τ	sec	1.89E8	PJ

PARAMETER	SYMBOL	UNITS	DEFAULT VALUE	REFERENCE
Resident adolescent	τ	sec	2.84E9	PJ
Resident adult	τ	sec	4.73E9	PJ
Nonresidential adult worker	τ	sec	2.08E9	PJ
Construction worker	τ	sec	3.15E7	PJ
GROUND WATER PROTECTION				
Distance to the point of exposure	X_{poe}	cm	0	PJ
Distance to the point of compliance	X_{poc}	cm	0	PJ
Half life (if with decay option is used)	$T_{1/2}$	days		

PJ – Professional Judgment
DAF – Dilution Attenuation Factor
References

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3.7.5 Physical and Chemical Properties of the Chemicals of Concern

The development of target levels requires the selection of values for the physical and chemical properties of COCs. Values of these parameters are listed in Appendix G. DEQ requires the use of values tabulated in Appendix G for all risk evaluations. The responsible party must provide sufficient justification to DEQ to use different values. The use of different values will be allowed only under RE-2 with prior DEQ approval. DEQ will update the data in Appendix G as new information becomes available.

3.7.6 Mathematical Models

Two types of models or equations, uptake equations and fate and transport models, are required to calculate target levels. A schematic and the equations for each of these models are presented in Appendix H. For IDTLs and RE-1, DEQ has selected the following fate and transport models:

- **Indoor Inhalation of Volatile Emissions from Soil and Water:** This pathway requires an emission model and an indoor air-mixing model. These models are combined together and included in the Johnson and Ettinger Model (EPA, 2003).

- **Surficial Soil Outdoor Inhalation:** This pathway requires an emission model for vapors, an emission model for particulates, and an outdoor air mixing model. The vapor emission model used is based on the volatilization model developed by Jury et al. (1983) for an infinite source, the particulate emission model is the Cowherd model (Cowherd, et al., 1985), and the outdoor air mixing model is based on a simplified form of the Gaussian Dispersion model. These models are presented in *Soil Screening Guidance: Technical Background Document* (EPA, 1996a).

- **Leaching to Ground Water:** This pathway uses a three-phase equilibrium partitioning algorithm to convert soil concentrations to leachate concentrations, and a dilution attenuation model to mix leachate with regional ground water. Models used are described in *Soil Screening Guidance: Technical Background Document* (EPA, 1996).

- **Horizontal Migration in Ground Water:** The Domenico steady-state analytical, infinite source model is used to quantify downgradient migration of chemicals (Domenico, 1982, 1990). This model incorporates the processes of advection, sorption, three-dimensional dispersion, and degradation.

As indicated in Table 2-1, different models may be used for RE-2 with prior DEQ approval.

3.8 PROTECTION OF GROUND WATER

Protection of ground water and potential exposures via the ground water ingestion pathway is an integral part of all three levels in the risk evaluation process (using IDTLs, RE-1, and RE-2) since over 90% of the state's population obtains its drinking water from ground water sources. During an evaluation using IDTLs, it is assumed that all impacted or potentially impacted ground water is used for drinking water. In RE-1 and RE-2, the responsible party conducts an evaluation of the likelihood of use of the ground water for drinking water. This section discusses the specifics of that evaluation process. The evaluation process described in this guidance and its use in the development of site-specific, target ground water cleanup levels is applicable only for programs using this guidance.

3.8.1 Objectives of Ground Water Protection

The evaluation process and ground water protection measures presented in this document are intended to be used in cases where ground water has been impacted or is likely to be impacted by chemical releases. This process has the following objectives:

- To protect all current and reasonably likely future domestic uses of ground water, and
- To provide a rational basis for incorporating site-specific characteristics into determination of target ground water cleanup levels.

3.8.2 Determination of Ground Water Suitability for Drinking Water

Ground water characterization is a critical part of the risk evaluation process. Data requirements for characterization of ground water impacted or potentially impacted by a chemical release are described in Section 4. These characterization requirements apply regardless of the current use of the ground water or its inherent properties (such as quality or yield). This is to state that, during the characterization process, no distinction is made between ground water and ground water that might be considered an aquifer, as that term is used in the Ground Water Quality Rule (IDAPA 58.01.11). After all ground water impacted or potentially impacted by a release has been adequately characterized subsequent steps in the process incorporate site-specific information to varying degrees in an attempt to identify all current and reasonably likely future beneficial uses of ground water.

As noted above, due to the lack of site-specific data, during an IDTL evaluation it is assumed that all ground water is suitable for use as drinking water. In contrast, during the RE-1 and RE-2 steps of the risk evaluation process, the determination described below is completed as to determine whether the potential future use of impacted ground water as a domestic water supply is high or low. This evaluation is based on the following criteria (IDAPA 58.01.11.007.22):

- Inherent natural water quality,
- Hydrogeologic conditions, specifically the sustainable yield,
- Current and projected future land use, and
- Social/economic considerations.

If the ground water is currently being used for drinking water purposes the current use establishes its suitability for drinking water use.

3.8.2.1 Inherent Natural Quality of the Water (background water quality)

The numerical and narrative ground water quality standards delineated in the Ground Water Quality Rule (IDAPA 58.01.11.200) define the water quality criteria at which ground water is considered protective of human health and the environment and suitable for drinking water purposes. The numerical standards include 80 primary, human health-based standards, 12 secondary aesthetic standards, and standards related to radioactive materials. The narrative standards list the factors DEQ considers when developing numerical standards for additional chemicals.

The natural background level describes the water quality conditions existing when unaffected by human activities. Where the natural background level of any constituent, as determined based on site-specific measurements, exceeds the water quality criteria described above, the background level will be considered the site-specific ground water quality standard. When this is the case, DEQ will take this information into consideration when determining whether the ground water will be considered to have a low potential of future use for drinking water purposes.

3.8.2.2 Hydrogeologic Conditions

Apart from water quality considerations, one of the primary hydrogeologic characteristics of a ground water system affecting the likelihood of its potential use as a drinking water source is its yield, the amount of water that can be produced over a defined period of time, and the sustainability of that yield over the long-term.

Ground water systems with an adequate, sustainable yield have a greater potential to be used to supply drinking water. For the purposes of this guidance, a yield is considered sustainable when a properly constructed well that is representative of the saturated zone of the aquifer under consideration is capable of supplying a minimum of an average of 5 gallons per minute over at least a four-hour, consecutive period. The maximum sustainable yield for a ground water system at a given site is typically estimated by conducting an appropriately designed ground water system test on a well that is designed and constructed in accordance with the standards of practice of the water well industry. When documenting the yield capabilities of a particular ground water system, only qualified professionals experienced in making these types of determinations should be consulted.

This yield criterion is derived from federal regulations for the Department of Housing and Urban Development for use in the approval of federally insured mortgages by the Federal Housing Administration (24 CFR 200.926d). DEQ will consider a variance from this criterion when the ground water system in question is the sole source of drinking water or where actual use of the ground water is documented.

The yield evaluation should take into consideration not only the rate at which water can be withdrawn but also the timing (how rapidly or slowly) and degree (compared to pre-test water level elevations) to which the ground water system recovers after this type of imposed stress is removed. Annual fluctuations in recharge and water level; the ability to deliver this supply under normal household use conditions; the source, magnitude, and timing of recharge; the vertical and lateral extent of the ground water system; and spatial variability should all be taken into consideration in making the yield determination.

For example, those ground water systems that depend primarily on irrigation water for recharge (via canal leakage or excess drainage after surface application) may experience a period during the non-irrigation season in which the above yield criteria cannot be achieved. This factor by itself would not automatically result in rejection for domestic use but should be evaluated in the context of long-term sustainability of use. Other ground water systems may be of such limited extent that the ability to reasonably assure its existence across the site may be limited, such as in some fractured geologic formations.

3.8.2.3 Current/Future Land Use

Current and future land use considerations assist in determining the likelihood that impacted ground water at a chemical release site will be used for drinking water purposes. Land use considerations include, but are not limited to:

- Current zoning and land use, including current and historical use of the ground water for drinking water and other beneficial uses,

- Land use development trends. Conversion of agricultural land to residential land uses requires development of drinking water sources. The proximity of these conversions to urban centers and available public drinking water supplies should be taken into account,
- Local ordinances that include agreements with Idaho Department Water Resources (IDWR) governing well drilling or state designated restrictions or specifications for constructing wells into ground water in a locality for drinking water purposes,
- The existence of source water assessment delineations and source water protection plans and ordinances associated with public drinking water supplies,
- The availability of alternative water supplies,
- Consultation with local planning and zoning officials regarding future land use planning direction and interpretation of planning and zoning policies, and
- The estimated timeframe to reach target levels.

3.8.2.4 Social/Economic Conditions

Social and economic considerations that influence the likelihood that a ground water system may be used for drinking water purposes include, but are not limited to:

- The degree to which the ground water in question is the dominant or sole source of drinking water for an area,
- The technical and economic feasibility of withdrawing the ground water (such as attempting to withdraw water from great depth where costs may be prohibitive), and
- The availability of alternative water supplies and the cost of developing those supplies (including the cost for potential treatment to required standards).

3.8.3 Evaluation of Ground Water for Drinking Water Use

Based on the criteria in Section 3.8.2 and that described below, ground water is classified by the responsible party, with approval by DEQ, into one of the following two groups:

- Ground water currently used for drinking water purposes or ground water that meets water quality and yield criteria and for which the future potential of use is reasonably likely, or
- Ground water for which the projected future potential of use is low.

These groups will be used to guide the selection and application of appropriate remedial target levels, remedial measures, and compliance conditions to ground water impacted or potentially impacted by a chemical release.

3.8.3.1 Ground Water with Current Use or Reasonably Likely Future Use as Drinking Water

Ground water in this grouping is assumed to meet the water quality and yield criteria described in Sections 3.8.2.1 and 3.8.2.2. and any one of the following conditions:

- The plume is within a delineated source water assessment or source water protection area for a public water supply well or the recharge/capture zone of a private well used for drinking water purposes.
- There exists current use of the ground water system under consideration for drinking water within a 0.5-mile radius of the impacted area.
- There is historical, documented use of the ground water system for drinking water within a 0.5-mile radius of the impacted area.
- The ground water is the only reliable source of water for drinking water.

The target levels for individual chemicals presented in Table 3-3 will represent the Remedial action target levels 1 and 2 (RATL-1 and RATL-2) for ground water ingestion, for impacted ground water in this group. These target levels will apply at the POE. The POE will be the downgradient property boundary, as it existed when the release occurred, or the nearest downgradient location where a well could be reasonably placed, whichever is closer to the source.

If an on-site well, used for domestic purposes, is completed in the impacted ground water system or in a separate system that may be impacted by the chemical release, the POE will be every point in the impacted plume where chemical concentrations exceed the RATL-1/RATL-2 concentrations presented in Table 3-3. In these cases, institutional controls to prevent exposure are required. These controls will be necessary on that portion of the site where concentrations exceed the RATL-1/RATL-2 concentrations in Table 3-3 and the area where the plume intersects the capture zone of potential pumping wells completed in the impacted ground water system. A variance from this policy may be made for on-site wells for which, under pumping conditions, it can be documented that the potential for impacts from the chemical release is unlikely.

Risk management plans must include provisions, to the extent practicable, to implement institutional controls during the course of remediation throughout the area of the plume that has migrated off site where concentrations exceed the RATL-1/RATL-2 concentrations for ground water ingestion in Table 3-3. These controls must remain in place until remediation is complete and concentrations do not exceed the target levels described in Table 3-3.

Risk management alternatives for sites in this grouping will emphasize source removal, active remediation, and short remedial timeframes.

Table 3-3. Target Levels For Ground Water Ingestion

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
Acenaphthene	6.26E-01	Risk-Based
Acenaphthylene	6.26E-01	Risk-Based
Acetochlor	2.09E-01	Risk-Based
Acetone	9.39E-00	Risk-Based
Acrolein	5.21E-03	Risk-Based
Acrylonitrile	1.03E-04	Risk-Based
Alachlor	2.00E-03	MCL
Aldicarb	1.04E-02	Risk-Based
Aldrin	3.29E-06	Risk-Based
Ammonia i	NA	
Aniline	9.80E-03	Risk-Based
Anthracene	3.13E-00	Risk-Based
Antimony	6.00E-03	MCL
Aroclor 1016	7.30E-04	Risk-Based
Aroclor 1221	2.79E-05	Risk-Based
Aroclor 1242	2.79E-05	Risk-Based
Aroclor 1248	2.79E-05	Risk-Based
Aroclor 1254	2.09E-04	Risk-Based
Aroclor 1260	2.79E-05	Risk-Based
Arsenic	1.00E-02	MCL
Atrazine	3.00E-03	MCL
Azobenzene	5.08E-04	Risk-Based
Barium	2.00E-00	MCL
Benzene	5.00E-03	MCL
Benzidine	2.43E-07	Risk-Based

Table 3-3 (cont'd)

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
Benzo(a)anthracene	7.65E-05	Risk-Based
Benzo(a)pyrene	2.00E-04	MCL
Benzo(b)fluoranthene	7.65E-05	Risk-Based
Benzo(g,h,i)perylene	3.13E-01	Risk-Based
Benzo(k)fluoranthene	7.65E-04	Risk-Based
Benzoic acid	4.17E+01	Risk-Based
Benzyl alcohol	3.13E-00	Risk-Based
Beryllium	4.00E-03	MCL
BHCb-alpha	8.87E-06	Risk-Based
BHC-beta	3.10E-05	Risk-Based
BHC-gamma(Lindane)	4.30E-05	Risk-Based
Bis(2-chloroethyl)ether	5.08E-05	Risk-Based
Bis(2-chloroisopropyl)ether	4.17E-01	Risk-Based
Bis(2-ethylhexyl)phthalate	6.00E-03	MCL
Bromodichloromethane	9.01E-04	Risk-Based
Bromoform	7.07E-03	Risk-Based
Bromomethane	1.46E-02	Risk-Based
4- Bromophenylphenylether	3.72E-06	Risk-Based
2-Butanone (Methyl Ethyl Ketone)	6.26E-00	Risk-Based
Butyl Benzyl Phthalate	2.09E-00	Risk-Based
Cadmium	5.00E-03	MCL
Carbofuran	4.00E-02	MCL
Carbon disulfide	1.04E-00	Risk-Based
Carbon Tetrachloride	5.00E-03	MCL
Chlordane	2.00E-03	MCL
4-Chloroaniline	4.17E-02	Risk-Based

Table 3-3 (cont'd)

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
Chlorobenzene	1.00E-01	MCL
Chloroethane	1.93E-02	Risk-Based
Chloroform	1.80E-03	Risk-Based
Chloromethane	4.30E-03	Risk-Based
2-Chloronaphthalene	8.34E-01	Risk-Based
2-Chlorophenol	5.21E-02	Risk-Based
2-Chlorotoluene	2.09E-01	Risk-Based
Chlorpyrifos	3.13E-02	Risk-Based
Chromium (III) total Chromium	1.00E-01	MCL
Chromium (VI)	3.13E-02	Risk-Based
Chrysene	7.65E-03	Risk-Based
Copper	1.30E-00	MCL
Cyanide (as Sodium Cyanide)	2.00E-01	MCL
Dacthal	1.04E-01	Risk-Based
Dalapon (2,2-dichloropropionic acid)	2.00E-01	MCL
DDDc	2.33E-04	Risk-Based
DDEd	1.64E-04	Risk-Based
DDTe	1.64E-04	Risk-Based
Demeton	4.17E-04	Risk-Based
Dibenzo(a,h)anthracene	7.65E-06	Risk-Based
Dibenzofuran	4.17E-02	Risk-Based
Dibromochloromethane	6.65E-04	Risk-Based
1,2-Dibromo-3-chloropropane	2.00E-04	MCL
1,2-Dichlorobenzene	6.00E-01	MCL
1,3-Dichlorobenzene	9.39E-03	Risk-Based
1,4-Dichlorobenzene	7.50E-02	MCL

Table 3-3 (cont'd)

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
3,3-Dichlorobenzidine	1.24E-04	Risk-Based
Dichlorodifluoromethane	2.09E-00	Risk-Based
1,1-Dichloroethane	1.04E-00	Risk-Based
1,2-Dichloroethane	5.00E-03	MCL
1,1-Dichloroethene	7.00E-03	MCL
1,2-Dichloroethene-(cis)	7.00E-02	MCL
1,2-Dichloroethene-(trans)	1.00E-01	MCL
1,2-Dichloropropane	5.00E-03	MCL
1,3-Dichloropropene-(cis)	5.59E-04	Risk-Based
1,3-Dichloropropene-(trans)	5.59E-04	Risk-Based
2,4-Dichlorophenol	3.13E-02	Risk-Based
2,4-Dichlorophenoxyacetic acid	1.04E-01	Risk-Based
Dieldrin	3.49E-06	Risk-Based
2,4-Dimethylphenol	2.09E-01	Risk-Based
Diethylphthalate	8.34E-00	Risk-Based
Dimethylphthalate	1.04E+02	Risk-Based
Di-n-butyl phthalate	1.04E-00	Risk-Based
2,4-Dinitro-6-sec-butylphenol (Dinoseb)	7.00E-03	MCL
2,4-Dinitrophenol	2.09E-02	Risk-Based
2,4-Dinitrotoluene	8.22E-05	Risk-Based
2,6-Dinitrotoluene	8.22E-05	Risk-Based
Di-n-octyl phthalate	4.17E-01	Risk-Based
1,2-Diphenylhydrazine	6.98E-05	Risk-Based
Diquat	2.00E-02	MCL
Diuron	2.09E-02	Risk-Based
Disulfoton	4.17E-04	Risk-Based

