ILLINOIS POLLUTION CONTROL BOARD
April 17, 1997

IN THE MATTER OF:	)	
	)	
TIERED APPROACH TO CORRECTIVE	)	R97-12 (A)
ACTION OBJECTIVES (TACO): 35 ILL.	)	(Rulemaking - Land)
ADM. CODE PART 742	)	

Proposed Rule. Second Notice.

OPINION AND ORDER OF THE BOARD (by M. McFawn and J. Yi):

On September 16, 1996 the Illinois Environmental Protection Agency (Agency) filed a proposal to add a new Part 742 to the Board s rules, which would create a tiered approach to establishing corrective action objectives (also known as TACO). The Board accepted this matter for hearing on September 19, 1996. On November 7, 1996, the Board sent this matter to First Notice without commenting on the merits of the proposal. By today s action, the Board sends the proposal to Second Notice, pursuant to the Administrative Procedure Act (5 ILCS 100/1-1 *et seq.* (1994)), for consideration by the Joint Committee on Administrative Rules.

The proposed rules create a tiered approach to establishing corrective action, *i.e.* remediation objectives, based on risks to human health and the environment, allowing consideration of the proposed land use at a subject site. Although this approach is premised upon the statutory mandates in the Site Remediation Program legislation (P.A. 89-431, as amended by P.A. 89-443), it is intended to apply to all types of remediation programs under the Act, including not only the Site Remediation Program, but also the Underground Storage Tank and the Resource Conservation and Recovery Act programs.

PROCEDURAL HISTORY

The proposed rules are required by P.A. 89-431, which was signed and became effective December 15, 1995, as amended by P.A. 89-443, effective July 1, 1996. P.A. 89-431, as amended by P.A. 89-443, added Title XVII to the Environmental Protection Act (Act)(415 ILCS 5/1 *et seq.* (1994)), also known as the Site Remediation or Brownfield legislation. Title XVII is intended to achieve five objectives. Those objectives are to: 1) establish a risk-based system of remediation based on the protection of human health and the environment relative to present and future use of the land; 2) assure that the land use for which remedial action was undertaken will not be modified without consideration of the adequacy of such remedial action for the new land use; 3) provide incentives for the private sector to undertake remedial action; 4) establish expeditious alternatives for the review of site investigation and remedial activities, including a privatized review process; and 5) assure that

the resources of the Hazardous Waste Fund are used in a manner that is protective of human health and the environment relative to present and future uses of the site and surrounding area. The proposed TACO rules are intended to achieve the first two of these objectives.

As noted by the Board in its September 19, 1996 order, the Agency filed two additional rulemaking petitions when it filed this rulemaking: a proposal for a new Part 740, In the Matter of: *Site Remediation Program and Groundwater Quality*, establishing procedures for the Site Remediation Program, docketed as R97-11; and In the matter of: *Leaking Underground Storage Tanks* docketed as R97-10, a proposal to amend the regulations governing underground storage tanks. Like the TACO rules in the instant docket, the Site Remediation Program was mandated by P.A. 89-431, while the underground storage tank amendments were mandated by P.A. 89-457, effective May 22, 1996. The TACO rules provide the acceptable methodologies for determining site-specific, risk-based remediation objectives. The programs to which TACO applies govern the scope and extent of the site investigation preceding the application of TACO, as well as the no further remediation determination made by the Agency after the TACO derived remediation objectives are achieved.

Docket B

Today the Board also adopts a separate opinion and order creating a Docket B. The Board finds it necessary to propose for First Notice new rules concerning a single issue. The Agency has requested that the Board adopt a mixture rule, *i.e.*, a rule which requires that an applicant consider the cumulative effect of similar-acting contaminants at a site when developing the appropriate remediation objectives. For the most part, the Agency s request was developed in a series of filings subsequent to the public hearings in this matter, and with minimum justification in support of such rules. Initially, the Agency only requested a mixture rule under Tier 2 for noncarcinogenic chemicals. In its later filings, the Agency requests that the Board also adopt a mixture rule applicable to the development of groundwater remediation objectives under Tier 1 for both carcinogenic and noncarcinogenic chemicals, and further requests that the Tier 2 rule be applicable to carcinogenic chemicals in groundwater. There is insufficient information in the record for the Board to adopt in its entirey the mixture rule ultimately requested by the Agency. The justification provided in support of expanding the rule s applicability however does indicate that absent such a rule, remediation objectives determined using TACO may not be protective of human health at sites with multiple, similar-acting chemicals. Therefore, the Board finds it necessary to clearly examine the mixture rule proposed by the Agency to determine to what extent it is necessary to insure that the remediation objectives developed under TACO are protective of human health in all circumstances. Docket B is opened for that purpose.

The Board has a statutory deadline of June 16, 1997 to finalize the TACO proposal presented by the Agency on September 16, 1996. Because this issue was introduced so late in this rulemaking process, it cannot be fully examined and resolved within that timeframe. In order to meet the statutory deadline for adopting rules based upon the Agency s proposal, the Board finds it necessary to bifurcate this rulemaking. As expeditiously as possible, the Board

will hold hearings under the new Docket B and proceed to final adoption of a mixture rule, to the extent such is demonstrated to be necessary.