Table 3-3 (cont'd)

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
Endosulfan	6.26E-02	Risk-Based
Endothall	1.00E-01	MCL
Endrin	2.00E-03	MCL
Eptam	2.61E-01	Risk-Based
Ethylbenzene	7.00E-01	MCL
Ethylene Dibromide	5.00E-05	MCL
Fluoranthene	4.17E-01	Risk-Based
Fluorene	4.17E-01	Risk-Based
Fluoride (as Sodium Fluoride)	4.00E-00	MCL
Glyphosate	7.00E-01	MCL
Heptachlor	4.00E-04	MCL
Heptachlor Epoxide	2.00E-04	MCL
Hexachlorobenzene	1.00E-03	MCL
Hexachlorobutadiene	7.16E-04	Risk-Based
Hexachloroethane	3.99E-03	Risk-Based
Hexachlorocyclopentadiene	5.00E-02	MCL
Hexazinone	3.44E-01	Risk-Based
Hydrogen Sulfide	3.13E-02	Risk-Based
Indeno(1,2,3-cd)pyrene	7.65E-05	Risk-Based
Iron (as Iron Oxide)	3.13E-00	Risk-Based
Isophorone	5.88E-02	Risk-Based
Isopropylbenzene (Cumene)	1.04E-00	Risk-Based
Lead	1.50E-02	MCL
Manganese	2.50E-01	Risk-Based
Mercury	2.00E-03	MCL
Methoxychlor	4.00E-02	MCL

Table 3-3 (cont'd)

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
Methylene Chloride	7.45E-03	Risk-Based
Metolachlor	1.56E-00	Risk-Based
Metribuzin	2.61E-01	Risk-Based
2-Methylnaphthalene	4.17E-02	Risk-Based
4-Methyl-2-pentanone	8.34E-01	Risk-Based
2-Methylphenol	5.21E-01	Risk-Based
4-Methylphenol	5.21E-02	Risk-Based
MTBEf	1.69E-02	Risk-Based
Naphthalene	2.09E-01	Risk-Based
Nickel	2.09E-01	Risk-Based
Nitrate (as Sodium Nitrate)	1.00E+01	MCL
Nitrite (as Sodium Nitrite)	1.00E-00	MCL
2-Nitroaniline	3.13E-02	Risk-Based
3-Nitroaniline	1.47E-03	Risk-Based
4-Nitroaniline	1.47E-03	Risk-Based
Nitrobenzene	5.21E-03	Risk-Based
4-Nitrophenol	8.34E-02	Risk-Based
N-Nitrosodimethylamine	1.10E-06	Risk-Based
N-Nitrosodi-n-propylamine	7.98E-06	Risk-Based
N-Nitrosodiphenylamine	1.14E-02	Risk-Based
Oxamyl (Vydate)	2.00E-01	MCL
Pentachlorophenol	1.00E-03	MCL
Phenanthrene	3.13E-01	Risk-Based
Phenol	3.13E-00	Risk-Based
Picloram	5.00E-01	MCL
Prometon	1.56E-01	Risk-Based

Table 3-3 (cont'd)

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
Pyrene	3.13E-01	Risk-Based
sec-Butylbenzene	1.04E-01	Risk-Based
Selenium	5.00E-02	MCL
Silver	5.21E-02	Risk-Based
Simazine	4.00E-03	MCL
Styrene	1.00E-01	MCL
2,3,7,8-TCDDg	3.00E-08	MCL
Terbutryn	1.04E-02	Risk-Based
tert-Butylbenzene	1.04E-01	Risk-Based
1,1,1,2-Tetrachloroethane	2.15E-03	Risk-Based
1,1,2,2-Tetrachloroethane	2.79E-04	Risk-Based
Tetrachloroethene	5.00E-03	MCL
Thallium	2.00E-03	MCL
Toluene	1.00E-00	MCL
Total Xylenes	1.00E+01	MCL
Toxaphene	3.00E-03	MCL
2,4,5 TPh (silvex)	5.00E-02	MCL
1,2,4-Trichlorobenzene	7.00E-02	MCL
1,1,1-Trichloroethane	2.00E-01	MCL
1,1,2-Trichloroethane	5.00E-03	MCL
Trichloroethene	5.00E-03	MCL
Trichlorofluoromethane	3.13E-00	Risk-Based
2,4,5-Trichlorophenol	1.04E-00	Risk-Based
2,4,6-Trichlorophenol	1.04E-03	Risk-Based
1,2,3-Trichloropropane	7.98E-06	Risk-Based
1,2,4-Trimethylbenzene (pseudocumene)	5.21E-01	Risk-Based

Table 3-3 (cont'd)

CHEMICALS OF CONCERN	Target Level [mg/L]	MCLa or Risk-Based?
1,3,5-Trimethylbenzene	5.21E-01	Risk-Based
2,4,6-Trinitrotoluene	1.86E-03	Risk-Based
Vinyl Chloride	2.00E-03	MCL
Zinc	3.13E-00	Risk-Based

a Maximum contaminant level
b Benzene hexachloride
c DDD
d DDE
e DDT
f Methyl tert-butyl Ether
g TCDD
h TP Silvex
i Not available; no ingestion toxicological data.

3.8.3.2 Ground Water with a Low Probability of Future Use for Drinking Water

Ground water may or may not meet the water quality and yield criteria described in Sections 3.8.2.1 and 3.8.2.2. To qualify as having a low probability of future use for drinking water, all the following conditions must be met:

- The plume is not in a delineated source water assessment area, designated source water protection area, or the recharge/capture zone of a private well used for domestic purposes,
- There is no current or documented historical use of the ground water for drinking water purposes within a 0.5-mile radius of the impacted area, and
- There is an established alternative drinking water supply for the area (e.g., from city, surface water, or deep aquifer sources) for which the release in question can be shown to have no current or potential future impacts.

Target POE concentrations for ground water in this group will be based on the most limiting concentrations determined from evaluation of complete or potentially complete pathways other than ground water ingestion. These pathways may include indoor or outdoor inhalation of vapors volatilized from ground water, ground water impacts to surface water, impacts to deeper ground water systems with the potential for use as drinking water supplies as well as incidental ingestion and dermal exposure from irrigation water. Also included is potential impairment of other beneficial uses of groundwater such as for agricultural or industrial water supplies. For chemicals which have natural as well as anthropogenic sources (such as metals and nutrients) background concentrations of these compounds will also need to be considered in developing limiting concentrations.

The applicable POE will be based on the location of the plume (on-site vs. off-site) and which pathway(s) and receptors are limiting with respect to risk and allowable groundwater concentration. In many cases, particularly if a plume has migrated off-site, there may be multiple POE that will need to be considered. For example, a VOC plume may have migrated off-site into a residential area and has the potential to discharge to a downgradient stream. Source area groundwater concentrations on-site must be controlled such that concentrations at the POE where groundwater discharges to the stream meets applicable criteria. In addition, residential indoor inhalation criteria must be met at the downgradient boundary of the source property and commercial indoor inhalation criteria for on-site POE.

Risk management plans must also include provisions in the final remedy to implement institutional controls to prevent exposure via ground water ingestion throughout the horizontal and vertical extent of the plume that exceeds the concentrations for ground water presented in Table 3-3. These controls must remain in place until it can be demonstrated to DEQ that concentrations are adequate to allow the unrestricted use of the ground water as a source of drinking water.

3.8.4 Additional Requirements

To insure adequate protection of human health and the environment, additional requirements will need to be met in all cases for each grouping (ground water likely or unlikely to be used for drinking water). These requirements involve monitoring plume dynamics and notification requirements.

3.8.4.1 Plume Dynamics

DEQ will require documentation, acquired through ground water monitoring, that the plume is shrinking in size and that COC concentrations in all wells in the impacted plume are decreasing. This ensures that, in time, the overall quality of the aquifer will improve, and that plumes contained within the boundaries of a large property will not increase in size and further degrade ground water. There may be situations where an expanding plume may be acceptable. For example, where source control measures have been implemented, plume dimensions may continue to expand, but constituent concentrations are decreasing. This may be the case with certain chlorinated solvent plumes where biodegradation processes are not present. These situations will be evaluated on a case-by-case basis.

At least one well downgradient of the source area, typically located at the property boundary, must be monitored on a regular basis during the course of remediation to demonstrate the absence of plume migration and that concentrations are decreasing. For plumes contained within the boundaries of large properties, this monitoring location may be on site. Remedial actions performed under specific programs may have different monitoring requirements. Check with the DEQ program for specific monitoring requirements.

3.8.4.2 Notification

In all cases, regardless of the ground water grouping, if a chemical release has impacted or has the potential to impact ground water off of the source property, all potentially affected off-site landowners should be notified in writing. Notification procedures are described in Section 3.16.

3.9 DEVELOPING RATL-1 AND RATL-2 TARGET CONCENTRATIONS FOR GROUND WATER INGESTION

The RATL-1 and RATL-2 target concentrations for ground water ingestion in aquifers with a high probability of future use for drinking water are equivalent to the federal MCLs or a risk-based calculated equivalent. MCLs are health-protective target concentrations promulgated by the EPA and adopted by the state of Idaho for the protection of drinking water and specified ground water resources.

For COCs with MCL, the RATL-1 and RATL-2 concentrations for ground water ingestion are equal to the MCL.

For COCs without MCLs, the risk-based equivalent levels for RE-1 and RE-2 are calculated using the following input values and equations:

- A target risk level of $1x10^{-6}$ for carcinogenic effects and an HQ of 1 for non-carcinogenic effects,
- The residential exposure factors in Table 3-2,
- The toxicity values in Appendix D, and
- Equations for the direct ingestion of water.

Calculations are made for child, adolescent, adult, and age-adjusted residential receptors and the lowest value is selected.

These groundwater concentrations for the COCs for ground water ingestion in high probability of use aquifers are listed in Table 3-3.

While performing site-specific evaluations under this process, the potential impacts to deeper aquifers must also be evaluated. In some cases, qualitative evaluation based on the vertical flow gradients may be sufficient; however, in other cases quantitative evaluation of potential vertical migration of COCs may be necessary. Such cases will be evaluated under RE-2.

3.10 SURFACE WATER PROTECTION

Potential impacts to streams and other surface waterbodies from a release must be evaluated and surface water quality must be protected as per IDAPA 58.01.02 (Water Quality Standards and Wastewater Treatment Requirements). The primary receptors and ROE for potentially impacted surface waters that will be evaluated in the risk evaluation process are described in Sections 3.3 and 3.4. Other ROE, such as contact with contaminated sediments or overland flow discharge, will be evaluated on a case-by-case basis.

This section describes the evaluation of potential impacts to surface water via discharge of impacted ground water to a surface waterbody. Sampling for COCs in surface waterbodies may be necessary when COC migration is known or suspected to affect a surface waterbody.

Within the risk evaluation process, protection of surface waterbodies requires the responsible party to determine or calculate the applicable surface water standards at the point where ground water discharges into a surface waterbody (C_{swpoe}). This determination is described below. Once the appropriate surface water standard is determined, compliance with the standard may be achieved in a number of ways. These include measuring surface water concentrations at the point of ground water discharge, measuring ground water concentrations at the point of discharge into the surface waterbody, or determining appropriate alternate concentrations in other media and at POC locations. Alternate concentrations (or RATL-1/RATL-2 levels) and POC locations can include:

- Source area soils (C_{soil}), or
- Compliance points in ground water at different distances between the surface water and the source (C_{cw}) other than the point where ground water discharges into the surface waterbody.

These concentrations and locations are schematically shown in Figure 3-2. The selection of these alternate locations may be most appropriate for those sites where contamination has not yet reached a surface waterbody.

The responsible party can back-calculate allowable soil (C_{soil}) and compliance well concentrations (C_{cw}) using the concept of dilution attenuation factors (DAFs). Specific equations, combining the Summer's mixing model and the Domenico analytical ground water transport model, are presented in Appendix H. If measured concentration(s) at the soil source or the compliance well exceeds corresponding allowable concentrations, cleanup to RATL-1/RATL-2 levels or performance of a more detailed, site-specific evaluation to refine DAFs are the available options.

Soil and ground water concentrations discussed above apply to the protection of surface water. Other ROEs from ground water, such as ingestion and inhalation of volatiles, must also be evaluated as part of the process. Cleanup criteria based on these ROEs may result in RATL-1/RATL-2 levels lower than those required for the protection of surface water.

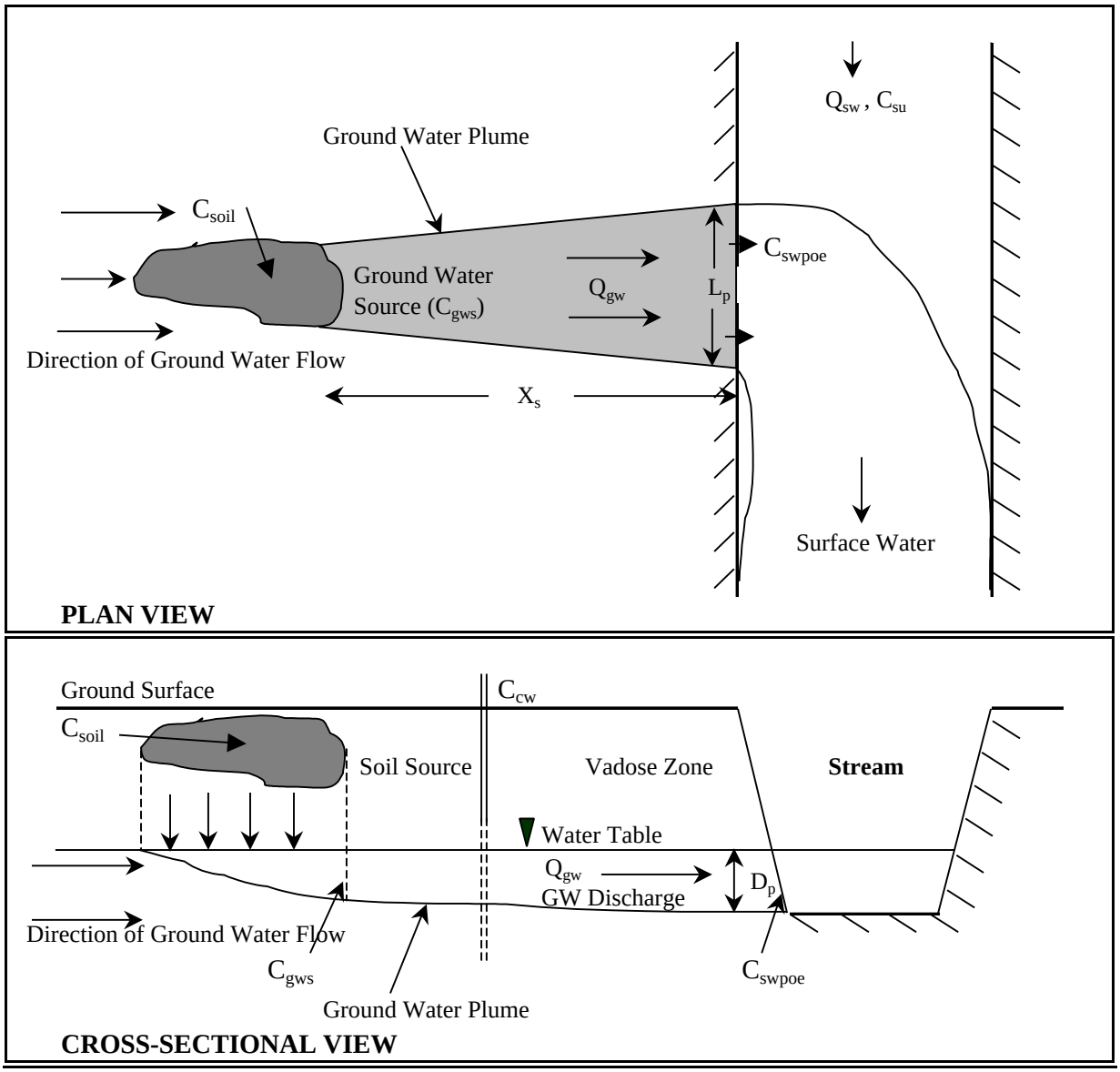
3.10.1 Surface Water Quality Standards

The allowable concentration at the point of ground water discharge into the surface water (C_{swpoe}), or the surface water quality standard, depends on the beneficial use designation of the surface waterbody as per IDAPA 58.01.02.100 and criteria assigned to protect those beneficial uses (IDAPA 58.01.02.200-250).

As described in Table 3-4, beneficial uses include:

- **Aquatic life:** Cold water, salmonid spawning, seasonal cold water, warm water, or modified.
- **Recreation:** Primary contact or secondary contact.
- **Water supply:** Domestic, agricultural, or industrial.