Development of the Proposal

Section 58.11 of the Act, adopted as part of the Site Remediation Program legislation, created the Site Remediation Advisory Committee (SRAC) to advise the Agency in developing the mandated TACO and the Site Remediation Program regulatory proposals. The SRAC consists of one member from each of the following organizations: the Illinois State Chamber of Commerce, the Illinois Manufacturers Association, the Chemical Industry Council of Illinois, the Consulting Engineers Council of Illinois, the Illinois Bankers Association, the Community Bankers Association of Illinois, and the National Solid Waste Management Association. In addition, representatives from the Illinois Petroleum Council, the Illinois Petroleum Marketers Association, and the City of Chicago participated. The Agency met with the SRAC, or subgroups thereof, ten times between March 14, 1996 and August 30, 1996, to discuss both the instant proposal and the proposed rules for the Part 740 Site Remediation Program. The Agency testified that, although minor differences may exist, consensus was reached on all major issues. (See Exh. 1 at 11.)

The Agency filed its proposal for rulemaking on September 16, 1996, accompanied by a motion for acceptance of proposal, the statement of reasons, and a motion regarding incorporations by reference. On September 19, 1996, the Board accepted this matter for hearing and granted the motion regarding incorporations by reference. Additionally, the Board directed the Agency to file a completed copy of the economic impact form required by the Joint Committee on Administrative Rules. The Agency submitted its economic impact form on October 28, 1996. On November 7, 1996, the Board sent this matter to First Notice without commenting on the merits of the proposal. Subsequently, on December 6, 1996 the proposal was published in the *Illinois Register* (20 Ill. Reg. 15429).

Two sets of hearings were held in this matter during First Notice. The first set of hearings, held on December 2 and 3, 1996, in Chicago, and on December 10, 1996 in Springfield, was reserved for the Agency s presentation of its proposal and questions for Agency witnesses. The second set of hearings, held on January 15 and 16, 1997 in Springfield, was for the purpose of addressing remaining questions for the Agency, allowing the presentation of testimony by other interested participants, and allowing questions directed to those testifying.

At the first hearing, the Agency presented the testimony of four witnesses: Mr. Gary King, who provided an overview of the proposal, and testified concerning Subpart A (Introduction), Subpart C (Exposure Route Evaluation), Subpart J (Institutional Controls) and Subpart K (Engineered Barriers); Mr. John Sherrill, who testified concerning Subpart B (General), Subpart E (Tier 1 Evaluation), Subpart F (Tier 2 General Evaluation), Subpart G (Tier 2 Soil Evaluation), Subpart H (Tier 2 Groundwater Evaluation), Appendix A (General), Appendix B (Tier 1 Tables and Illustrations), Appendix C (Tier 2 Tables and Illustrations), and Appendix D (Procedures for Determination of Class II Groundwater); Dr. Thomas

Hornshaw, who testified concerning Subpart D (Determining Area Background), Subpart E (Tier 1 Evaluation), Subpart F (Tier 2 General Evaluation), and Subpart H (Tier 2 Groundwater Evaluation); and Ms. Tracey Virgin, who testified concerning Subpart I (Tier 3 Evaluation). Additionally, the Agency had four additional personnel available throughout the proceedings to respond to questions: Messrs. Ken Liss, Douglas Clay, Jim O Brien, and Lawrence Eastep.

At the second set of hearings, the following persons presented testimony concerning the rulemaking proposal: 1) Mr. Harry Walton, on behalf of the Illinois State Chamber of Commerce, the Illinois Manufacturers Association, and the Illinois Environmental Regulatory Group; 2) Ms. Karen Lyons, on behalf of the Illinois Petroleum Council; 3) Mr. John Watson and Ms. Linda Huff, on behalf of Gardner Carton & Douglas, and a coalition of clients including B.F. Goodrich Company, Commonwealth Company, Hydrosol Inc., INX International Ink Company, Northern Illinois Gas Company, William Wrigley Jr. Company, and Woodward Governor Company (the Site Remediation Coalition); 4) Mr. Ray Reott, on behalf of Jenner & Block; and 5) Mr. David Rieser, on behalf of the Illinois Steel Group.

The following exhibits were submitted at hearing:

Exhibit No.	**Exhibit Name**
1.	Pre-filed Testimony of Gary King re: Legislation and Regulatory Development, submitted December 2, 1996.
2.	Pre-filed Testimony of Gary King re: Subparts A and C, submitted December 2, 1996.
3.	Pre-filed Testimony of Gary King re: Subparts J and K, submitted December 2, 1996.
4.	Pre-filed Testimony of John Sherrill re: Subparts B, E, F, G, and H, and Appendices A, B, C, and D with Attachments A through H , submitted December 2, 1996.
5.	Pre-filed Testimony of Dr. Thomas Hornshaw re: Subparts D, E, F, and H, with Attachments A through D, submitted December 2, 1996.
6.	Pre-filed Testimony of Tracey Virgin re: Subpart I, submitted December 2, 1996.
7.	Agency Errata Sheet No. 1, submitted December 2, 1996.
8.	Agency s Revised 742.Appendix A though Appendix D, submitted December 2, 1996.
9.	Agency Table: Comparison of Physical/Chemical Constants Used in ASTM s Risk Based Corrective Action Example Look-up Table (Table X2.1) and Part 742 Tier I Tables (Appendix B, Tables A and B).
10.	Agency 3-page Handout: 742.600(e) - (g) Tier 2 Examples 1 - 3.