Each beneficial use has associated numerical and narrative criteria. Numerical criteria are specified values that are not to be exceeded. For narrative criteria, amounts of the pollutant are not specified, but must be low enough to ensure no impacts to the beneficial use. Numerical criteria associated with aquatic life uses include, but are not limited to, standards for dissolved oxygen, temperature, ammonia, and other toxic substances. Numerical criteria for recreation uses include standards for bacterial contamination and toxic substances. For domestic water supply uses, sediment, radioactive materials, and toxic substances constitute the primary numerical criteria categories. Narrative criteria, which apply to all beneficial uses, include hazardous, deleterious, and radioactive materials, toxic substances, excess nutrients, sediment, floating, suspended, or submerged matter, and oxygen-demanding materials.



Explanation of Symbols

Q_{sw} = Stream flow upstream of the point of ground water discharge[ft^3/day]
C_{su} = Concentration upstream of the ground water discharge [ft^3/day]
Q_{gw} = Impacted ground water discharge into the stream [ft^3/day]
C_{sw} = Allowable downstream concentration after uniform mixing [mg/L]
C_{swpoe} = Allowable concentration at the point of ground water discharge to the stream [mg/L]
C_{gws} = Allowable concentration in the ground water at the edge of the soil source [mg/L]
C_{soil} = Allowable soil concentration at the source protective of the stream [mg/kg]
C_{cw} = Allowable soil concentration in ground water at different distances between the stream and the source [mg/L]
L_p = Width of ground water plume discharging to the stream [ft]
D_p = Thickness of ground water plume discharging to the stream [ft]
X_s = Distance from the downgradient edge of the ground water source to the stream [ft]

Figure 3-2. Schematic of Leachate Migration from the Soil Source to the Stream

Table 3-4. Surface Water Designation And Numeric Criteria

DESIGNATION	NUMERIC CRITERIA
I AQUATIC LIFE Cold water (COLD): water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species. Salmonid spawning (SS): waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes. Seasonal cold water (SC): water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species, where cold water aquatic life may be absent during, or tolerant of, seasonably warm temperatures. Warm water (WARM): water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species. Modified (MOD): water quality appropriate for an aquatic life community that is limited to one or more conditions set forth in 40 CFR 131.10(g) which precludes attainment of reference streams or conditions.	All aquatic life uses have numeric criteria for toxic substances, pH, total dissolved gas, total residual chlorine, dissolved oxygen, temperature, and ammonia. Toxic Substances: The surface water standards (see Table 3-5) define the criteria for fresh water (maximum concentrations) [B1], (continuous exposure) [B2], and for human health for consumption of organisms only (D2).
II RECREATION Primary contact recreation (PCR): water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities is likely to occur. Such activities include, but are not restricted to, those used for swimming, water skiing, or skin diving.	*E. coli*: Single sample not to exceed 406 organisms/100mL; geometric mean of a minimum of 5 samples taken within 30 days not to exceed 126 organisms/100mL. Toxic substances: Use Column D2 (Human Health for Consumption of Organisms Only) of Table 3-5

DESIGNATION	NUMERIC CRITERIA
II RECREATION (continued)	
Secondary contact recreation (SCR): water quality appropriate for recreationaluses on or about the water and which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur.	*E. coli*: Single sample not to exceed 576 organisms/100mL;geometric mean of a minimum of 5 samples taken within 30 days not to exceed 126 organisms/100mL. Toxic substances: Use Column D2 (Human Health for Consumption of Organisms Only) of Table 3-5
III WATER SUPPLY	
Domestic: water quality appropriate for drinking water supplies.	Domestic water supply: Protected under radioactive, and turbidity criteria (IDAPA 58.01.02.252), and toxic substance numeric criteria. Toxic substances: Use Column D1 of Table 3-5 for domestic water supplies.
Agricultural: water quality appropriate for the irrigation of crops or as drinking water for livestock. This use applies to all surface waters of the state.	Contact DEQ for appropriate numeric criteria.
Industrial: water quality appropriate for industrial water supplies. This use applies to all surface waters of the state.	Contact DEQ for appropriate numeric criteria.

The allowable concentrations for certain toxic substances associated with these beneficial uses are tabulated in Table 3-5. Criteria B1, B2, and D2 apply to any aquatic life or recreation use, while the water and organisms human health criteria (D1) only apply to domestic water supply uses.

For substances with more than one criterion, the most protective value must not be exceeded in the surface water. For chemicals that are not included in Table 3-5, narrative criteria are used to determine if there is harm to beneficial uses. On a site-by-site basis, specific surface water standards may also be developed by DEQ for any COC.

3.10.2 Total Maximum Daily Loads

In addition to surface water quality standards, specific surface waters may receive additional levels of protection associated with a total maximum daily load (TMDL). Total maximum daily loads are specific water pollution control plans developed to resolve existing or potential water quality problems. These plans set pollutant load allocations for the surface water in question. Any additional loading resulting from seepage of contaminated ground water may result in additional controls being set forth in those plans.

It may be determined that a discharge of treated ground water to surface water is necessary as a part of the remediation process. In such cases, the surface water discharge would require appropriate regulation and permitting, possibly including establishing a mixing zone as per IDAPA 58.01.02.060.

TABLE 3-5. SURFACE WATER STANDARDS

Chemical of Concern	Fresh Water (B)		Human Health (D) ($1x10^{-6}$ Risk for Carcinogens) for Consumption Of:	
	Criterion Maximum Concentration (B1) [ug/L]	Criterion Continuous (B2) [ug/L]	Water and Organisms (D1) [ug/L]	Organisms Only (D2) [ug/L]
Antimony			14	4300
Arsenic, dissolved	360	190	50	50
Berylium				
Cadmium, dissolved[a]	$(CVC)e^{(1.128(lnH)-3.828)}$	$(CVC)e^{(0.7852(lnH)-3.49)}$		
Chromium (III), dissolved	$(0.316)e^{(0.819(lnH)+3.688)}$	$(0.86)e^{(0.819(lnH)+1.561)}$		
Chromium (IV), dissolved	15	10		
Copper, dissolved	$(0.96)e^{(0.9422(lnH)-1.464)}$	$(0.96)e^{(0.8545(lnH)-1.465)}$		
Lead, dissolved[b]	$(CVL)e^{(1.273(lnH)-1.46)}$	$(CVL)e^{(1.273(lnH)-4.705)}$		
Mercury, dissolved	2.1	0.012	0.14	0.15
Nickel, dissolved	$(0.998)e^{(0.846(lnH)+3.3612)}$	$(0.997)e^{(0.846(lnH)+1.1645)}$	610	4600
Selenium	18 (dissolved)	5 (total recoverable)		
Silver, dissolved	$(0.85)e^{(1.72(lnH)-6.52)}$			
Thallium			1.7	6.3
Zinc, dissolved	$(0.978)e^{(0.8473(lnH)+0.8604)}$	$(0.986)e^{(0.8473(lnH)+0.7614)}$		
Cyanide, wad	22	5.2	700	220000
Asbestos		7000000 fibres/L		
2,3,7,8-TCDD[c] (Dioxin)			0.000000013	0.000000014
Acrolein			320	780
Acrylonitrile			0.059	0.66
Benzene			1.2	71
Bromoform			4.3	360
Carbon tetrachloride			0.25	4.4
Chlorobenzene			680	21000
Chlorodibromoethane			0.41	34
Chloroethane				
2-Chloroethylvinyl ether				
Chloroform			5.7	470
Dichlorobromomethane			0.27	22
1,1-Dichloroethane				
1,2-Dichloroethane			0.38	99
1,1-Dichloroethylene			0.057	3.2
1,2-Dichloropropane				
1,3-Dichloropropylene			10	1700
Ethylbenzene			3100	29000
Methyl bromide			48	4000
Methyl chloride				
Methylene chloride			4.7	1600
1,1,2,2-Tetrachloroethane			0.17	11
Tetrachloroethylene			0.8	8.85

TABLE 3-5. SURFACE WATER STANDARDS (CON'T)

Chemical of Concern	Fresh Water (B)		Human Health (D) ($1x10^{-6}$ Risk for Carcinogens) for Consumption Of:	
	Criterion Maximum Concentration (B1) [ug/L]	Criterion Continuous (B2) [ug/L]	Water and Organisms (D1) [ug/L]	Organisms Only (D2) [ug/L]
Toluene			6800	200000
1,2-trans-Dichloroethylene				
1,1,1-Trichloroethane				
1,1,2-Trichloroethane			0.6	42
Trichloroethylene			2.7	81
Vinyl chloride			2	525
2-Chlorophenol				
2,4-Dichlorophenol			93	790
2,4-Dimethylphenol				
2-Methyl-4,6-dinitrophenol			13.4	765
2,4-Dinitrophenol			70	14000
2-Nitrophenol				
4-Nitrophenol				
3-Methyl-4-chlorophenol				
Pentachlorophenol	$e^{(1.005(pH)-4.83)}$	$e^{(1.005(pH)-5.29)}$	0.28	8.2
Phenol			21000	4600000
2,4,6-Trichlorophenol			2.1	6.5
Acenaphthene				
Acenaphthylene				
Anthracene			9600	110000
Benzidine			0.00012	0.00054
Benzo(a) anthracene			0.0028	0.031
Benzo(a) pyrene			0.0028	0.031
Benzo(b) fluoranthene			0.0028	0.031
Benzo(g,h,I) perylene				
Benzo(k) fluoranthene			0.0028	0.031
Bis(2-chloroethoxy) methane				
Bis(2-chloroethyl) ether			0.031	1.4
Bis(2-chloroisopropyl) ether			1400	170000
Bis(2-ethylhexyl) phthalate			1.8	5.9
4-Bromophenyl phenyl ether				
Butylbenzyl phthalate				
2-Chloronaphthalene				
4-Chlorophenyl phenyl ether				
Chrysene			0.0028	0.031
Dibenzo(a,h) anthracene			0.0028	0.031
1,2-Dichlorobenzene			2700	17000
1,3-Dichlorobenzene			400	2600
1,4-Dichlorobenzene			400	2600
3,3'-Dichlorobenzidine			0.04	0.077

TABLE 3-5. SURFACE WATER STANDARDS (CON'T)

Chemical of Concern	Fresh Water (B)		Human Health (D) ($1x10^{-6}$ Risk for Carcinogens) for Consumption Of:	
	Criterion Maximum Concentration (B1) [ug/L]	Criterion Continuous (B2) [ug/L]	Water and Organisms (D1) [ug/L]	Organisms Only (D2) [ug/L]
Diethyl phthalate			23000	120000
Dimethyl phthalate			313000	2900000
Di-n-butyl phthalate			2700	12000
2,4-Dinitrotoluene			0.11	9.1
2,6-Dinitrotoluene				
Di-n-octyl phthalate				
1,2-Diphenylhydrazine			0.04	0.54
Fluoranthene			300	370
Fluorene			1300	14000
Hexachlorobenzene			0.00075	0.00077
Hexachlorobutadiene			0.44	50
Hexachlorocyclopentadiene			240	17000
Hexachloroethane			1.9	8.9
Indeno(1,2,3-cd) pyrene			0.0028	0.031
Isophorone			8.4	600
Naphthalene				
Nitrobenzene			17	1900
N-Nitrosodimethylamine			0.00069	8.1
N-Nitrosodi-n-propylamine				
N-Nitrosodiphenylamine			5	16
Phenanthrene				
Pyrene			960	11000
1,2,4-trichlorobenzene				
Aldrin	3		0.00013	0.00014
alpha-BHC[d]			0.0039	0.013
beta-BHC			0.014	0.046
gamma-BHC	2	0.08	0.019	0.063
delta-BHC				
Chlordane	2.4	0.0043	0.00057	0.00059
4-4'-DDT[e]	1.1	0.001	0.00059	0.00059
4,4'-DDE[f]			0.00059	0.00059
4,4'-DDD[g]			0.00083	0.00084
Dieldrin	2.5	0.0019	0.00014	0.00014
alpha-Endosulfan	0.22	0.056	0.93	2
beta-Endosulfan	0.22	0.056	0.93	2
Endosulfan sulfate			0.93	2
Endrin	0.18	0.0023	0.76	0.81
Endrin aldehyde			0.76	0.81
Heptachlor	0.52	0.0038	0.00021	0.00021
Heptachlor epoxide	0.52	0.0038	0.0001	0.00011

TABLE 3-5. SURFACE WATER STANDARDS (CON'T)

Chemical of Concern	Fresh Water (B)		Human Health (D) ($1x10^{-6}$ Risk for Carcinogens) for Consumption Of:	
	Criterion Maximum Concentration (B1) [ug/L]	Criterion Continuous (B2) [ug/L]	Water and Organisms (D1) [ug/L]	Organisms Only (D2) [ug/L]
PCBs[h]		0.014	0.00017	0.00017
Toxaphene	0.73	0.0002	0.00073	0.00075

[a](CVC) = cadmium conversion factors: acute = 1.136672-(lnH x 0.041838) chronic = 1.101672-(lnH x 0.041838)

[b](CVL) = lead conversion factor: acute and chronic = 1.46203-(lnH x 0.145712) H = hardness (mg/l as $CaCO_3$)

[c] Tetrachloro di benzo-p-dioxin

[d] Benzene hexachloride

[e] Dichloro diphenyl trichloroethane

[f] Dichloro diphenyl dichloroethylene

[g] 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethane

[h] Polychlorinated biphenyl

3.11 ESTIMATING POINT OF COMPLIANCE WELL CONCENTRATIONS

As a part of the risk evaluation process, it is necessary to designate and monitor appropriate POCs. The POCs, located onsite and/or offsite, are used to provide additional assurance that approved concentrations at a selected POE are not exceeded. Monitoring of POC locations is required, and data obtained must be used to compare with approved RATL-1/RATL-2 concentrations. Monitoring of POC locations must be continued until the concentrations stabilize below approved levels. Concentrations at the POC may also be used to determine the need for additional remedial activities.

3.12 MANAGEMENT AND CONTROL OF NUISANCE CONDITIONS

The risk evaluation process determines COC target levels appropriate for a site, and this determination is based primarily on protection of human health from problems due to chronic exposure. These calculations may not take into account nuisance conditions such as taste, odor, or visible staining of soils that do not impact health but may impair the use or enjoyment of resources. When evaluating the necessity of remedial action with respect to a release, DEQ may require mitigation of nuisance conditions. As such, corrective action plans presented by responsible parties should include provisions for mitigating nuisance conditions.

3.13 ECOLOGICAL EXPOSURE

Exposures to ecological receptors, threatened and endangered species, and habitats such as wetlands and other sensitive environments must be thoroughly evaluated. Where an ecological threat may exist due to a release, the responsible party must perform an ecological evaluation as part of a RE-1 or RE-2 evaluation. Note that within the risk evaluation process, protection of surface waters and streams is independent of ecological risk evaluation.

3.14 DOCUMENTING THE RISK EVALUATION PROCESS

The risk evaluation for a site must be clearly and concisely documented and submitted to DEQ for review. An example outline of a risk evaluation report is presented in Appendix I.

3.15 INSTITUTIONAL CONTROLS AS PART OF REMEDIAL ACTION

An institutional control is a legal or administrative tool or action taken to reduce the potential for exposure to contaminants at a release site. For purposes of this guidance, there are two categories of institutional controls: remedial action and non-remedial action. Those controls that are selected or approved by DEQ through the risk evaluation process to limit exposure to contamination at a release site are remedial action institutional controls. Other governmentally-imposed land use restrictions (e.g., local zoning ordinances), which may serve the purpose of limiting human exposure to a chemical release, but which may change or be removed absent DEQ approval, are non-remedial action institutional controls. While non-remedial action institutional controls are not reviewed and approved by DEQ as part of a RMP, they may be relevant to evaluating current and reasonably likely future use and exposure scenarios at a site.

3.15.1 Remedial Action Institutional Controls

The tool used by DEQ as a remedial action institutional control to restrict property uses is an Equitable Servitude and Conservation Easement (Servitude). A Servitude is a written agreement entered into by the responsible party and DEQ for on-site use restrictions.

A Servitude can be implemented on surrounding impacted property(ies) only when the owner(s) of the impacted property(ies) enter into the Servitude. Servitudes must be recorded in the county property records for the impacted property(ies). Responsible parties may propose a Servitude(s) as part of the RMP. When reviewing proposed Servitude language, DEQ will consider a number of factors, including, but not limited to, effectiveness, enforceability, long-term reliability, implementability, implementation risk, and reasonableness of cost. Servitude language is considered and approved on a case-by-case basis.

Following is a non-exclusive list of the types of use restrictions, or affirmative actions, that may be agreed to in a Servitude.

Restrictions on Water Use:

- Prohibit use
- Limit use
- Monitor use
- Prohibit well installation and operation
- Abandon an existing well.

Restrictions on Land Use:

- Prohibit, or require DEQ approval for, disturbance of soil, cap, or vegetation
- Limit activities and land use
- Limit structures and buildings.

Actions Regarding Access:

- Grant DEQ access
- Limit or deny public access.

DEQ has prepared model Servitude language for use by a responsible party proposing the use of a remedial action institutional control as part of a RMP. The model Servitude language can be found in Appendix B.

3.15.2 Use of Remedial Institutional Controls on Impacted Neighboring Properties

Implementability and enforceability issues are complicated when a responsible party proposes use of a remedial action institutional control on impacted neighboring properties. When proposing such a control, the responsible party must negotiate language with both DEQ and the impacted party.

Often, depending on restrictions, multiple agreements may be needed, and the responsible party may have to compensate the impacted innocent party. Due to these and other related issues, as a general rule, DEQ generally discourages the sole use of remedial action institutional controls to address impacted neighboring properties unless complemented by active engineering remedial actions.

3.15.3 Non-Remedial Action Institutional Controls

As stated above in Section 3.15, many institutional controls are not reviewed and approved by DEQ in the risk evaluation process, but already exist, and are typically implemented by other governmental agencies. The presence of such non-remedial action institutional controls may be relevant when determining the current and likely future uses of impacted properties. Examples of non-remedial institutional controls include, but are not limited to, the following:

- City and County Zoning Ordinances,
- Idaho Department of Water Resources “Ground Water Area of Drilling Concern” (IDAPA 37.03.09.040),
- Source Water Protection Areas,

- Idaho Department of Water Resources "Critical Ground Water Areas" (Section 42-233a Idaho Code), and
- Idaho Department of Water Resources "Ground Water Management Areas" (Section 42-233b Idaho Code).

3.16 NOTIFICATION REQUIREMENT

In DEQ's experience, investigation into and remediation of environmental releases is most successful when responsible parties keep impacted and potentially impacted parties in the vicinity of the release informed of the decision-making process. It is helpful to have these parties kept informed as to the extent of contamination and the actions the responsible party, with DEQ oversight, is taking to assure protection of human health and the environment. Accordingly, in addition to complying with the release reporting requirements (reporting to DEQ) discussed in Section 1.3.1 of this Guidance, DEQ recommends responsible parties notify impacted and potentially impacted parties as follows.

Responsible parties should immediately notify property owners when it is determined contamination has migrated off-site and the contamination presents an imminent and substantial endangerment or emergency situation to an impacted property. To the maximum extent practicable without delaying the notification, the responsible party should provide information on the source of contamination, the COCs at issue, the rate of migration and the steps the responsible party is taking to avert further migration and to otherwise remedy the situation. The notification should also include a contact name and number where the impacted property owner may obtain additional information.

In situations where off-site contamination exists, when the responsible party submits an RMP to DEQ for review and approval, the responsible party should provide written notice to impacted and potentially impacted property owners that a RMP is under DEQ review.

In non-emergency situations, if the responsible party determines at anytime in the risk evaluation process that contamination has migrated off-site, the responsible party should notify both DEQ and the impacted property owner(s) within fourteen (14) days of confirming the off-site contamination. When complying with this recommendation, the responsible party should use the Notification of Contamination form located in Appendix J of this Guidance.

When contamination has not yet moved off site, but has the potential to do so in the future, within thirty (30) days of DEQ approval of the responsible party's site characterization report, the responsible party should notify all potentially impacted property owners of the contamination using the Notification of Contamination form located in Appendix J of this Guidance.

Responsible parties should be informed that, as determined appropriate on a case-by-case basis, DEQ may recommend that a responsible party provide impacted or potentially impacted parties with additional information beyond that described above. If a responsible party determines not to provide impacted or potentially impacted parties with information DEQ determines should be provided, DEQ reserves the right to provide the information.

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4.0 DATA REQUIREMENTS FOR THE RISK EVALUATION PROCESS

4.1 INTRODUCTION

This section describes general data collection objectives and requirements for the risk evaluation process, categories of data necessary to meet these objectives, and data collection techniques. Also included are discussions of development of a site conceptual model, a tool to guide the data collection planning process, and quality assurance/quality control considerations to help ensure the data collected is of sufficient quality and quantity to meet desired objectives.

Data collection objectives for risk evaluation include, but are not limited to:

- Accurately characterize the nature and extent of contamination, including the identification of maximum contaminant concentrations or representative concentrations for all media, as appropriate,
- Allow the development and validation of an accurate site conceptual model, and
- Develop sound estimates of risks posed by the release.

Depending on which step a given site is at in the risk evaluation process, the relative importance of each of these objectives and specific data requirements will vary. Details regarding minimum data requirements for each tier of evaluation in the risk evaluation process are presented in subsequent sections of this document: initial site characterization requirements for IDTL screening are presented in Section 7.0, RE-1 requirements in Section 9.0, and RE-2 requirements in Section 10.0.

4.2 SITE CONCEPTUAL MODEL

A site conceptual model provides a convenient format to compile all the relevant data and provides an overall understanding of the site. The SCM provides a framework for the entire project and, in particular, can help identify specific data needs. It is an important communication tool for regulators, responsible parties, and stakeholders. A basic SCM should be developed even for initial site characterization efforts that are intended for use in IDTL screening. A more extensive SCM is required for RE-1 and RE-2 evaluations, and it is necessary in the development of any work plan. The SCM should be revised as additional data is collected.

Early development of a SCM assists in collecting the correct quality and quantity of data. A SCM should include elements described in Sections 4.2.1 through 4.2.6.

4.2.1 Release Scenario and Distribution of Chemicals at the Site

This portion of the SCM should include a discussion of the nature, location, timing, size, and magnitude of products spilled at the site, the COCs should be determined. Based on the product released any actions performed as a part of emergency response should be described and their impact on the source discussed. Based on this step the residual size of the source should be determined.

4.2.2 Current and Potential Future Receptors

This portion of the SCM should describe the current and future land uses and the nature of activities at the site and near receptors of concern. Current land use should be determined based on a site visit. Future land use must be estimated based on zoning, the location of the property, and the general land development patterns around the site. The assumption of residential land use is the most conservative. This step should include a receptor survey including the location of all surface water bodies and water use wells near the site and utilities that may act as conduits for hemicals.

4.2.3 Site Stratigraphy and Hydrogeology

This section should include a brief discussion of regional geology and hydrogeology and a detailed discussion of site-specific stratigraphy and hydrogeology. Site stratigraphy should be determined based on boring logs and an adequate number of geologic cross sections. The hydrogeologic discussion should include estimates of horizontal and vertical hydraulic gradients, seasonal variations in flow direction and magnitude, and hydraulic conductivity of relevant water bearing zones. Ground water classification should be addressed.

4.2.4 Chemicals of Concern and Spatial and Temporal Trends

This section should include a discussion of chemicals detected in each media and their spatial and temporal distribution. As appropriate, contour maps of individual COCs at different times of the year and in different years should be presented. Graphs of COC ground water concentrations in individual wells and concentration along the flow line (concentration vs. distance plots) are useful. Based on data collected over time, it should be determined whether the ground water plume is stable, declining, or expanding.

4.2.5 Complete Pathways and Routes of Exposure

A SCM should identify the area over which exposure to site chemicals can occur and media of concern within that area. Based on current and potential future receptors and knowledge of COCs, the SCM should identify the migration mechanisms (volatilization or leaching). Based on migration mechanisms, current and potential future migration pathways and ROE by which chemicals enter the human body should be identified. The POE for each ROE and receptor should be established for each complete pathway. For large sites, it may be useful to subdivide the site into multiple exposure units.

4.2.6 Ecological Risk Considerations

In addition to identifying potential impacts to human receptors the SCM should also attempt to identify potential pathways by which sensitive habitats, such as wetlands, surface water bodies, or other ecologically significant environments near the site, may be impacted by the release. Endangered species that may be exposed to site-specific chemicals should be identified.

4.3 DATA COLLECTION PLANNING

To accomplish the objectives identified in Section 4.1, the following categories of data are required:

- Nature, magnitude, and extent of the release,
- Site information,
- Adjacent land use and receptor information,
- Vadose zone soil characteristics,
- Saturated zone characteristics,
- Surface waterbody characteristics,
- Distribution of COCs in soil, ground water, surface water bodies, and sediment, and
- Information regarding risk management measures.

Discussion of each of these categories of data is presented in subsequent sections. Ideally, all data necessary to perform a risk-based evaluation should be collected in one mobilization; however, several phases of characterization are often performed.

At most impacted sites, necessary data may have been collected over an extended period of time, even several years. Prior to collection of additional data, the responsible party should complete a SCM, identify data collection objectives, carefully review all available data, and identify any data gaps. As appropriate, a work plan to fill identified data gaps should be prepared and implemented with the concurrence of DEQ. Work plans are recommended prior to all RE-2 evaluations. The amount of detail to be included in the work plan will vary among sites. At sites where a considerable amount of data has already been collected, the work plan may be a brief letter indicating activities to be performed to fill in the data gaps. For a complex or large site, a very detailed work plan, including the SCM, data collection methodology, analysis methods, a data quality assurance project plan, and a health and safety plan may need to be developed. Only after all necessary data have been collected should the responsible party develop target levels and prepare a risk management plan, if necessary.

For many of the above data categories, the exact number of samples required is a site-specific decision that requires professional judgement and expertise. All samples should be collected with the goal of being representative of site conditions. Numerous tools are available to estimate the number of samples required, but none of them give an exact definitive number. These tools include, but are not limited to, data quality objectives (DQO) and statistical and geo-statistical evaluation. Following are selected references to assist in developing and completing sound data collection efforts:

EPA, 1992, *Guidance for Data Usability in Risk Assessment,* Part A, Office of Solid Waste and Emergency Response, 92857-09A, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1994, *Guidance for the Data Quality Objectives Process*, Office of Research and Development, EPA/600/R-96/055, Washington, D.C.

EPA, 1998, *Guidance for Data Quality Assessment: Practical Methods for Data Analysis*, Office of Research and Development, EPA/600/R-96/084, Washington, D.C.

EPA, 1997, *Expedited Site Assessment Tools for Underground Storage Tank Sites*, EPA/510 B-97-001, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1993, *Data Quality Objectives Process for Superfund, Interim Final Guidance,* EPA/540-R-93-071, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1986, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document Draft,* OSWER-9950.1, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA,* OSWER-9335.3-01, Office of Solid Waste and Emergency Response, Washington, D.C.

4.4 NATURE, MAGNITUDE, AND EXTENT OF THE RELEASE

Knowledge about the nature, magnitude, and extent of the release is necessary to identify the soil and/or the ground water source at the site as well as to identify the COCs. The following information regarding a release is necessary:

- Release location,
- Release quantity,
- Product released, and
- Interim corrective action measures performed.

Release-related information can be obtained by reviewing inventory records, interviewing current and past employees, and checking any spill incident reports filed with DEQ. Information related to site activities, as discussed in Section 4.5 (Site Information), can also help identify source location and COCs.

4.4.1 Location of Release

The location of the release defines the soil and ground water source area. Likely release locations include, but are not limited to, corroded or damaged tanks, pipe bends and joints, loading and unloading areas, waste disposal areas, landfills, and industrial lagoons.

The responsible party should review operational history to determine the location and timing of past spills and releases. The exact location and timing of the spill source area may not be known. Moreover, the site may have had multiple spills/releases at various times and locations. In these cases, soil and ground water sampling should be used to identify the extent (vertical and horizontal) of residual soil and/or ground water source.

The exact number and location of necessary samples shall be determined on a site-specific basis using professional judgement and concurrence of DEQ.

4.4.2 Quantity of Release

The risk evaluation process does not necessarily require knowledge of the exact release quantity. However, an estimate of the amount released may help evaluate the severity of the impact and extent of contamination, and help in planning site characterization measures. Estimation of release quantities is typically based on inventory records.

4.4.3 Chemicals of Concern

Identification of specific product(s) spilled or released is important to identify the COCs. At sites where chemical mixtures or multiple chemicals may have been released, it is important to identify all chemicals. Where definitive information on chemicals released is not available, soil and ground water may require analysis for an extended list of chemicals.

The environmental behavior (mobility, persistence, bio-degradation, and inter-media transport) of the product and its adverse environmental and human health effects depend on constituent properties and their concentration in the product.

If a release can be identified as a single product based on a documented release, free product analysis, or location of impact (e.g., tank bottom of a particular product tank), only COCs for that product need be analyzed. If the product released cannot be conclusively identified, all COCs associated with the products suspected to have been stored at the site must be analyzed.

If previously collected data did not include all suspected site COCs, additional sampling may be necessary for all potential COCs before a risk evaluation can be performed.

4.4.4 Interim Corrective Actions

Interim corrective action measures are implemented to mitigate imminent threats to human health and the environment, prevent the further spread of contamination, and minimize existing impacts. Typical interim corrective actions include excavating and disposing contaminated soil, removing free product, extracting soil vapor, and pumping and treating ground water. Corrective actions performed at the site may have already removed all or part of the product released. Soil and ground water data collected prior to such activities may not be representative of current conditions and should not be used in risk evaluation. At such sites, additional soil and ground water concentration data should be collected after completion of interim corrective measures. Data collected prior to completion of corrective action may be used to determine the locations where additional data should be collected. DEQ must be notified upon initiation of any interim corrective action measures, prior to the development of a full RMP.

4.5 SITE INFORMATION

The following site information is necessary to complete the risk evaluation:

- Site map,
- Ground surface condition,
- Location of utilities on and adjacent to the site,
- On-site ground water use, and

- Regional hydrogeology and aquifer characteristics.

Relevant site information can be obtained by a site visit and reviewing engineering drawings showing the layout of the site, regional information, and DEQ files related to the site or adjacent sites. In addition, a comprehensive chronology of events including remediation projects, tank removal activity, reported releases, etc. must be developed. The chronology of events must be clearly and accurately documented.

4.5.1 Site Map

All maps should be made to scale, with a bar scale and north arrow. As appropriate, multiple site maps should be prepared to show monitoring points and locations of various site structures. A detailed facility map showing the layout of past and current underground storage tanks (USTs), above ground storage tanks (ASTs), pipes, loading and unloading areas, sumps, paved and unpaved areas, canopy buildings, landfills, lagoons, etc. should be prepared. A second facility map should be prepared to show locations of all on-site monitoring wells including those that may have been abandoned, water use wells, soil borings, soil vapor extraction wells, and soil excavation areas. All on-site structures should be clearly identified.

4.5.2 Ground Surface Conditions

Prior to performance of a risk evaluation, a site visit and walk through is highly recommended. It is important to document areas of the site that are paved, unpaved, landscaped, or covered with buildings. Also note the type, extent, slope, and general condition of the ground surface, and current land use.

4.5.3 Location of Utilities on and Adjacent to the Site

Due to potential for preferential flow of contaminated ground water and vapors into underground utility lines and conduits, a thorough evaluation of potential and existing impacts to underground utilities must be performed. Utilities include phone lines, water lines, sanitary sewers, storm sewers, and natural gas lines. A combination of site observations, knowledge of buried utilities, and discussions with utility representatives and the site owner should reveal the utility locations. At a minimum the following activities should be performed:

- Locate all underground utility lines and conduits within the area of known or potential soil and ground water impact, both on site and off site, where the release may have migrated, or may migrate in the future.
- Determine the direction of flow and backfill slope in the utilities (water, storm water, and sewage).
- Identify utility lines/conduits on a base map that illustrates the extent of soil and ground water impacts.

- Determine depth of utility lines/conduits relative to the depth of ground water. Seasonal fluctuations of ground water levels should be carefully evaluated. As appropriate, a cross-sectional diagram should be provided illustrating the depth to ground water and the locations and depths of the lines/conduits.
- Determine the types of materials used for lines/conduits (i.e., PVC, terra-cotta, concrete, steel, etc.).
- Determine any past impacts to utilities and any pertinent complaints that may have been previously filed with DEQ.
- As appropriate, sample adjacent to utilities and vaults by taking samples or using explosimeters. If explosive conditions are encountered, immediately inform the local fire department and DEQ.
- Where a utility is threatened, or where an explosive situation exists, take appropriate measures to eliminate fire, explosive, and vapor hazards.
- Remove free product (if present) to the maximum extent practicable.
- Evaluate potential impacts of dissolved contamination, where present.

4.5.4 On-Site Ground Water Use

Determine if a water well is, or was located on the site. If necessary, contact former owners of the site to determine if a water well was located on site in the past. If a well is identified, obtain construction details of the well. At a minimum, the total depth of the well, screen interval, and the use of water should be determined. If the well is identified and not currently in use or likely to be used in the future, it should be properly abandoned with the approval of DEQ and IDWR. Any dewatering wells on or adjacent to the facility should be identified, and current and past use of water should be documented. See Section 3.8 for additional information on characterizing ground water.

4.5.5 Regional Hydrogeology and Aquifer Characteristics

Review published literature and any investigations conducted on adjacent sites should be reviewed to determine regional hydrogeology, soil types, and aquifer characteristics. This evaluation should be used to determine the type and depth of aquifers in the area and whether they are confined, semi-confined, or unconfined. General aquifer characteristics such as yield, total dissolved solids, and salinity of water will help determine the possibility it may be used as a potable water source. Regional information will help the responsible party in efficiently collecting site-specific soil and ground water information, as discussed in Sections 4.5 and 4.6.

The survey should also locate potentially impacted surface water bodies located within 0.5 mile of the site. If a surface waterbody is identified, collect information including the type (perennial or intermittent), water flow rate, flow direction, depth of water, width or surface area of the waterbody, and water use. The waterbody must be located on an area map.

4.6 ADJACENT LAND USE AND RECEPTOR INFORMATION

Land use information is used to identify the location and type of receptors and complete ROE by which receptors may be exposed to COCs. This information is critical in developing a site conceptual exposure scenario.

The following information should be collected:

- Current land use,
- Potential future land use,
- Water well survey, and
- Ecological receptor survey.

Typically a land use and receptor survey covering a radius of 0.5 mile from the source is adequate. At sites where there is likelihood that the extent of impacts may be greater, due to the magnitude of the spill or other site-specific conditions, a land use map covering the entire impacted and potentially impacted area is necessary.