11. Agency Errata Sheet No. 2.

12. Pre-filed Testimony of Harry Walton.

13. Pre-filed Testimony of Karen Lyons, with Attachments A, B, and C.

14. Pre-filed Testimony of John Watson, with Attachments A and B.

15. Pre-filed Testimony of Linda L. Huff, with Attachments A and B.

16. Group Exhibit 16, Attachments C, D, E, F, and G to Pre-filed Testimony of Linda Huff.

17. Group Exhibit 17 from Pre-filed Testimony of Linda Huff - Documents from other states programs: Michigan (Documents A and D), Massachusetts (Document B), and Indiana (Document C).

18. Pre-filed Testimony of Ray Reott of Jenner & Block.

19. Group Exhibit 19, Attachments A, B, and C to Pre-filed Testimony of Ray Reott of Jenner & Block.

20. Agency s Rebuttal Testimony.

21. Agency s Second Revised Appendices A, B, C, and D.

In addition to the testimony presented at hearing and the exhibits submitted at hearing, the following public comments were submitted into the record:

PC No.	Public Comment	Date
1.	Comment of Robert L. Johnson, P.E.	1/2/97
2.	Technical Assistance Document for complying with the TC rule and Implementing the Toxicity Characteristic Leaching Procedure (TCLP), submitted by Ray Reott of Jenner & Block.	1/24/97
3.	Letter to Doug Clay, Bureau of Land, Illinois Environmental Protection Agency.	1/27/97
4.	Post-Hearing comments of the Illinois Environmental Regulatory Group, submitted by Whitney Wagner Rosen.	2/20/97
5.	Post-Hearing comments of the Site Remediation Advisory Committee, submitted by Whitney Wagner Rosen.	2/20/97

6.	Post-Hearing Comments submitted by Scott R. Green, C.P.G. Chicago, Illinois.	2/20/97
7.	Post-Hearing Comments of the Illinois Steel Group, submitted by David L. Rieser.	2/20/97
8.	Post-Hearing Comments of the Illinois Petroleum Council, submitted by David L. Rieser.	2/20/97
9.	Final Comments of Gardner Carton & Douglas, submitted by Lewis Putman.	2/21/97
10.	Final Comments of the Illinois Environmental Protection Agency, including final errata changes.	2/24/97
11.	Comments of Mayer, Brown & Platt, submitted by Patricia F. Sharkey.	2/24/97
12.	Pre-filed testimony of Roy O. Ball on behalf of the Illinois Steel Group.[1]	12/24/96
13.	Comments of the City of Chicago submitted by Henry L. Henderson, Commissioner.	3/13/97
14.	Comment from SEECO Environmental Services, Inc. submitted by Collin w. Gray, S.E., P.E., President.	3/13/97
15.	Additional Comments of the Illinois Environmental Protection Agency submitted by Kimberly A. Robinson.	3/13/97
16.	Statement of the Site Remediation Advisory Committee submitted by Whitney Wagner Rosen.	3/13/97
17.	Comment of the Illinois Environmental Protection Agency submitted by Kimberly A. Robinson as a Motion to File Instanter Additional Language	2/13/97

[1]Roy O. Ball s comments were originally, submitted as pre-filed testimony; however Mr. Ball was unavailable for hearing, and his pre-filed testimony was admitted into the record as a public comment.

18.	Post-Hearing Comments of Jenner & Block submitted by Raymond Reott.	3/13/97
19	Public Comment submitted by Jeffery L. Pope, P.E., Director, Environmental Management and Remediation, Clayton Environmental Consultants.	3/13/97
20.	Additional Comments of the Illinois Petroleum Council submitted by David L. Rieser.	3/13/97
21.	Site Remediation Advisory Committee s Motion to File Instanter; Additional Comments of the Site Remediation Advisory Committee.	3/27/97
22.	Follow-Up Comments of the Illinois Environmental Protection Agency submitted by Kimberly A. Robinson.	3/27/97

OVERVIEW OF THE TACO PROCESS

The proposed rules establish procedures for developing remediation objectives for soil and groundwater at remediation sites based on risks to human health, taking into account the existing pathways for human exposure and current and future use of the remediation site. The proposed methodology consists of a three tiered approach for establishing remediation objectives. The tiers can operate fully independent of each other, and it is not necessary to perform a Tier 1 analysis before performing a Tier 2 or Tier 3 analysis, or to perform a Tier 2 analysis before performing a Tier 3 analysis. Each successive tier allows the person conducting a remedial investigation pursuant to the Act (hereinafter referred to as the applicant) to rely on more site-specific information, and requires a concomitant increase in the level of site-specific investigation and analysis under Part 742.

As a prerequisite to using the tiered approach to establish remediation objectives, the applicant must determine the contaminants of concern at the site. This is done by conducting a site investigation under the applicable remediation program; such investigation is not part of the TACO process. Again, the programs with which TACO is to be used include the Leaking Underground Storage Tank program at Parts 731 and 732, the Site Remediation Program proposed at Part 740, and the RCRA Part B Permits and Closure Plans at Parts 724 and 725. As mentioned at the outset, these programs govern the activities at the site which address the contamination, including the scope of the site investigation and ultimately the no further remediation determination made by the Agency. (Hereinafter in the opinion, these programs are referred to as the governing programs.) The specific requirements of the governing program control how TACO is applied to determine the applicable remediation objective.

After identifying the contaminants of concern, the applicant can use the TACO process to establish remediation objectives. Each tier of the TACO process requires the applicant to consider up to four potential exposure routes for each contaminant of concern: 1) the inhalation exposure

route; 2) the soil ingestion route; 3) the dermal contact exposure route;[2] and 4) the groundwater ingestion route. The groundwater ingestion route is further subdivided into two components: 1) the migration to groundwater, or soil component which must be investigated to establish a soil remediation objective; and 2) the direct ingestion of groundwater, or groundwater component, which must be investigated to establish a groundwater remediation objective. (Hereinafter each component of the groundwater ingestion route is referred to as the soil component or the groundwater component). Alternatively, as described in greater detail below, the applicant can: 1) demonstrate that a particular exposure route is not available for a contaminant of concern, and thereby exclude further consideration of that exposure route for that contaminant, or 2) rely on area background concentrations in establishing remediation objectives or to demonstrate that further remediation is not warranted.

A Tier 1 analysis requires the applicant to compare levels of contaminants of concern at the remediation site to pre-determined remediation objectives. The pre-determined remediation objectives are listed in the rules at Appendix B, Tables A through E. Separate remediation objectives are established for properties designated for residential use and for industrial/commercial use. The residential levels are the most stringent and are considered protective for all uses. The industrial/commercial levels are less stringent and must be accompanied by an institutional control, such as a deed restriction, in order to assure that the site is used only for industrial/commercial purposes. Additionally, if the site is to be remediated to industrial/commercial levels, the applicant must assure that the remediation levels established for construction workers are also achieved. If any contaminants of concern at a remediation site are found to exceed the applicable pre-determined levels, the applicant is required to remediate the contamination until the remediation objectives are achieved, or alternatively, to develop site-specific remediation objectives using a Tier 2 or Tier 3 analysis. Under Tier 1, if multiple noncarcinogenic chemicals with similar-acting properties are present in the groundwater, their cumulative effect must be evaluated as part of the development of remediation objectives.

A Tier 2 analysis uses equations set forth in the proposed rules to develop alternative remediation objectives for contaminants of concern using site-specific information. The equations used to develop site-specific remediation objectives are from the United States Environmental Protection Agency s (USEPA) Soil Screening Levels Guidance (SSL) and the American Society of Testing and Material s (ASTM) Risk Based Corrective Action (RBCA). The equations are set forth in the proposed rules at Appendix C, Tables A and C, respectively. If any contaminants of concern are found to exceed the remediation objectives developed using the Tier 2 equations, the applicant is required to remediate the contamination until the objectives are achieved or to develop alternative objectives using a Tier 3 analysis. The mixture rule for noncarcinogens is also applicable under Tier 2. Unlike a Tier 1 analysis, however, it is applicable when developing both soil and groundwater remediation objectives.

A Tier 3 analysis allows the applicant to develop remediation objectives using alternative parameters not found in Tier 1 or Tier 2. It allows the applicant great flexibility in developing

---

[2]The dermal contact exposure route need only be considered if the applicant elects to use the Tier 2 Risk Based Corrective Action (RBCA) equations set forth in Appendix C, Table C, or a Tier 3 formal risk assessment, to establish remediation objectives.

remediation objectives appropriate for a particular site based upon site-specific information rather than relying on general categories of information. The options available under Tier 3 include: use of modified parameters in the Tier 2 equations; use of alternative models; conducting a site-specific risk assessment; assessment of impractical remediation; and variation of the target risk level. If any contaminants of concern are found to exceed the remediation objectives developed using the Tier 3 analysis, the applicant is required to remediate the contamination until the objectives are achieved. At this time, the mixture rule is not specifically applicable to a Tier 3 analysis.

Outside of the individual tiers of analysis, there are two alternative means for addressing the presence of contamination: exclusion of pathways and reliance on area background. The first option, exclusion of pathways, is based on the premise that an exposure pathway must exist for contamination to present a threat to human health. If it can be shown that a pathway does not exist for any contaminants of concern, the applicant need not address that exposure pathway for those contaminants. The methods for evaluating and excluding exposure routes are set forth at Subpart C. The second option, reliance on area background, is based on Section 58.5(b)(1) of the Act, which provides that applicants shall not be required to remediate contaminants of concern to levels that are less than area background levels. If it can be shown that a contaminant of concern is present at levels that do not exceed area background levels for the site, the applicant need not further address that contaminant. Under appropriate circumstances, the applicant can also use background levels as remediation objectives. The methods for determining area background concentrations are set forth in Subpart D.

The applicant can use any combination of tiers if multiple contaminants of concern are present at a site. Remediation objectives established under any tier are considered equally health protective for a particular land use. Upon completion of remedial activities which achieve the established remediation objectives, the applicant is entitled to a no further remediation determination in accordance with the terms of the governing program. The TACO rules themselves do not provide for the no further remediation determination; they provide only the process for determining site-specific remediation objectives based upon risk. The no further remediation determination is made at the conclusion of the process by the Agency pursuant to the governing program. For example, the Agency s no further remediation determination in the Site Remediation Program is effected through a No Further Remediation Letter. The same instrument is used in the Underground Storage Tank Program.

The following section contains a more detailed summary of the components of the rules. A third section of the opinion beginning at page 33 contains a detailed summary of the major issues raised concerning various components of the TACO rules.

SUMMARY OF THE SECOND NOTICE PROPOSAL

Subpart A: Introduction

This subpart contains sections concerning intent and purpose, applicability, overview and key elements of the tiered approach, and the requirements for site characterization. Section 742.100, entitled Intent and Purpose, states that Part 742, the TACO process, is intended to establish procedures for use in evaluating risks to human health posed by environmental conditions, and procedures for use in developing objectives for remediation which assure that risks are at

acceptable levels. Furthermore, Section 742.100(b) states that the procedures are intended to provide adequate protection of human health and the environment based on risks to human health posed by environmental conditions while incorporating site-related information.