4.6.1 Current Land Use

Land use of the site and its vicinity defines on-site and off-site receptors that may be exposed to COCs. There should be no ambiguity about current land use. A walking land use survey within a 1,000-foot radius of the source, or extent of the area that may be impacted, should be conducted. The survey should clearly identify the following: schools, hospitals, residences (apartments, single-family homes), basements, day care centers, nursing homes, and types of businesses. The map should also identify surface water bodies, parks, recreational areas, wildlife sanctuaries, wetlands, and agricultural areas. The results of such a survey should be accurately documented on a land use map.

4.6.2 Future Land Use

Unless the future land use is known, assumptions concerning future land use should be based on local zoning laws and surrounding land use patterns. As appropriate, zone atlases and maps, aerial photographs, local planning offices, the U.S. Census Bureau, community master plans, changing land use patterns, interviews with current property owners, and commercial appraisals of a site can provide information for determining future land use. Proximity to wetlands, critical habitat, and other environmentally sensitive areas are additional criteria that may help determine future land uses.

When future land use is highly uncertain, the default assumption should be residential—a land use that is conservative when considering exposure. A risk evaluation under a less conservative land use scenario may require a deed restriction.

4.6.3 Water Well Survey

A water well survey should be conducted to locate all public water supply wells within a 1-mile radius of the site and all water use wells within a 0.5-mile radius. Information sources include the U.S. Geological Survey, IDWR, water system operators, and local residents. In areas where water use wells are likely, a door-to-door survey of businesses and residences may be necessary. Well characteristics including age, depth, water use, screened interval, and mode of operation (continuous or intermittent) should be documented. Identification of dewatering wells located within a 1,000-foot radius of the site (or greater if the ground water plume is extensive) is necessary.

4.6.4 Ecological Receptor Survey

As appropriate, a walking survey within a 0.5- mile radius of the site may be necessary to identify ecological receptors. Habitats for receptors include, but are not limited to, wetlands, surface water bodies, and other sensitive areas. Ecological receptors of concern include, but are not limited to, threatened and endangered species. Any site where ecological receptors of concern may be impacted will require consultation with DEQ, IDFG for state species of concern, and if endangered species are at risk, the U.S. Fish and Wildlife Service.

4.7 VADOSE ZONE SOIL CHARACTERISTICS

The vadose zone soil is the media through which COCs migrate to the ground water and vapors move upward to the surface or into an enclosed space. Thus, characteristics of vadose zone soils have considerable impact on target levels. Relevant soil characteristics include:

- Vadose zone thickness and depth to ground water,
- Porosity,

- Water and air content,
- Fractional organic carbon content, and
- Bulk density.

For the development of IDTL and RATL-1 target levels, DEQ assumed conservative values of these parameters as presented in Table 3-2. For RE-2, site-specific values of these parameters, representative of the source area and vadose zone should be obtained.

For releases involving organic contaminants, organic carbon content should be determined using soil samples not impacted by the release. Since organic carbon content varies with depth, wherever appropriate, samples representative of vadose and saturated zones should be collected. For measuring porosity and bulk density of soil, an undisturbed sample is necessary. Such a sample can be collected using a Shelby tube or a similar coring device. Consideration must be given to collecting multiple samples if multiple lithologies are present that might affect COC transport.

In addition to parameters mentioned above, additional parameters that may be measured include:

- Vapor permeability and effective diffusion coefficient (where indoor inhalation is a complete pathway), and
- Infiltration rates, redox potential, and adsorption coefficients (column or batch tests). These are particularly important for inorganic COCs. These parameters are useful in developing a detailed evaluation of leachate to ground water.

4.7.1 Thickness of Vadose Zone and Depth to Ground Water

Vadose zone thickness is determined from boring logs. This thickness is the distance from the ground surface to the depth at which the water table is encountered, less capillary fringe thickness.

Depth to ground water is used in estimating vapor emissions from ground water. For indoor inhalation, depth to ground water below the “floor” of an existing structure of concern or the most likely location of a future structure should be used.

For sites with considerable seasonal fluctuation in water table level, a yearly average depth for each well may be used. Shallower water table depths often result in lower ground water target levels protective of inhalation pathways.

4.7.2 Dry Bulk Density

Dry bulk density is the dry weight of a soil sample divided by the field volume of the soil sample. An accurate measurement of bulk density requires determining the dry weight and volume of an undisturbed sample. This method involves collecting a core of known volume, using a thin-walled sampler to minimize disturbance of the sample, and transporting the core to a laboratory for analysis. This method is described in American Society for Testing and Materials (ASTM) Method D2937-00, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method* (ASTM, 2000a).

4.7.3 Porosity

Porosity is the ratio of the volume of voids to the soil sample volume. Many laboratories use dry bulk density and specific gravity data to determine porosity using the following equation:

$$n = 1 - \rho_b/\rho_s \qquad (4\text{-}1)$$

where,

n = porosity (cc/cc)

ρ_b = dry bulk density (gm/cc)

ρ_s = specific gravity or particle density (gm/cc)

The *Standard Test Method for Specific Gravity of Soil*, ASTM Method D854-00 (ASTM, 2002), may be used to determine specific gravity. If specific gravity is not assessed, then 2.65 gm/cc can be assumed as the particle density. If site-specific values of porosity are not available, it should be estimated from an appropriate literature source.

4.7.4 Volumetric Water Content/Moisture Content

Volumetric water content is the ratio of water volume to the total soil. The ASTM Method D2216-98, *Standard Test Method for Laboratory Determination of Water [Moisture] Content of Soil and Rock by Mass* (ASTM, 1998) is a gravimetric oven drying method. The water content value used in most models is the volumetric water content.

Hence, it may be necessary to use the following equation to convert gravimetric water content to a volumetric basis:

$$q_{wv} = q_{wg} * \frac{r_b}{r_l} \quad (4\text{-}2)$$

where,

q_{wv} = volumetric water content (cc water/cc soil)

q_{wg} = gravimetric water content, typically reported by the laboratory (gm of water/gm of soil)

r_b = dry bulk density (gm of dry soil/cc of soil)

r_l = density of water (gm/cc)

Volumetric water content can also be measured in the field through the use of a variety of instruments such as a neutron probe, time domain reflectometry, or gypsum block sensors. For more information on these methods see Part VII of Wilson et al. (2000).

4.7.5 Fractional Organic Carbon Content in Soil

Fractional organic carbon content is the organic carbon weight in the soil divided by soil weight and is expressed either as a ratio or as a percent. The Walkley Black Method (Page et al., 1982) is a chemical oxidation method (rapid dichromatic oxidation) while ASTM Method 2974-00 is a furnace method (ASTM, 2000b) for determining fractional organic carbon content in soil. Results are usually reported as percent organic carbon content. The reported value can be converted to a fraction by dividing by 100.

If measurements of total organic matter content are available, they should be divided by 1.724 to estimate the fractional organic carbon content. This adjusts for the portion of soil organic matter that is actually carbon. Typically, total organic carbon content is estimated using ASTM Method 2974-00.

4.8 SATURATED ZONE CHARACTERISTICS

COCs that reach the water table typically travel horizontally in the saturated zone. However if a vertical gradient is present, chemicals may also move vertically in the direction of the gradient. Saturated zone characteristics that determine the travel time and direction for the COCs include:

- Horizontal hydraulic conductivity
- Horizontal and vertical hydraulic gradients (magnitude and direction)

- Saturated zone soil characteristics (fractional organic carbon content and porosity)

4.8.1 Hydraulic Conductivity

Hydraulic conductivity is the discharge of water per unit area per unit hydraulic gradient in a subsurface formation. Estimates of site-specific hydraulic conductivity can be obtained by conducting aquifer tests such as slug or pump tests. Data gathered during the tests are then analyzed using appropriate methods. Slug tests are easier to conduct than pump tests, generate no wastewater for treatment, and may be more appropriate for low permeability formations. The primary disadvantages are the small aquifer volume that is explored, resulting in the need to conduct multiple tests across the site. Properly conducted pump tests will often provide better estimates of hydraulic conductivity. The simplest pump tests are single well short duration (2 to 4 hours) tests. The best pump tests employ a pumping well and multiple observation wells and are of longer duration (12 hours or more). These tests will identify boundary effects. Regardless of the type of test conducted, different methods of data analysis will often yield different estimates of hydraulic conductivity. ASTM Method D4043 provides guidance on the selection of aquifer test methods (ASTM, 1996).

In the absence of these tests, estimates of hydraulic conductivity may be obtained from literature values corresponding to the type of soil in the saturated zone, using empirical equations based on the grain size distribution of the porous formation, or using specific capacity data from well logs of wells in the vicinity of the site that are representative of the aquifer being investigated. In either case, adequate references and justification for the value chosen should be provided.

4.8.2 Hydraulic Gradient

The magnitude and direction of the hydraulic gradient is estimated by comparing water levels measured in the monitoring wells. Typically, water level contour maps are prepared based on measured data using a computer program or manual calculations along with professional judgment. Calculations done using automated procedures should be spot-checked with hand calculations. A minimum of three wells is needed to adequately estimate the direction of flow and magnitude of the gradient. When drawing the contour maps, care should be taken to ensure that measurements in monitoring wells screened in the same interval or hydrologic unit are used. For sites that have seasonal variation in hydraulic gradient, estimate the average hydraulic gradient for each season. Consideration should also be given to determining any vertical gradients. This requires a comparison of adjacent water levels in wells screened in different intervals.

In areas where the shallow aquifer has been impacted and a deeper aquifer is used for drinking water, the vertical gradient must be determined. When drilling deep wells, care should be taken to avoid cross contamination.

4.8.3 Saturated Zone Soil Characteristics

In addition to hydraulic conductivity, other important saturated zone soil characteristics include fractional organic carbon content, porosity, and bulk density. These parameters are required to quantify the movement of chemicals within the saturated zone. The laboratory methods to measure these parameters were discussed in Section 4.7.

4.8.4 Indicators of Biodegradation

Several indicators (chemical concentrations, geochemical indicators, microorganisms, and carbon dioxide) can be measured at a site to demonstrate the occurrence of biodegradation of organic substances. These indicators can be broadly classified into three groups: primary, secondary, and tertiary lines of evidence. Data collected under each line of evidence can be evaluated qualitatively or quantitatively to determine the occurrence of biodegradation.

The primary line of evidence demonstrates a reduction in chemical concentrations at a site by evaluating measured concentrations within monitoring wells, ground water velocity, rates of contaminant transport, and time of the release.

The secondary line of evidence refers to measurement of geochemical indicators including dissolved oxygen, dissolved nitrates, manganese, ferrous iron, sulfate, and methane. These indicators should be measured in at least three wells located along the flow line. The wells used should be located at a background or upgradient location, within the plume near the source, and within the plume downgradient from the source.

The tertiary line of evidence involves the performance of microbiological studies such as identification of types of subsurface microbial and microbe cell counts.

Commonly used methods to estimate biodegradation rates include mass balance analysis for expanding, stable, or shrinking plumes and plume concentration vs. distance plots. Additional details on biodegradation for petroleum and chlorinated solvent-related COCs are provided in Appendix K.

4.9 DISTRIBUTION OF CHEMICALS OF CONCERN

Chemicals of concern may be distributed between soil, soil gas, ground water, surface water, and sediments present at a release site. Knowledge of contaminant distribution entails a determination of the spatial extent and magnitude of concentrations in each of these media, where they are present.

4.9.1 Distribution of Chemicals of Concern in Soil

Adequate soil concentration data are necessary to estimate risk to receptors, compare representative concentrations for each complete pathway to target levels, and define the soil source dimensions. Sufficient data should be collected to define horizontal and vertical extent of impacts, using IDTL concentrations as general, bounding criteria. If it becomes apparent during the site investigation that IDTL concentrations will not be exceeded, then no additional information may be needed at the site. However, if concentrations are likely to exceed IDTLs, the site investigation should obtain as much of the data needed to perform an RE-1 or RE-2 evaluation as possible.

The soil investigation(s) should be organized to:

- Identify the area impacted by COCs, appropriate to the characteristics of the material released.
- Identify areas of maximum concentration of COCs.
- Collect samples adequate to estimate representative concentrations for the potentially complete exposure pathways that exist.
- Identify the horizontal and vertical extent of soil impacts. Unless otherwise directed by DEQ, the extent of impact should be defined as those areas where concentrations exceed IDTL concentrations.

To determine the spatial extent of contamination, soil borings should be drilled starting from the known or suspected source area and drilling outwards until borings with sample concentrations at or below IDTLs are reached in all directions. To determine the vertical extent of contamination, soil borings should be extended through the water table and samples collected from surface and subsurface soil zones as explained in following sections (Sections 4.9.1.1 through 4.9.1.4).

4.9.1.1 Surficial Soil Sampling

The risk evaluation process distinguishes between surficial soil and subsurface soil zones. Surficial soil is defined as the soil zone from the ground surface to 1 foot below ground surface. Pathways that may apply to the surficial soil zone include direct contact exposure via incidental ingestion, inhalation of vapors and particulates, dermal contact, and leaching of COCs to ground water and surface water.

Evaluation of soil exposure pathways within the surficial soil zone requires collection of an adequate number of soil samples to estimate both maximum and representative concentrations of all potential COCs. Given the small vertical depth interval of this soil zone, close attention should be given to vertical variations in contamination. The acceptability of vertical depth-composite samples versus samples from discrete depth intervals is a site-specific decision. Criteria that influence this decision include the type of COCs, vertical extent of contamination, and areal extent of the contaminated zone. Sampling within the surficial soil zone is typically done from test pits using hand samplers such as trowels or corers.

The presence of impervious (paved) surfaces poses difficulties for sampling. In some cases, very permeable material may be located 2 inches below the pavement. Residues from the paved surface may also be present. When sampling beneath impervious surfaces, sampling should begin 2 inches below concrete or asphalt pavement. Cracked areas in impervious surfaces may represent conduits for chemical migration or leaching and should be evaluated during the selection of sampling locations.

4.9.1.2 Subsurface Soil Sampling

Soil below the surficial soil zone (greater than one foot below ground surface) and extending to the water table is termed the subsurface soil zone. Pathways evaluated for this zone include volatilization from soil to indoor air and leaching to ground water and surface water. Most receptors will not have direct exposure to this soil. However, some construction workers may be involved in excavation activities below the surficial soil zone. A primary goal of subsurface soil sampling for IDTL screening purposes is to determine maximum COC concentrations present at the release site. Estimation of representative concentrations in the subsurface soil zone during RE-1 and RE-2 evaluation process depends on the pathway and the exposure domain of the receptor. Development of representative concentrations is detailed in Appendix L.

To test for indoor inhalation of vapors from subsurface soils, soil samples should be collected to characterize the complete horizontal and vertical extent of contamination. Depth and thickness of contamination and moisture and vapor permeability are important parameters. If contamination exists adjacent to existing structures, additional sampling should be focused in these areas. To test for exposure to a construction or utility worker during excavation activities, soil samples should be collected from both surface and subsurface soil zones to depths where construction-related activities are likely to occur.

To test for leaching of COCs in soil to ground water, determining the thickness of the contaminated soil zone, distance from the bottom of the contaminated zone to the water table, if any, and representative concentration of COCs within the contaminated zone is critical.

Soil sampling must be done in accordance with the following guidelines and procedures:

- Samples must be collected from the source area(s). Additionally, it may be necessary to collect background samples.

- Samples must be collected to determine the full horizontal and vertical extent of soil contamination. Sampling should strive to characterize any horizontal or vertical stratigraphic variation at the site that could impact COC fate and transport. Where required to fully characterize the vertical extent of contamination, borings should be extended to the water table and features such as the capillary fringe and any smear zone, if encountered, should be characterized. Vertical sampling intervals should not be greater than 5 feet.

- Soil borings should be logged and samples for laboratory evaluation collected in accordance with current industry practice.

- All samples must be adequately preserved according to requirements of the laboratory analyses and analyzed within holding times required by each method. Sample analyses must be conducted in accordance with current DEQ analytical requirements, EPA Office of Solid Waste and Emergency Response SW-846 Methods, or other accepted methods.

- Adequate quality assurance/quality control (QA/QC) procedures must be used to ensure sample quality and integrity. Section 4.11 contains additional information on QA/QC considerations.

- All sampling equipment must be decontaminated using current state of industry practice such as described in ASTM D-5088-90, *Practice for Decontamination of Field Equipment Used At Nonradioactive Waste Sites* (ASTM, 1990).

Appropriate methodology for abandoning boreholes is described in detail in the *Standard Guide for Decommissioning Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities,* Standard Guide D5299-99 (ASTM, 1999a). The borehole should be sealed from total depth to the surface with a bentonite/cement grout (6% to 8% bentonite powder). For borings less than 50 feet total depth, grout placement by tremie pipe or grout pump should be considered. Abandonment of boreholes that extend to the water table, which are considered wells by IDWR, should follow IDWR abandonment procedures (IDAPA 37.03.09.025).

4.9.1.3 Subsurface Soil Gas Data

At sites where COCs in soil or ground water are volatile and there is concern about potential indoor inhalation of vapors, it may be useful to assess soil vapor concentrations. For details about these samples, refer to EPA and ASTM literature, open literature, and Appendix C (Evaluation of the Indoor Air Inhalation Pathway).

4.9.1.4 Soil Source Data

The soil analytical data, along with the historical use of the site, should help identify the soil source area. If more than one source area is identified at a site, each source area should be evaluated separately. Once the soil source(s) is identified, source dimensions can be estimated. These dimensions are used to estimate IDTLs and RE-1 and RE-2 levels protective of indoor inhalation and to evaluate the soil to ground water leaching pathway. Depth to subsurface soil source (used to estimate the target levels) should be the depth, in the source area, from the surface to the zone where concentrations are above quantification limits. Professional judgment should be used in choosing the representative depth.

4.9.1.5 Logging of Soil Boreholes

Each soil boring must be logged to record depths correlating with changes in lithology (with lithologic descriptions), soil vapor (e.g., photo-ionization detector) analyses, occurrence of ground water, total depth, visual and olfactory observations, and any other pertinent data.

When a monitoring well is installed, as-built diagrams with depth to ground water and construction details must be submitted for each well. A continuous soil profile from at least one boring should be developed with detailed lithologic descriptions. Particular emphasis should be placed on characteristics that control chemical migration and distribution, such as zones of higher or lesser permeability, changes in lithology, correlation between soil vapor concentrations and different lithologic zones, obvious areas of soil discoloration, organic content, fractures, and other lithologic characteristics.

4.9.2 Distribution of Chemicals of Concern in Ground Water

Adequate ground water samples should be collected to delineate the extent of dissolved contaminant plumes in all directions and to provide representative concentrations based on a site conceptual exposure model. Soil source delineation can serve as a guide in choosing monitoring well locations.

4.9.2.1 Ground Water Sampling

If ground water has been impacted, temporary sampling points may be used to screen levels of ground water impacts and to assist in determining optimal locations of permanent monitoring wells. A sufficient number of monitoring wells should be installed (a minimum of three for an IDTL evaluation) to identify source areas, document COC migration and ground water flow. The monitoring wells should be installed in accordance current industry standards such as ASTM D 5092-95, *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers* (ASTM, 1995b). EPA documents such as the RCRA technical guidance for ground water monitoring (EPA, 1986, 1992a) are also useful references.

Specifically;

- Adequate numbers of monitoring wells must be installed to sufficiently delineate the horizontal and the vertical extent of the ground water plume. At a minimum, three monitoring wells must be installed: one at the source, one upgradient, and one downgradient.
- Well placement and design must consider the concentration of COCs in the source area, and the occurrence of non-aqueous phase liquid (NAPL) or dense non-aqueous phase liquid (DNAPL) at the site.
- Well casing and screen materials must be properly selected. The screen interval length should be minimized to the extent possible but should be set at least 2 to 3 feet above the expected high water table and encompass the range of expected variation in water table depth. EPA (1992) recommends lengths of 10 to 15 feet except where specific monitoring objectives result in other requirements. For example, the need to identify DNAPL may result in deviation from these recommendations.
- Wells must be properly developed and gauged after installation.
- A site survey must be conducted to establish well casing elevations. Based on the ground water elevations, ground water flow direction and gradient should be determined and plotted on a map.

Ground water samples must be collected in accordance with the following guidelines and procedures:

- Monitoring wells must be purged the adequate number of well volumes prior to collecting a sample (usually 3 to 5 volumes). Low-flow purging and sampling techniques (EPA, 1996) may also be acceptable with DEQ approval.
- Samples must be collected using EPA approved methods and equipment.
- All samples must be adequately preserved according to the requirements of the laboratory analyses and analyzed within holding times required by each method.
- Sample analyses must be conducted in accordance with current DEQ analytical requirements and EPA Office of Solid Waste and Emergency Response SW846 Methods, or other accepted methods.
- Adequate QA/QC procedures must be used to ensure sample quality and integrity. See section 4.11 for additional information on QA/QC considerations. All sampling equipment must be decontaminated using current state of industry practice such as described in ASTM D-5088-90, *Practice for Decontamination of Field Equipment Used At Nonradioactive Waste Sites* (ASTM, 1990).
- If the plume is not delineated in all directions, locations of new monitoring wells must be chosen based on ground water flow direction and location of the soil source area.

4.9.2.2 Surface Water and Sediment Sampling

Appropriate samples should be collected when COC migration is known or suspected to affect a surface waterbody. Water samples should be collected from upstream and downstream of a ground water discharge point. Sediment samples should be collected if site conditions warrant.

In places where a ground water plume may discharge into a stream, it is necessary to estimate the discharge concentration into the stream. This can be achieved by installing one or more monitoring wells or temporary wells within the plume adjacent to the stream.

4.10 BACKGROUND SOIL AND GROUND WATER CONCENTRATIONS

The objective of Idaho's risk evaluation process is to identify and remediate chemical concentrations that exceed risk-based target levels and are related to site-specific activities. A key part of the site characterization is determining site-specific background concentrations of COCs. Concentrations of chemicals in soil and ground water not directly related to site activities are considered background concentrations. For certain chemicals and in certain areas, the background concentrations may exceed risk-based target levels (IDTLs, RATL-1, or RATL-2). In this case, DEQ will not require the responsible party to remediate sites below the background concentrations. Thus it is often necessary to distinguish between chemical concentrations attributable to current and past site activities and those attributable to other non-site related factors termed as background concentrations.

Technical issues associated with determining background concentrations include:

- Identifying COCs,
- Identifying media,
- Selecting appropriate, representative background sampling locations,
- Determining and following appropriate sampling procedures, and
- Evaluating background concentrations using statistical analyses.

These issues are briefly discussed below. For further information, the reader is referred to the references included at the end of this section.

4.10.1 Identification of Chemicals of Concern

COCs are determined based on knowledge of site history, site activities, and interviews with personnel who have direct knowledge of the site. Of these COCs, those that may have elevated background concentrations should be identified. Elevated background concentrations may be due to natural occurrence, such as the presence of certain metals in soil, or due to local anthropogenic activities, such as the historic use of pesticides in an agricultural area. Examples of potential elevated background concentrations include elevated concentrations of metals in mining areas, pesticides in agricultural areas, or chemicals in air due to emissions from automobiles, etc.

Thus, knowledge of site-specific activities, regional geology, and regional activities can help identify COCs for which background concentrations need establishing.

4.10.2 Identification of Media

Depending on the media of concern at a site, background concentrations may have to be established for soil, surface water, sediments, ground water, and indoor and outdoor air. At large sites these media may have to be further subdivided; for example, different background concentrations may have to be established for shallow versus deep ground water. Similarly, soils may have to be divided into different zones or formations. Further background concentrations need to be established only for those zones and formations in which site concentrations exceed risk-based target levels where the exceedance may be related to natural background or regional anthropogenic activities.

4.10.3 Selection of Background Sampling Locations

Concentrations of naturally occurring chemicals vary spatially and, in certain cases, temporally (e.g., diurnal variations in air concentrations, seasonal variations in sediment concentrations). Thus it may not be possible to establish a single background concentration at a site. Hence it may be necessary to identify multiple sampling locations in each media and, in some cases, background measurements may have to be made over time. Due to spatial and temporal variability, it is often necessary to define a range of background concentrations for each chemical and in each relevant media, or use statistical analysis to establish a specific background concentration.

The location of background sampling points will depend on site-specific considerations. However, generally, background locations should be upgradient, upwind, upslope, or upstream of the site.

Concentrations of COCs may be affected by factors such as pH, Eh, salinity, organic carbon content, soil texture, and cation exchange capacity. Thus, to the extent possible, background measurement points should be located where these factors are similar to site-specific factors, except at sites when hazardous waste site activities affect these parameters. At such sites, these factors should be measured concurrently with COCs.

4.10.4 Determination of Appropriate Sampling Procedures

Sample collection, preservation, handling, and analytical analysis procedures for the background samples should be identical for the samples collected on site. All sampling analysis methods should follow standard EPA or DEQ methods.

4.10.5 Evaluation of Background Concentrations

Statistical analyses are often used to evaluate background concentrations. The objective of statistical analyses is to compare site media-specific concentrations with background concentrations to determine whether elevated site concentrations (those exceeding risk-based target levels) are due to site-specific activities or background concentrations. Several statistical procedures (t-tests, analysis of variance) are available depending on the number of data, underlying distribution, and variability in the measured concentrations, etc. The responsible party is encouraged to consult a statistician to design and review a sampling plan and have the plan approved by DEQ prior implementing it. Additional information may be obtained from the following sources:

EPA, 1992, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance, EPA/530-R-93-003.

EPA, 1995a, *Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites,* (Breckenridge & Crockett), Office of Research and Development, Office of Solid Waste and Emergency Response, EPA/540/S-96/500.

EPA, 1995b, *Guidance for Data Quality Assessment, External Working Draft,* EPA QA/G-9, Quality Assurance Management Staff, Washington D.C.

EPA, 2002b, *Role of Background in the CERCLA Cleanup Program,*OSWER Directive 9285.6-07P, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 2002c, *Guidance for Comparing Background and Chemical Concentrations in Soil at CERCLA Sites,*OSWER Directive 9285.7-41, Office of Solid Waste and Emergency Response, Washington, D.C.

Gilbert, 1987, Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold Company, NY.

4.11 QA/QC CONSIDERATIONS

The risk evaluation process relies on site-specific data to make decisions related to the magnitude of site risk, nature and extent of remedial activity, and site-closure. Thus it is very important that data be reliable, representative, complete, and of known quality.

In order to assure the data will be of appropriate quality, QA/QC activities must be applied throughout the site characterization and environmental data collection process.

Elements of QA/QC include:

- Using approved methodologies to collect data
- Decontaminating field equipment as appropriate
- Using EPA approved methods for laboratory analysis
- Including QA/QC samples, such as travel blanks, trip blanks, etc.

While the level of QA/QC applied to data collection efforts will vary (depending on factors such as site complexity, size of the release, and the immediacy of the response) all the elements of QA/QC described above that were used during a given data collection effort should be provided to DEQ when reporting the results of environmental sampling. This will allow an adequate review of the quality of the data used in the analysis.

When a work plan is submitted to DEQ for approval it should include a Quality Assurance Project Plan (QAPP).The QAPP integrates the appropriate technical and quality aspects of a project, including planning, implementation, and assessment. The purpose of the QAPP is to document planning for environmental data collection and to provide a project-specific "blueprint" for obtaining the type and quality of data needed for a specific decision or use. The QAPP documents the QA/QC procedures applied to various aspects of the project to assure that the data obtained are of the type and quality required.

DEQ has established a guidance document Ground Water and Soils Quality Assurance Project Plan Development Manual (DEQ, 2001) that guides the user through the QAPP development process. To further assist in the development of a QAPP, DEQ has also developed an abbreviated QAPP form. The purpose of the abbreviated QAPP form is to provide the user with an annotated outline format of a QAPP with all the required information headings. From there it is a simple matter to fill in appropriate site-specific information applicable to each heading or section. The QAPP development manual, abbreviated QAPP form, and additional QA/QC guidance can be obtained from DEQ upon request.

Documentation of all QA/QC efforts implemented during data collection, analysis, and reporting phases is important to data users, who can then consider the impact of these control efforts on data quality.

Prior planning is critical in programs where standard procedures are not defined, or compounds of interest and action levels are not specified by regulations.

The QAPP is implemented during the data collection process. Problems can be identified and corrected at this stage. The impact of field and laboratory techniques and sampling and analysis conditions on data quality are determined using field and laboratory QC samples and periodic audits. Oversight and corrective action can prevent improper procedures or techniques from continuing.

Data verification, validation, and assessment should be performed to validate data quality and assess data quality and usability. Data verification and validation is particularly dependent on compliance with field and laboratory procedures for sample collection, identification, handling, preservation, chain of custody, shipping, analysis, and reporting.

The *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 1994b) and *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999) provide guidance for performing verification and validation of contract laboratory program (CLP) data and may be used as guidance for non-CLP data verification and validation.

4.12 DOCUMENTATION OF THE DATA COLLECTED

Once data have been collected, a field investigation report should be prepared and include:

- Dates when data were collected and names of individuals who collected the data.
- A list of data collected and reference to the work plan that was being followed.
- All data collected, clearly tabulated, and contoured (if necessary),
- All boring logs and relevant cross-sections, where appropriate, to depict site stratigraphy,
- All QA/QC data, laboratory results, and chain of custody forms,
- Contour maps of chemical concentration and ground water potentiometric surface indicating the predominant direction of ground water flow, and
- A discussion of the SCM.

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5.0 SITE DISCOVERY

The risk evaluation process starts with initial discovery of the site and continues until all regulatory issues associated with the release have been resolved to the satisfaction of DEQ.

Site discovery can be triggered by a number of events or activities. These include, but are not limited to:

- Routine inspection by DEQ personnel,
- Accidental releases,
- Complaints or referrals from other agencies or the public,
- Activities associated with real estate transactions, and
- Discovery of chemicals in surface water, water use wells, etc.

The responsible party must inform DEQ of any release. DEQ will identify the specific program under which the site will be managed. The various programs and specific reporting requirements for each are discussed in Section 1.5.1.

In all cases, **the first step** after site discovery is to **determine whether any type of emergency response is necessary**. This determination is discussed in Section 6.0.

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6.0 IMMINENT THREATS AND EMERGENCY RESPONSE ACTIONS

6.1 DETERMINING IMMINENT THREATS

The first step upon identification of an impacted site or knowledge of a release is to determine whether contamination poses any immediate risk to human health or the environment. If there is an imminent threat, or uncertainty regarding potential threats associated with a release, call the State Communications Center (STATECOM). If there is no imminent threat, notify DEQ as outlined in Section 1.5.1.

Idaho law requires that all hazardous substance releases be reported immediately to STATECOM at 1-800-632-8000 or (208) 846-7610. The STATECOM office is staffed 24 hours a day, 365 days a year. The staff are capable of establishing bridge calls or conference calls among involved private parties and local, regional, state, and federal government agencies and personnel who can help respond to a hazardous substance emergency. STATECOM maintains a current roster of all local, regional, and state emergency response and technical support staff, as well as federal agency teams and personnel who are available to assist in the state.

When STATECOM is notified of a hazardous substance discovery or release, DEQ emergency response personnel are contacted. They determine whether it is an emergency that requires public sector assistance, or whether the matter can be handled as a contamination incident between DEQ and involved parties.

6.2 SELECTING AND IMPLEMENTING INITIAL RESPONSE ACTIONS

If an emergency does exist, the initial response will typically be managed collaboratively among involved private parties and local, state, and federal agencies to resolve the emergency through the STATECOM system. Under Idaho law, local emergency responders are in charge of managing the incident (incident commanders) while an emergency exists unless they ask regional, state, or federal responders to assume that responsibility.

If it is determined by STATECOM that an emergency does not exist, the reporting party will be instructed to notify the local DEQ office the next business day. The moderator on duty will also notify the local DEQ office so it can follow up with the responsible parties.

The communications moderator is the Department of Environmental Quality (chemical hazardous materials) or the Bureau of Hazardous Materials (radioactive materials and weapons of mass destruction) person initially contacted via pager by STATECOM. The Communications Moderator evaluates available information, consults with bridge participants, classifies the incident to determine the required notification category, and moderates any conference calls made during the incident.

6.3 TRANSITIONING FROM EMERGENCY RESPONSE TO REMEDIATION

In instances where there is an emergency response to hazardous substance discovery or release, the on-site incident commander determines when the emergency is over. Once it has been determined that the emergency is over, the incident is turned over to DEQ and managed as a remediation project by the responsible regional or state program office.

7.0 INITIAL SITE CHARACTERIZATION

7.1 INTRODUCTION

Within the risk evaluation process, initial site characterization is performed upon completion of any necessary emergency response actions. The overall objective of the initial site characterization is, at a minimum, to identify the maximum chemical concentrations on site in each of the affected media. These maximum concentrations are then compared with IDTLs to determine the need for further action.

A brief description of the initial site characterization process is presented below.

7.2 SITE DESCRIPTION AND ADJACENT LAND USE

The responsible party should conduct a thorough site reconnaissance and a historical review of site operations to identify existing and potential source(s) of contamination and potential COCs on site. Sources and COCs may be identified based on knowledge of a known or documented release; location of certain structures that typically represent a source such as underground storage tanks, pipes, process area, pumps, etc.; interviews with current and former site employees who may have knowledge of source areas; materials purchased, sold, handled, or produced; material safety data sheet records; and permits issued or applied for.

In addition to identifying sources, the responsible party should collect data related to historic, current, and future land use on and adjacent to the site. A chronology of relevant site activities is often useful in understanding the site.

Based on this information, the responsible party should develop a list of COCs that may have been released at the site. For large sites (several acres in area), with multiple process units or sources, it may be convenient to divide the site into several sub areas or exposure units. Since activities/sources in each exposure unit may be different, the COCs for each sub area may be different.

Data collected during initial site characterization should at a minimum satisfy the following requirements:

- EPA recommended QA/QC requirements have been met,
- Analyte detection limits, where feasible, do not exceed IDTLs,
- All potential COCs have been identified and included for analysis,
- Source areas have been adequately characterized to identify the maximum concentration,
- Analytical methods used are appropriate for chemicals expected at the site, and

- As appropriate, background data has been collected.

7.3 SOIL SOURCE CHARACTERIZATION

The responsible party should collect soil data representative of the maximum concentration on site. For inorganic chemicals, background concentrations should also be determined. At larger sites subdivided into smaller areas, the responsible party should attempt to collect maximum soil concentrations representative of each area.