Section 742.105 sets forth the situations in which the rules are intended to apply. The applicant may use the Part 742 procedures to the extent allowed by state and federal law. The procedures must be used in accordance with the requirements of the program pursuant to which the remediation is being conducted. Section 742.105 specifically references the Leaking Underground Storage Tank program, the proposed Site Remediation Program, and the RCRA Part B Permits and Closure Plans. The use of Part 742 is subject to the limitation that it cannot be used where there is an imminent and substantial endangerment to human health and the environment. Section 742.105 also makes clear that groundwater remediation objectives established pursuant to the TACO process can exceed the groundwater quality standards set forth at 35 Ill. Adm. Code Part 620. This exception is based upon a statutory provision; the record does not otherwise support such a rule. Section 58.5 of the Act authorizes the use of groundwater remediation objectives for contaminants of concern that are greater than the groundwater quality standards established by the Board at 35 Ill. Adm. Code 620 pursuant to the Illinois Groundwater Protection Act. (415 ILCS 55/1 *et seq*.) The Board has made clarifying changes to Section 742.105 to notify the applicant that remediation objectives greater than the Part 620 standards may be developed only under Tier 3.

The Agency also proposed a rule to the effect that a no further remediation determination constitutes *prima facie* evidence that the contaminants of concern addressed at a site do not cause or tend to cause water pollution pursuant to Section 12(a) of the Act, or create a water pollution hazard pursuant to Section 12(d) of the Act. Such a statement would be particularly critical at sites remediated to groundwater objectives greater than the State s groundwater quality standards because those groundwater quality standards were adopted as being the minimum levels protective of human health and the environment pursuant to the Illinois Groundwater Protection Act. (Id.) As explained above, Section 58.5 of the Act allows an applicant to propose and the Agency to approve pursuant to Tier 3 of TACO, remediation objectives greater than the State s groundwater quality standards. Therefore, once such a remediation objective is achieved, the Agency s no further remediation determination in effect deems the levels of contamination remaining at the site as protective of human health. Yet, the programs used in conjunction with TACO govern the scope and extent of the legal protection provided by a No Further Remediation Letter or any other type of no further remediation determination made by the Agency. Therefore, the Board will not adopt under TACO the rule proposed by the Agency addressing the effect of a no further remediation determination.

Section 742.110 contains an overview of the tiered approach, which is similar to the summary of the rules set forth above. We will not repeat that discussion here. The applicant is well advised to consult the illustrations in the Appendices when trying to understand the TACO process generally, and any particular provisions. The illustrations provide road maps and decision trees which work well to explain the TACO process. Generally, Illustrations A and B of Appendix A provide decision trees for developing soil and groundwater remediation objectives, respectively. Illustration A of Appendix B provides such a road map for Tier 1, and Illustrations A and B of Appendix C provides the same for Tier 2. However, none of the illustrations include the effect of the mixture rule adopted today.

Moreover, Section 742.115 addresses the Key Elements of the Tiered Approach. It sets forth the exposure routes that must be evaluated, the factors that must be considered in determining the remediation objectives for contaminants of concern, and the potential land use classifications for the site. Section 742.115(a) sets forth the potential exposure routes that must be addressed at a remediation site, specifically: inhalation, soil ingestion, groundwater ingestion, and dermal contact with soil. The groundwater ingestion route is further divided into two components: the soil component and the groundwater component. The dermal contact exposure route need only be addressed if the applicant develops remediation objectives using RBCA equations set forth in Appendix C, Table C, or through a formal risk assessment under Tier 3. For each contaminant of concern, the applicant must develop remediation objectives for each applicable exposure pathway or demonstrate that a pathway has been excluded from consideration.

Section 742.115(b) sets forth the factors that must be considered when identifying the contaminants of concern at the remediation site. These factors include: 1) the materials and wastes managed at the site; 2) the extent of the no further remediation determination which the applicant is seeking from the Agency under the governing program, *e.g.*, under the Site Remediation Program, a comprehensive or focused No Further Remediation Letter; and 3) the general requirements applicable under the governing program. In the Site Remediation Program or a Section 4(y) voluntary cleanup, the applicant determines the scope of the remediation and the contaminants of concern that will be addressed. In other programs, the scope of the remediation and contaminants of concern will be dictated by the governing program s requirements. At the conclusion of the process, the Agency will make a determination about whether further remediation is necessary under the governing program. If the Agency determines that no further remediation is necessary, the scope of the determination will extend only to the scope of the remediation performed.

Section 742.115(c) sets forth the possible land use classifications under the TACO process. The rules allow the proposed land use to be characterized as one of the following: residential, conservation, agricultural, or industrial/commercial. The land use classification determines the expected exposure scenario at the site, which is a principal factor in establishing health protective remediation objectives.

Tier 1 sets forth separate remediation objectives for residential and industrial/commercial used. Similarly, Tier 2 has separate equations for developing remediation objectives for residential and industrial/commercial uses which reflect the different exposure rates expected for each land use. The remediation objectives for industrial/commercial property are premised upon a lower exposure rate, and therefore are less stringent than those established for residential property. Accordingly, an industrial/commercial designation under any tier requires an accompanying institutional control to assure that the land use is appropriately restricted to that property classification. Furthermore, because the rules as currently proposed do not reflect consideration of the appropriate exposure expected for a conservation or agricultural land use designation, these designations require a Tier 3 demonstration based on individual site use characteristics to assure appropriate protection of human health and the environment.