The exact number of samples, analytical methods to be used, and specific technology to be applied to collect data will vary among sites. Thus, the responsible party should develop a work plan and have it approved by DEQ prior to implementing the work. At a minimum, the responsible party should verbally confer with DEQ before collecting any data.

The overall intent of initial site characterization is to identify maximum concentrations of COCs. However, for sites that will likely require further characterization, it may be efficient and cost-effective to collect additional data at this stage of the evaluation to identify the nature and extent of contamination and potential for exposure. For example, if contamination is suspected to exist in both surficial and subsurface soil zones, samples representing maximum concentrations in both zones should be collected.

7.4 GROUND WATER SOURCE CHARACTERIZATION

In the initial site characterization, the responsible party should collect ground water samples below or immediately adjacent to the source. For sites with a very localized source, it may be sufficient to collect only one ground water sample using a temporary well. Sites with multiple sources may require multiple wells and samples. For sites that will require further characterization, it may be more efficient and cost-effective to install at least three monitoring wells so the magnitude and direction of flow can also be established.

7.5 DOCUMENTATION OF INITIAL SITE CHARACTERIZATION

The responsible party should document the results of the characterization in a brief report. The chemical data collected should initially be evaluated using the IDTLs, as discussed in Section 8.0. The responsible party should prepare a single report, describing the initial site characterization and the IDTL evaluation, to submit to DEQ. The report should discuss:

- Site history,
- Site description,
- Current site use,
- Sources and COCs identified at the site,
- Methods used to collect soil chemical data,

- Locations of all samples (identified on a site map), including sample depths,
- Results from soil chemical data analyses,
- Methods used to collect ground water chemical data,
- Locations, construction, and lithology of all wells,
- Results of ground water chemical data analyses,
- Other site hydrogeological test data results, and
- QA/QC information.

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8.0 INITIAL DEFAULT TARGET LEVEL EVALUATION

8.1 INTRODUCTION

Data collected during the initial site characterization is first evaluated using IDTLs. The objective of this evaluation and steps involved in the evaluation are discussed in this section.

8.2 OBJECTIVES

The objectives of the IDTL evaluation are to:

- Demonstrate that the site or portions of the site do not pose a threat to human health and hence does not require any further evaluation, and
- Identify areas of the site that need further evaluation.

The above objectives are achieved by comparing the maximum site concentrations (or maximum concentrations in portions of the site) with the IDTLs.

8.3 INITIAL DEFAULT TARGET LEVELS

The IDTLs for a number of chemicals have been developed by DEQ and are included in Appendix A. The IDTLs are risk-based target levels developed using conservative input parameters, a target acceptable risk of 10-6, and an HQ of 1. Specific factors and models used to develop IDTLs are presented in Section 3.7. IDTLs are the lowest target levels for soil and ground water representative of residential conditions.

Specifically, IDTLs for soil are the lowest of the following concentrations:

- Surficial soil concentrations protective of exposures via ground water ingestion at MCL or equivalent risk-based concentrations at the downgradient edge of the source,
- Subsurface soil concentrations protective of exposure via ground water ingestion at MCL or risk-based concentrations at the downgradient edge of the source,
- Subsurface soil concentrations protective of exposure via indoor inhalation of vapors emanating from soil for a residential scenario (e.g., child or age-adjusted receptor), and
- Surficial soil concentrations protective of combined ingestion, dermal contact, and outdoor inhalation exposures for a residential scenario.

IDTLs for ground water are the lowest of the following concentrations:

- Maximum contaminant levels for chemicals having MCLs or calculated values for ingestion of water by either a child, adolescent, adult, or age-adjusted individual in a residential scenario, and
- Ground water concentrations protective of indoor inhalation for a residential scenario (e.g., child or age-adjusted receptor).

Appendix A lists IDTLs, the critical pathway used to determine each of the IDTLs, and the receptor (if applicable). As a result of the methods and assumptions used in the development of the IDTLs and the current limitations of laboratory analytical methods the calculated IDTLs may be lower than the practical quantitation limit reported by a laboratory for selected chemicals. In these situations site-specific review by DEQ will be required. Examples of some issues involved in a review include the total number of COCs, if the chemical in question is responsible for a large proportion of site-risk, cost of alternate analytical methods, and the nature and proximity of receptors. Several options are available based on this review. DEQ may require the use of specialized analytical techniques; monitoring to ensure that levels remain at detection limits, institutional controls, or the use of surrogate measures of contamination.

8.4 COMPARISON OF IDTLS WITH SITE CONCENTRATION

Based on the initial site characterization (discussed in Section 7.0), the responsible party should identify the maximum soil and ground water COC concentrations. These maximum concentrations are compared with IDTLs, obtained from Appendix A.

For inorganic chemicals, especially metals, the site-specific background concentration would replace the IDTL (from Appendix A) if the background concentration exceeds the IDTL.

If the maximum site concentration for any COC does not exceed the IDTL and no other regulatory issues remain with respect to the release, the responsible party may request DEQ approval for site closure. If the maximum site concentration for any COC exceeds the IDTL, the responsible party must select one of the following options:

Option 1: Adopt IDTLs as cleanup levels and develop a RMP (see Section 11.0).

Option 2: Perform a more detailed, site-specific evaluation (evaluate the site under RE-1 or -2).

The responsible party should clearly convey the chosen option to DEQ.

8.5 INITIAL DEFAULT TARGET LEVEL EVALUATION REPORT

The responsible party must submit an IDTL evaluation report to DEQ. The report should include, at a minimum:

- A description of site history and activities leading to the release,
- A description of current land use on and adjacent to the site,
- A summary of initial site characterization results for soil and groundwater,
- An estimation of background concentrations (if applicable) and methods used to determine background concentrations,
- A discussion of data quality,
- A comparison of maximum soil and ground water concentrations with IDTLs,
- A list of recommendations,
- Site maps indicating land use, structures on site, locations and depths of samples, and locations of sources,
- Tables documenting data collected showing comparisons with IDTLs, and
- Original laboratory reporting sheets, including QA/QC data.

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9.0 RISK EVALUATION-1

RE-1 requires estimation of site-specific cumulative risk based on DEQ default exposure factors, fate and transport models, chemical-specific properties, quantitative toxicity values, and documented site-specific values for selected fate and transport parameters and ground water use evaluation. Estimated cumulative risk is then compared with acceptable risk. RE-1 requires the following steps:

Step 1: Develop and validate the site conceptual model.

Step 2: Estimate representative concentrations.

Step 3: Estimate cumulative site risk and, if necessary, RE-1 target levels for each chemical and each route of exposure.

Step 4: Make recommendations for the next course of action.

Details of the steps follow.

9.1 STEP 1: DEVELOP AND VALIDATE THE SITE CONCEPTUAL MODEL

The objective of this step is to develop, validate, and refine the SCM. Details and key elements of the SCM were presented in Section 4.2. Validation of the SCM involves collecting site-specific data. The amount of data required is typically based on site-specific considerations; the categories of data needed were presented in Section 4.

The responsible party is encouraged to develop a work plan and to contact DEQ to discuss data gaps and the specific data requirements. A key element of the SCM is the EM. The EM identifies sources, routes of exposure, points of exposure, and media of concern. For large sites with varying exposure conditions and receptors, it may be necessary to divide the site into several different exposure units and develop an EM for each exposure unit (also see Section 3.5). For example, at a commercial site where the plume has migrated off site under residential conditions, it may be necessary to divide the site into two areas: on-site commercial and off-site residential.

9.2 STEP 2: ESTIMATE REPRESENTATIVE CONCENTRATIONS

The objective of this step is to estimate the representative concentration for each COC and for each complete or potentially complete ROE identified in the SCM.

The RE-1 report should clearly identify specific data, method used to calculate the representative concentrations, and rationale for the method used for each complete exposure pathway. Both the data and method used should be clearly tabulated. An example is shown in Table 9-1.

Table 9-1. Example Table Describing Derivation of Representative Concentrations

Media	Route of Exposure	Data Used	Method
Surficial Soil	Direct Contact by Resident	Consider unpaved area	Average
	Direct Contact by Commercial Worker	Consider unpaved area	Average
	Direct Contact by Future Construction Worker	Consider potential unpaved area	Maximum
Subsurface Soil	Indoor Inhalation by Resident	Consider building footprint area	Average
	Indoor Inhalation by Commercial Worker	Consider building footprint area	Average
Ground Water	Indoor Inhalation by Resident	Consider building footprint area	Average
	Indoor Inhalation by Commercial Worker	Consider building footprint area	Average
	Outdoor Inhalation by Commercial Worker	Consider unpaved area	Average

As presented in Table 9-1, a representative concentration is estimated for each complete ROE. Various methods available to estimate the representative concentrations are discussed in Appendix L. Use of the maximum concentration as the representative concentration is most conservative and also the easiest to calculate when compared with other representative concentrations (average, area-weighted average, upper limit of the 95% confidence interval around the mean). Thus, if the risk calculated using the maximum concentration is acceptable, considerable computational effort can be avoided.

For both surficial and subsurface soils, the estimation of the representative concentration assumes the site is adequately characterized. Representative soil concentrations used to evaluate protection of the ground water pathway should be calculated based on soil data collected within the source area only.

Soil data from the most recent investigation (assuming it was a comprehensive investigation) should be used. Use of older (> 4 years old) soil data is discouraged. Where only older (> 4 years old) data are available, the maximum value may be suitable, if there have been no additional releases since data were collected. If a new release has or may have occurred, soil assessment activities adequately characterizing current conditions should be performed.

The responsible party should collect soil data representative of current conditions to estimate the representative concentration. New data collection efforts should be documented in a work plan and approved by DEQ.

9.2.1 Surficial Soil

Representative concentrations should be determined based on available surficial soil concentration data within the area over which a receptor may be exposed to surficial soil. This may include areas outside the source area. Maximum surficial soil concentrations from recent investigations should be noted.

9.2.2 Subsurface Soil

Representative concentrations should be calculated using available source area subsurface soil concentration data. Maximum subsurface soil concentrations from most recent investigations should be noted.

9.2.3 Ground Water

Based on the site conceptual model, several representative ground water concentrations may have to be estimated at a site. These could include representative concentrations for the source area, compliance wells, protection of indoor inhalation on site, protection of indoor inhalation off site, and off site areas.

If adequate data obtained from appropriate locations are available to characterize the areal extent of contamination in all areas of concern, an RE-1 can be performed at sites using data from a minimum of two discrete sampling events. If temporal data indicate significant variability, additional samples may be required prior to conducting the RE-1. In addition, subsequent to risk evaluation, DEQ may require additional monitoring data to be collected. If recent ground water data (< one year old) is unavailable, current data will be necessary for the RE-1. Data collection objectives should be documented in a work plan approved by DEQ.

9.3 STEP 3: ESTIMATE RISK AND TARGET LEVELS

As presented in Section 3.7.1, for each receptor the cumulative risk and HI at a site for all COCs and complete ROEs (except ingestion of water) should not exceed $1x10^{-5}$ and 1 respectively.

If estimated site risk or HI exceeds these levels and RE-2 will not be performed, RE-1 target levels (RATL-1) for each COC and complete ROE should be developed. An RMP should then be implemented to attain these target levels at the site, thus meeting cumulative risk and HI criteria.

Target levels must be estimated using an allocated risk process: apportioning allowable (target) cumulative risk and HI to each chemical-pathway combination. As no unique way to apportion the cumulative risk exists several alternatives are available. Common alternatives are listed below:

- Apportion cumulative risk equally among all complete chemical-pathway combinations,
- Apportion cumulative risk proportional to chemical toxicity, or
- Apportion cumulative risk so target concentration levels are proportional to representative concentrations.

To develop RATL-1 and RATL-2 concentrations, the default option selected by DEQ apportions cumulative risk and HI equally among all contributing chemical-pathway combinations. This methodology is implemented in the computational software developed to complement this guidance.

Site-specific considerations may result in a responsible party choosing to utilize a different method for calculating target levels. For example, at a site having volatile and semi-volatile COCs contributing to the cumulative risk, the responsible party may choose a technology that specifically reduces the volatile chemical's concentrations but marginally reduces the concentration of the semi-volatile chemical. A different responsible party may choose to significantly reduce the concentration of the semi-volatile chemical and marginally reduce the concentration of the volatile chemical. The two strategies will result in different cleanup levels for each chemical; however, both will be acceptable provided cumulative risk meets acceptable risk criteria.

9.3.1 Developing Target Levels

The default method for developing target levels is described in the following steps:

Step 1: Based on complete or potentially complete routes of exposure identified earlier and estimated representative concentrations, calculate the corresponding risk ($Risk_{i,j}^{rep}$) and hazard quotient ($HQ_{i,j}^{rep}$) for each chemical (i) for each complete pathway (j).

Inputs used to calculate risk and HQ are discussed in Section 3.7. Results can be used to generate a matrix of risk and HQ values as shown in (Table 9-2) below.

Table 9-2 Example Matrix for Calculation of Remedial Action Target Levels

COC	Pathway						Cumulative		Number	
	Pathway 1		Pathway 2		Pathway 3		Risk	HI	Carc.	Non-carc.
	Risk	HQ	Risk	HQ	Risk	HQ				
C1	X	N/A	X	N/A	-	N/A	SUM	SUM	2	0
C2	N/A	X	N/A	X	N/A	X	SUM	SUM	0	3
C3	N/A	X	-	X	N/A	X	SUM	SUM	0	3
C4	X	N/A	X	N/A	X	N/A	SUM	SUM	3	0
C5	X	X	N/A	X	N/A	X	SUM	SUM	1	3
Site Cumulative							**$Risk_{site}$= SUM(SUM)**	**HI_{site}= SUM(SUM)**	**6**	**9**

X: Pathway complete.

N/A: Not applicable because there is no relevant toxicity data or physical-chemical property.

- : Not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a COC for the pathway being evaluated based on release history or based on site characterization data.

Step 2: Calculate cumulative risk and HI at the site (site risk and site HI).

$$Risk_{site} = \sum_{i=1}^{n_c} \sum_{j=1}^{m_i} Risk_{i,j}$$

$$HI_{site} = \sum_{i=1}^{n_{nc}} \sum_{j=1}^{m_i} HQ_{i,j}$$

Where:

$Risk_{i,j}$ = Risk from exposure to chemical i through pathway j

$HQ_{i,j}$ = Hazard quotient for exposure to chemical i through pathway j

m_i = Number of complete pathways for chemical i (the suffix to m indicates that the number of complete pathways can be different for different chemicals)

n_c = Number of carcinogenic chemicals at the site

n_{nc} = Number of non-carcinogenic chemicals at the site

If the cumulative risk and HI for all the receptors at the site are below the acceptable levels, the site does not require the development of RATL-1. Site closure may be appropriate if other required regulatory issues have been resolved.

Step 3: Determine the number of chemical-pathway combinations (for carcinogens and non-carcinogens separately) at the site.

Number of chemical-pathway combinations for carcinogens, $$N_c = \sum_{i=1}^{n_c} \sum_{j=1}^{m_i} p_{i,j}$$

Number of chemical-pathway combinations for non-carcinogens, $$N_{nc} = \sum_{i=1}^{n_{nc}} \sum_{j=1}^{m_i} p_{i,j}$$

Where:

$p_{i,j}$ = Complete pathway for chemical i and pathway j

m_i = Number of complete pathways for chemical i (the suffix to m indicates that the number of complete pathways can be different for different chemicals)

n_c = Number of carcinogenic chemicals at the site

n_{nc} = Number of non-carcinogenic chemicals at the site

Note that some chemicals show both carcinogenic and non-carcinogenic toxicity and should be counted in both categories. For example, chemical C5 in the example above has three complete pathways for the non-carcinogenic effects and one pathway for the carcinogenic effects.

Step 4: Based on equal apportioning of target cumulative risk and HI, compute allocated risk and HQ contribution by chemical i through pathway j using:

$$Risk_{i,j}^{allocated} = \frac{1 \times 10^{-5}}{N_c}$$

$$Risk_{i,j}^{allocated} = \frac{1}{N_{nc}}$$

Step 5: Estimate the risk reduction factor (RRF) in risk or HQ required so the contribution by chemical i acting through pathway j is equal to the allocated risk or allocated HQ.

Risk reduction factor for chemical i acting through pathway j:

$$RRF_{i,j} = \frac{Risk_{i,j}^{rep}}{Risk_{i,j}^{allocated}}$$

Hazard quotient reduction factor for chemical i acting through pathway j:

$$HQRF_{i,j} = \frac{HQ_{i,j}^{rep}}{HQ_{i,j}^{allocated}}$$

Step 6: Calculate the target level for chemical i acting through pathway j.

For carcinogens:

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{RRF_{i,j}}$$

For non-carcinogens:

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{HQRF_{i,j}}$$

If a chemical has $C_{i,j}^{allowable}$ ***based on carcinogenic and non-carcinogenic toxicity, the applicable RATL for that chemical should be the lower of the two allowable concentrations.***

9.3.2 Developing Target Levels: Example

The following is an example of target level calculations described in Section 9.3.1. Table 9-3 presents fictitious representative concentrations for each of five chemical and three pathways, two of which are soil and one ground water.

Table 9-3 Fictitious Representative Concentrations Used in Target Level Calculation Example

COC	Pathway		
	P1(mg/kg)	P2 (mg/kg)	P3 (mg/l)
C1	1	2	--
C2	2	4	2
C3	3	6	3
C4	4	8	4
C5	5	10	5

Step 1: Use these representative concentrations to calculate risk and HQ for each chemical and pathway the chemical acts through. The resulting matrix of risk and HQ values is shown in Table 9-4.