Section 742.120 sets forth the requirement that the applicant perform a site characterization prior to developing remediation objectives pursuant to TACO in order to establish the extent and concentrations of contamination at the site. The site investigation must be conducted in accordance

with the requirements of the governing program. The TACO rules therefore do not set forth a separate site investigation procedure.

Subpart B: General

Subpart B of the rules contains general sections including definitions, a severability clause, and incorporations by reference. Additionally, Subpart B sets forth procedures for determining the soil attenuation capacity, the soil saturation limit, and demonstrating compliance with remediation objectives. These procedures apply across the entire TACO process. Finally, Subpart B contains the general rule that submittals to the Agency and subsequent review and approval by the Agency are to be done in accordance with the governing program s rules.

Definitions. Section 742.200 sets forth the definitions of terms used in these proposed rules. Most of these are self-explanatory, however several warrant further discussion.

The definition of the term carcinogen repeats the statutory language from Section 58.2 of the Act. This definition requires that contaminants that fall into any of the following categories be considered carcinogens: 1) Category A1 or A2 carcinogens, as defined by the American Conference of Governmental Industrial Hygienists, 2) Category 1 or 2A/2B carcinogens, as defined by the World Health Organization s International Agency for Research on Cancer; 3) a Human Carcinogen or Anticipated Human Carcinogen, as defined by the United States Department of Health and Human Service National Toxicological Program; or 4) a Category A or B1/B2 carcinogen as defined by the United States Environmental Protection Agency in its Integrated Risk Information System (IRIS), or a final rule issued in a Federal Register notice by the USEPA. Because the USEPA Soil Screening Level Guidance, which the Agency relied upon in developing the Tier 1 Tables for soil remediation objectives, includes Category C carcinogens within its definition of carcinogens, the Agency recalculated the soil remediation objectives for those contaminants classified as Category C carcinogens by USEPA. The Board agrees that this properly reflects the statutory intent.

At the Board s request, the Illinois Department of Transportation (IDOT) introduced into the record the definitions of the terms highway, highway authority, and right of way from the Illinois Highway Code. (See Dec. 10, 1996 Transcript at 114 - 115.) The Agency proposed that these definitions be included in the proposed rules in its Errata Sheet No. 2. The Board believes that including these definitions in the rules clarifies these terms and ensures consistency in their application and, therefore, adopts the proposed definitions into the proposal.

The definition of residential property proposed by the Agency paraphrased the statutory language for Section 58.2 of the Act. The Agency s proposed definition reads:

> Residential Property means any real property that is used for habitation by individuals or properties where children have the opportunity for exposure to contaminants through ingestion or inhalation at educational facilities, health care facilities, child care facilities or playgrounds.

Based upon the reasons further explained at pages 33-35, *supra,* the Board finds that the Agency s proposed definition requires further clarification. The Board adopts today a slightly

modified definition for Part 742, as well as in Part 740 in the R97-11 rulemaking, to more closely reflect the statutory intent. The Board s definition adds to the Agency s definition the term soil as a modifier to ingestion, and replaces playgrounds with outdoor recreational areas . The Board s definition reads as follows:

> Residential Property MEANS ANY REAL PROPERTY THAT IS USED FOR HABITATION BY INDIVIDUALS, or where children have an opportunity for exposure to contaminants through soil ingestion or inhalation at an educational facilities, health care facilities, child care facilities, or outdoor recreational areas.

Soil Attenuation Capacity and Saturation Limit. Section 742.215 requires that the concentrations of organic contaminants remaining in the soil not exceed the attenuation capacity of the soil and sets forth the method for determining soil attenuation capacity.

The requirement that the soil attenuation capacity not be exceeded is intended to insure the integrity of the soil remediation objectives established under the tiered approach, since the models which are used to derive the soil remediation objectives do not account for the existence of free product. Contaminant transport models generally assume equilibrium between contaminants that adhere to soil particles and contaminants that dissolve in water in the soil pores. This assumption is violated if the soil attenuation capacity is exceeded; then the models cannot accurately predict the behavior and movement of contaminants. (See Exh. 4 at 3-5.) Furthermore, John Sherrill testified that the requirement that the soil attenuation capacity not be exceeded will achieve three objectives. First, it will ensure that there will be no migration of mobile free products. Second, it will protect against potentially unacceptable health risks from accidental exposure to contamination left in place which might occur if an engineered barrier or institutional control is breached. Finally, it will provide a ceiling on the level of exposure from high contaminant concentrations from multiple organic contaminants. (Dec. 2, 1996 Transcript at 151-152.)

Similarly, because the models which are used to derive the soil remediation objectives do not account for the existence of free product, Section 742.220 provides two circumstances under which remediation objectives cannot exceed the soil saturation limit (C_{sat}). The soil saturation limit is defined in Section 742.200 as the contaminant concentration at which soil pore air and pore water are saturated with the chemical and the adsorptive limits of the soil particles have been reached. Pursuant to Section 742.220, the applicant must ensure that the soil saturation limit is not exceeded when establishing a Tier 2 or Tier 3 remediation objective for the inhalation exposure route for an organic contaminant with a melting point below 30^{o}C, or when establishing a Tier 2 or Tier 3 remediation objective for the soil component of the groundwater ingestion exposure route for any organic contaminant.