Table 9-4 Example of Risk/COC/Pathway Matrix for Target Level Calculation

COC	Pathway						Cumulative		Number	
	Pathway 1		Pathway 2		Pathway 3		Risk	HI	Carc.	Non-carc.
	Risk	HQ	Risk	HQ	Risk	HQ				
C1	1E-5	N/A	2E-5	N/A	N/A	N/A	3E-5	N/A	2	0
C2	N/A	1	N/A	3	N/A	1	N/A	5	0	3
C3	N/A	1	-	1	N/A	3	N/A	5	0	3
C4	1E-5	N/A	1E-5	N/A	1E-5	N/A	3E-5	N/A	3	0
C5	2E-5	1	N/A	1	N/A	1	1E-5	3	1	3
						Site Cumulative	**$Risk_{site}$= 7E-5**	**HI_{site}= 13**	**6**	**9**

N/A: Not applicable because there is no relevant toxicity data or physical-chemical property or because there was no entry under representative concentrations. This could mean that the chemical is not a COC for the pathway being evaluated based on release history or based on site characterization data.

-: Not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a COC for the pathway being evaluated based on release history or based on site characterization data.

Step 2: Calculate the cumulative site risk and HI for all chemicals and pathways for a given receptor (in this case the risk and HI are 7x10-5 and 13, respectively).

Step 3: Determine the number of chemical-pathway combinations (for carcinogens and non-carcinogens separately) at the site. In this example the number of chemical-pathway combinations for carcinogens is six and the number of chemical-pathway combinations for non-carcinogens is nine.

Step 4: Based on equal apportioning of the target cumulative risk and HI, calculate the allocated risk and HQ contribution by chemical i through pathway j.

Step 5: Estimate the RRF in risk or HQ required so that the contribution by a given chemical acting through a particular pathway is equal to the allocated risk or HQ.

$$Risk_{i,j}^{allocated} = \frac{1\times10^{-5}}{6} = 1.67\times10^{-6}$$

$$HQ_{i,j}^{allocated} = \frac{1}{9} = 0.111$$

Risk reduction factor for chemical i acting through pathway j:

$$RRF_{i,j} = \frac{Risk_{i,j}^{rep}}{Risk_{i,j}^{allocated}}$$

Hazard quotient reduction factor for chemical i acting through pathway j:

$$HQRF_{i,j} = \frac{HQ_{i,j}^{rep}}{HQ_{i,j}^{allocated}}$$

The calculations of the RFs for the example are presented in Table 9-5. At actual sites the reduction factors are rarely uniform as in the example.

Table 9-5 Reduction Factor Example for Target Level Calculations

COC	Pathway					
	Pathway 1		Pathway 2		Pathway 3	
	RRF	**HQRF**	**RRF**	**HQRF**	**RRF**	**HQRF**
C1	1E-5/1.67E-6 = **5.99**	N/A	2E-5/1.67E-6 = **11.98**	N/A	-	N/A
C2	N/A	1/0.111 = **9.0**	N/A	3/0.111 = **27.0**	N/A	1/0.111 = **9.0**
C3	N/A	1/0.111 = **9.0**	-	1/0.111 = **9.0**	N/A	3/0.111 = **27.0**
C4	1E-5/1.67E-6 = **5.99**	N/A	1E-5/1.67E-6 = **5.99**	N/A	1E-5/1.67E-6 = **5.99**	N/A
C5	2E-5/1.67E-6 = **11.98**	1/0.111 = **9.0**	N/A	1/0.111 = **9.0**	N/A	1/0.111 = **9.0**

N/A: Not applicable because there is no relevant toxicity data or physical-chemical property or because there was no entry under representative concentrations. This could mean that the chemical is not a COC for the pathway being evaluated based on release history or based on site characterization data.

-: Not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a COC for the pathway being evaluated based on release history or based on site characterization data.

Step 6: Calculate the target level for a chemical acting through a given pathway.

For carcinogens:

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{RRF_{i,j}}$$

For non-carcinogens:

$$C_{i,j}^{allowable} = \frac{C_{i,j}^{rep}}{HQRF_{i,j}}$$

The resulting RATL calculations, carcinogenic and/or non-carcinogenic, for the example are presented in Table 9-6. The RATL concentrations are presented in bold.

Table 9-6 Example RATL Concentrations for Target Level Calculations

COC	Pathway					
	Pathway 1 (mg/kg)		Pathway 2 (mg/kg)		Pathway 3 (mg/l)	
	RATLc	RATLnc	RATLc	RATLnc	RATLc	RATLnc
C1	1/5.99 = **0.17**	N/A	2/11.98 = **0.17**	N/A	-	N/A
C2	N/A	2/9.0 = **0.222**	N/A	4/27.0 = **0.148**	N/A	2/9.0 = **0.222**
C3	N/A	3/9.0 = **0.333**	-	6/9.0= **0.667**	N/A	3/27.0 = **0.111**
C4	4/5.99 = **0.67**	N/A	8/5.99 = **1.34**	N/A	4/5.99 = **0.67**	N/A
C5	5/11.98 = **0.42**	5/9.0 = **0.555**	N/A	10/9.0 = **1.11**	N/A	5/9.0 = **0.555**

N/A: Not applicable because there is no relevant toxicity data or physical-chemical property or because there was no entry under representative concentrations. This could mean that the chemical is not a COC for the pathway being evaluated based on release history or based on site characterization data.

-: Not calculated because there was no entry under representative concentrations. This could mean that the chemical is not a COC for the pathway being evaluated based on release history or based on site characterization data.

In this example, for chemical C5 and pathway P1, both carcinogenic and non-carcinogenic RATLs are calculated. The lower of the two, 0.42 mg/kg, (the carcinogenic RATL, would be used.

9.4 STEP 4: MAKE RECOMMENDATIONS FOR THE NEXT COURSE OF ACTION

After calculating site risks as mentioned above, the responsible party should document and submit results to DEQ with recommendations for further actions required at the site. If the following conditions are met, DEQ may issue a "no further action" (NFA) letter:

- The site satisfies all (individual COC, ROE, and cumulative) risk conditions discussed in Section 3-7,
- No nuisance conditions exist,
- Free product (both DNAPL and light non-aqueous phase liquid [LNAPL]) has been removed to the maximum extent practicable,
- DEQ agrees with the overall RE-1,
- Fate and transport parameters used to estimate RATL-1 values are either representative of those used as defaults in the RE-1 or are more conservative, and
- No wells have increasing concentrations or concentrations consistently above the target levels. Thus, an important requirement for NFA is a ground water plume that is stable or decreasing in size and concentration.

If the calculated RE-1 risk or hazard exceeds acceptable risk values, or any of the above conditions are violated, the following two risk management alternatives are available.

The responsible party should carefully review site conditions and recommend one of the two alternatives listed below. The selection will most likely be based on technical feasibility and cost-benefit considerations. For example, where the cost of cleanup is low (relative to the potential benefits of modified target levels developed through additional data collection and analysis under a RE-2), it may be preferable to adopt RE-1 target levels as cleanup levels.

9.4.1. Alternative 1: Select RE-2 Evaluation

The responsible party conducts a RE-2, which may require acquisition of additional site data, use of other fate and transport models, and more sophisticated analyses. RE-2 may be desirable when fate and transport assumptions used in RE-1 are significantly different from known or suspected site-specific conditions and incorporation of those different assumptions or data results in significantly different estimates of risk or target levels. Default fate and transport parameters used in RE-1 calculations are provided in Table 3-2. For example, at sites where depth to ground water is less than the RE-1 default depth of 300 cm it will be necessary to perform an RE-2. An RE-2 may also be necessary if additional COCs are discovered.

9.4.2 Alternative 2: Remediate to RE-1 Values

The responsible party develops a risk management plan to remediate the site to RE-1 cleanup levels. The RMP must be approved by DEQ.

10.0 RISK EVALUATION-2

This section provides details for the Risk Evaluation-2. This level of evaluation should be used when:

- Representative concentrations developed for estimated RE-1 risks are based on inadequate sample data,
- RE-1 assumptions are sufficiently different from site-specific conditions, so that the estimated RE-1 risks may not be representative of site-specific conditions,
- Site-specific COCs are not listed in the RE-1 tables,
- The site has significant ecological risk issues that require evaluation, or
- Target levels are exceeded and it is determined that remediation of the site to RE-1 levels may not be feasible.

As indicated in Section 2, an RE-2 evaluation may also be undertaken without having completed an IDTL or RE-1 evaluation, if adequate data is determined to be available. In these instances DEQ should be contacted to assist in the determination of data adequacy.

As indicated in Table 2-1, RE-2 allows considerable flexibility related to the use of alternative fate and transport models and input parameters. Since RE-2 provides considerable flexibility it it is recommended that the responsible party develop an overall work plan clearly outlining the methodology and input parameters used.

Depending on differences between RE-1 and the proposed RE-2 evaluation, the work plan may be in the form of a letter or a formal report. For example, if the proposed RE-2 will use all default models and parameters except site-specific soil geotechnical parameters, a letter work plan may be sufficient. However, if the proposed RE-2 includes the use of alternative models or data evaluation methods, a more detailed work plan may be necessary.

10.1 CONTENTS OF A RE-2 WORK PLAN

The RE-2 work plan should address each item discussed in Sections 10.1.1 through 10.1.7.

10.1.1 Site Background

This portion of the work plan may refer to documents previously submitted to DEQ; it is not necessary to repeat the entire site background description. Reference should be made to document(s) that contain a comprehensive chronology of site investigations.

10.1.2 Site Conceptual Model

In most cases where a RE-1 has been completed, this step will involve either revisions to the previously developed SCM or reference to the previously submitted SCM if no revisions are necessary. Refer to Section 4.2 for the content of the SCM.

10.1.3 Exposure Model

If not already completed, an EM that identifies complete routes of exposure and pathways should be developed. All COCs and all complete routes of exposure should be evaluated under RE-2 (even those that satisfy RE-1 levels). Thus, the EM for RE-2 will be exactly the same as that for RE-1, unless additional information warrants a change. The work plan should contain a complete description of the EM.

10.1.4 Calculating RATL-2 Levels

This section presents the input parameters for calculating RATL-2.

10.1.4.1 Target Risk

RE-2 uses the same acceptable carcinogenic and non-carcinogenic levels used in RE-1. Specific target levels are presented in Section 3.7.1.

10.1.4.2 Exposure Factors

The responsible party may use exposure factors used in RE-1. Alternate exposure factors may be proposed in the work plan. These factors must be justified and acceptable to DEQ. RE-1 exposure factor values are listed in Table 3-2.

10.1.4.3 Physical and Chemical Properties

Responsible parties may use physical and chemical properties of the COCs as listed in Appendix G. Alternate physical and chemical properties for listed COCs may be proposed, but must be justified and accepted by DEQ prior to use. If a COC is not listed, physical and chemical properties of the COC and data source should be provided.

10.1.4.4 Toxicity

DEQ requires that toxicity values listed in Appendix D be used. For other COCs, the evaluator must propose and justify toxicity values to be used.

10.1.4.5 Fate and Transport Models

For RE-2, the responsible party may use models and algorithms used in RE-1 or propose alternative models. If alternative models are proposed, the work plan must include reasons for using alternative models and demonstrate proposed models will better simulate site-specific conditions. Specific models to be used must be identified in the work plan. Alternative models must be approved by DEQ prior to implementation and acceptance of calculated RATL-2.

10.1.4.6 Fate and Transport Parameters

DEQ requires use of representative site-specific fate and transport parameters for RE-2. At a minimum, site measured values of soil source dimensions, depth to subsurface soil sources, thickness of capillary fringe, thickness of vadose zone, depth to ground water, hydraulic gradient, hydraulic conductivity, and distances to the point of exposure and point of compliance must be used. Where site-specific values are not available, professional judgment must be used to determine whether to perform additional assessment or t use appropriate literature values. If additional data is necessary, proposed collection efforts should be included in the work plan for approval by DEQ prior to performing RE-2. The work plan should include either the value of each parameter or the method used to estimate it.

DEQ will allow use of chemical-specific biological decay rates in the fate and transport models based on site-specific historic monitoring well data. Refer to Appendix K for data necessary to demonstrate occurrence of natural attenuation and methods to calculate decay rates. Note that use of decay rates in RE-2 must be justified based on site-specific information including, but not limited to:

- Consistent decreasing concentration trends in properly located and constructed monitoring wells, and
- Measurements of natural attenuation parameters that provide evidence of biodegradation.

10.1.5 Calculating Representative Concentrations

Representative soil and ground water concentrations are calculated as for RE-1 (see Appendix L) and these representative concentrations may be used to estimate site risk. If site risk exceeds the acceptable risk level, the work plan should specify the method to be used to develop RATL-2. The work plan should include a discussion of how representative concentrations will be calculated.

10.1.6 Calculating Risk and RE-2 Levels

The process of calculating risk and RE-2 target levels (RATL-2) is similar to the process for RE-1, described in Section 9.0.

10.1.7 Schedule and Deliverables

The work plan should include an overall project schedule and deliverables that will be submitted to DEQ. The schedule should include any agency meetings necessary during workplan implementation.

10.2 IMPLEMENTING THE WORK PLAN

Upon receipt of work plan approval, the responsible party should implement the work plan as per the schedule in the work plan. In case there are delays, it is the responsible party's duty to inform DEQ of the delay and revised schedule.

Upon completion of work, the responsible party should document the results and submit them to DEQ. The RE-2 report must include recommendations and the future course of action, as discussed below.

10.3 FUTURE ACTIONS

After the completion of a RE-2, DEQ may determine the site can be considered for no further action if the following conditions are met:

- The cumulative risk does not exceed the target risk,
- No nuisance conditions exist,
- Potential impacts to unaffected portions of the aquifer or underlying aquifers have been evaluated and addressed,
- LNAPL free product, where present, has been removed to the maximum extent practicable,
- DEQ agrees with the RE-2 and determines additional confirmatory or compliance point monitoring is not necessary, and
- Other regulatory issues associated with the site or facility are resolved, such as adequate fulfillment of all terms of any consent order or compliance agreement.

If target risk exceeds the acceptable risk level, RATL-2 concentrations must be developed and proposed. Upon acceptance of these target levels as cleanup levels by DEQ, the responsible party will prepare a RMP as discussed in Section 11.

11.0 DEVELOPING AND IMPLEMENTING RISK MANAGEMENT PLANS

Development and implementation of RMP is the last step in the risk evaluation process. If, after the IDTL screening or RE-1, an unacceptable risk to a receptor is identified and the responsible party has chosen not to perform additional evaluation, the responsible party must develop cleanup levels and create a plan to achieve those cleanup levels. If a RE-2 identifies an unacceptable risk, the only option available to the responsible party is to develop and implement a RMP. Cleanup levels may be developed as in a RE-1, or alternative strategies to manage the unacceptable risk may be proposed.

The overall objective of a RMP is to ensure that residual soil and ground water concentrations are protective of human health and the environment. The remedial strategies described in the RMP depend on the results of the risk evaluation (which pathways, chemicals, and media are responsible for the unacceptable risk) and other circumstances unique to the site.

Examples of activities that may be conducted under a RMP include, but are not limited to:

- Actively remediate to achieve applicable target levels. This may require collecting data during remediation to demonstrate that active remediation is working, the site is being remediated according to schedule. Data will also be used to confirm that the remediation goals are met.
- Remediate through natural attenuation to achieve target levels. This requires monitoring or collecting data until remediation goals are met. Refer to Appendix K for more details.
- Establish institutional controls to prevent unacceptable exposures.

11.1 CONTENTS OF A RISK MANAGEMENT PLAN

A RMP must include a discussion of each of the following items:

- A brief site description,
- A brief description of the risk evaluation approved by DEQ, including assumptions used for receptors and land use, and a list of approved cleanup levels for specific pathways, media, chemicals, and specific areas of the site (if applicable),
- A clear description of reasons an RMP is needed,
- An identification of the area(s) to be managed under the RMP,

- A description of the strategy selected to achieve cleanup goals, including a comparison and evaluation of remedial alternatives considered in development of the overall strategy. A rationale for the strategy selected should be presented. Any data collected in support of or to determine the feasibility of a particular remedial measure such as pilot testing, should be presented, and
- An implementation schedule for the selected strategy. The implementation schedule should include the following items:
  - An overall RMP schedule and the projected endpoint
  - The type, quantity, frequency, and method of data collection
  - A description of data evaluation methods
  - A description of a backup plan if risk management activities are not as effective as anticipated
  - A reporting schedule.

11.2 IMPLEMENTING A RISK MANAGEMENT PLAN

Upon approval of the RMP, the responsible party must implement the plan according to the proposed schedule. Major deviations in schedule or plan implementation must be communicated to DEQ for review and approval well in advance of proposed implementation, along with recommended modifications if necessary. All performance data should be evaluated and submitted to DEQ in a timely manner. Upon completion of RMP activities, the responsible party should document relevant activities and as appropriate, request site closure. Additional confirmatory sampling may be required to demonstrate RMP completion prior to a request for NFA.

When the RMP has been successfully implemented, the site has been remediated to the established levels, and all other site conditions are otherwise acceptable to DEQ, the responsible party may petition DEQ for NFA.

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