Section 742.220 establishes three methods for determining the soil saturation limit. These methods are: 1) use of the chemical-specific default values set forth in Appendix A, Table A; 2) use of a value derived from Equation S29 in Appendix C, Table A; or 3) use of a value derived from another method approved by the Agency.

Compliance with Remediation Objectives. Section 742.225 sets forth the method for demonstrating compliance with remediation objectives. For groundwater remediation objectives,

compliance with remediation objectives is demonstrated by comparing discrete samples to the applicable groundwater remediation objective. The location of groundwater sampling points is determined in accordance with the requirements of the governing program pursuant to which remediation is being conducted.

Similarly, compliance with soil remediation objectives can be demonstrated by comparing discrete samples of contaminant concentrations to the applicable soil remediation objective, unless the applicant elects to composite or average soil samples in accordance with subsections (c) and (d) of this section, as explained below. Again, the number of locations is determined by the governing program.

Subsection (c) of Section 742.225 sets forth the requirements and limitations applicable to compositing or averaging soil samples for the soil component of the groundwater ingestion exposure route. For contaminants other than volatile organic compounds (VOCs), discrete samples from the same boring may be composited or averaged. For VOCs, discrete samples from the same boring may be averaged but compositing of samples is not allowed. This is because compositing would tend to allow VOCs to volatilize and escape and the sampling would thus underestimate the presence of volatile contaminants of concern in the soil. A minimum of two sampling locations for every 0.5 acres of contaminated area is required, with discrete samples at each location taken at every two feet of depth, beginning six inches below the ground surface, and continuing through the zone of contamination. Samples may not be taken from below the water table.

Subsection (d) of Section 742.225 sets forth the requirements and limitations applicable to compositing or averaging soil samples for the inhalation or ingestion exposure routes. As proposed at First Notice, this section contained detailed requirements for the number and location of samples to be taken. However, in response to comments, the Agency proposed that the detailed compositing and averaging requirements be replaced with a requirement that each applicant submit a sampling plan for the Agency to approve based upon site-specific information. This was much the same as the alternative approach originally provided at Section 742.225(f). Accordingly, the Agency proposed that the latter be deleted as redundant.

The Board accepts both modifications proposed by the Agency. The reasons for that decision are set forth at pages 35-36**,** *supra*. With the revisions to Section 742.225, the compositing and averaging requirements will be established on a site-specific basis, based upon a sampling protocol approved by the Agency.

Pursuant to Section 742.225(e), for the purposes of calculating averages under Section 742.225, if no more than 50 percent of the samples are reported as non-detect or below detection limits, such results must be included in the sampling results as one-half of the reported detection limit for the contaminant. If more than 50 percent are reported as non-detect, the applicant must obtain Agency approval for an alternate procedure which is statistically valid for determining the average.

Section 742.230 returns to the more general format of Subpart B. An omnibus provision, Section 742.230 addresses Agency review and approval of submittals. This section makes clear that the applicant must submit documents and requests in accordance with the governing program

under which the remediation is being addressed and the Agency will review and approve the same in accordance with the governing program.

Subpart C: Exposure Route Evaluations

Subpart C sets forth the requirements and methodologies for determining and evaluating the following exposure routes: inhalation, soil ingestion, and groundwater ingestion. The rules allow the applicant to exclude from consideration contaminants of concern for one or more exposure routes if the applicant demonstrates that the identified exposure route is not available for that contaminant. The principle underlying the pathway exclusion is different from that underlying the development of numeric remediation objectives. It is premised on the concept that an exposure route must exist which enables a contaminant to reach a receptor for the contaminant to present a threat to human health. Thus, Agency witness Mr. Gary King testified that pathway exclusion is based on effective source control, coupled with site conditions and an appropriate institutional control that effectively prohibits human exposure through a given pathway. (Exh. 2 at 4.) The rules set forth five general criteria, as well as exposure route-specific criteria, which must be satisfied to exclude an exposure route for a particular contaminant of concern.

General Criteria for Exclusion of Pathways. There are five general criteria which must be satisfied before any exposure route may be excluded from consideration. These criteria are intended to insure that the contamination left in place when the pathway is excluded will not present a threat to human health. The first two criteria, set forth in Sections 742.305(a) and (b), require that the soil attenuation capacity and the soil saturation limit capacity not be exceeded, as set forth in Section 742.215 and 742.220, respectively. These criteria are intended to insure that there is no free product present and to insure that the behavior of the contaminants can be accurately modeled.

Criteria three through five, set forth in Sections 742.305(c) through (e), require the applicant to insure that the contaminated soil which remains in place will not exhibit the hazardous characteristics of reactivity, corrosivity, or toxicity. Section 742.305(c) requires that any soil that contains contaminants of concern cannot exhibit any of the characteristics for reactivity for hazardous waste, as determined under 35 Ill. Adm. Code 721.123. Section 742.305(d) requires that any soil that contains contaminants of concern cannot exhibit a pH less than or equal to 2.0, or greater than or equal to 12.5. Finally, Section 742.305(e) requires that any soil that contains one or more of the inorganic chemicals arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, or the salts of any of these chemicals cannot exhibit characteristics of toxicity. The toxicity determination is made pursuant to the methods set forth at 35 Ill. Adm. Code 721.124.

Jenner & Block expressed concern regarding the proposed pathway exclusion requirements. The Agency disagreed with Jenner & Block and asked that the Board not make any changes to Subpart C. Each of these concerns is addressed in detail at pages 36-38, *supra*. For the reasons given there, the Board adopts Subpart C as proposed by the Agency without the modifications advocated by Jenner & Block. Additionally, the Board has made a number of non-substantive format changes in Sections 742.310 and 742.315 for purposes of clarity.

Specific Criteria for Exclusion of Pathways. Sections 742.310, 742.315 and 742.320 set forth the specific criteria which must be satisfied to exclude from consideration each particular

pathway, *i.e.*, inhalation, soil ingestion, and groundwater ingestion respectively. These criteria must be satisfied in order to exclude the applicable exposure route, in addition to the five general criteria set forth in Section 742.305.

Section 742.310 sets forth additional criteria which must be satisfied in order to exclude the inhalation exposure route for contaminants of concern. In order to exclude this exposure route, the concentration of any contaminant of concern within ten feet of the land surface or any man-made pathway cannot exceed the Tier 1 remediation objective for the inhalation exposure route. Alternatively, the applicant can install an engineered barrier, as set forth in Subpart K, which is approved by the Agency. The applicant must also obtain an institutional control, in accordance with the requirements of Subpart J, which ensures compliance with these requirements and ensures the safety of construction workers.

Section 742.315 sets forth additional criteria which must be satisfied in order to exclude the soil ingestion exposure route for contaminants of concern. To exclude this pathway, the applicant must demonstrate that the concentration of any contaminant of concern within three feet of the land surface does not exceed the applicable Tier 1 remediation objective or that an engineered barrier has been installed, in accordance with the requirements of Subpart K and approved by the Agency. Furthermore, the applicant must obtain an institutional control which ensures that these requirements are met and ensures the safety of construction workers.

Section 742.320 sets forth the additional criteria which must be satisfied in order to exclude the groundwater ingestion exposure route from consideration. These criteria include location and groundwater quality demonstrations, as well as a requirement that an institutional control, *i.e.* an ordinance adopted by the local government, be in place. Taken together, these criteria are intended to ensure that potable drinking water supplies will not be impacted by contamination left in place.

Specifically, the applicant must demonstrate that corrective action measures have been completed to remove any free product. The applicant must also demonstrate that the source of the release is not located within the minimum or designated maximum setback zone or within a regulated recharge area of a potable water supply well. The applicant must also demonstrate that the concentration of any contaminant of concern in the groundwater within the minimum or designated maximum setback zone of an existing water supply well meets the applicable Tier 1 groundwater remediation objectives. Finally, the applicant must demonstrate that the concentration of any contaminant of concern in groundwater which discharges to a surface water will meet the applicable surface water quality standards under 35 Ill. Adm. Code 302. These last two demonstrations must be made using Equation R26 in Appendix C, Table C.

In order to exclude the direct ingestion of groundwater pathway, in addition to satisfying the location and groundwater quality demonstrations, the applicant must demonstrate, in accordance with Subpart J: Institutional Controls, that the unit of local government has adopted an ordinance that effectively prohibits the installation or use of groundwater as a potable supply of water. Such an ordinance must be in effect for any area within 2500 feet of the source of the release. As originally proposed by the Agency, the ordinance did not have to prohibit the use of the potable water supply well by the unit of local government. Subsequent to hearing, the Agency explained its belief that the rule needs to be modified to insure that public potable water supply wells, as well as

private wells, do not unwittingly tap into a contaminated source. The Agency proposed that unit of local government must enter into a Memorandum of Understanding (MOU) with the Agency if the local ordinance used as an institutional control does not prohibit the local government from installing and using a potable water supply well. The MOU must commit the local government to: 1) keep a registry of sites within its boundaries that have received no further remediation determinations; 2) consider whether groundwater contamination from those sites may be present at potential public well sites; and 3) take appropriate protective measures if wells are sited near such locations. (PC 15 at 5-6; Errata Sheet No. 2.)

The Board agrees with the revisions proposed by the Agency. Subsection (d) of Section 742.320 now cross-references Section 742.1015 of Subpart J, and the modifications proposed by the Agency at that section still allow ordinances which do not prohibit the installation or use of potable water supply wells by local governments to be used as institutional controls, but only if the local government has entered into a MOU with the Agency. (See pages 31-32, *supra*, for a further discussion of the ordinance requirements under Section 742.1015.)

Subpart D: Determining Area Background

This subpart sets forth the procedures for determining area background concentrations for contaminants of concern. As set forth in Section 58.5(b) of the Act, applicants shall not be required to remediate contaminants of concern to levels that are less than area background levels, subject to two statutory exceptions which have been included in the rules at Section 742.415. First, if the contaminant concentration is equal to or less than the area background level, yet it exceeds the Tier 1 residential level, the property cannot be converted to residential use unless that remediation level or an alternative developed under Tier 2 or Tier 3 is achieved. (Section 58.5(b)(2) of the Act.) Second, if the Agency determines in writing that the area background level poses an acute threat to human health or the environment in consideration of the post-remedial land use, appropriate risk-based remediation levels must be developed. (Section 58.5(b)(3) of the Act.) If neither of these exceptions applies, and the applicant can demonstrate that contaminant concentrations are at area background levels, no further remediation is required. Another use of area background levels is for the applicant to demonstrate that area background levels should be used as the remediation objectives for contaminants of concern. This alternative is limited to industrial/commercial properties only, and accordingly requires the use of an institutional control.

Determination of Area Background for Soils. Section 742.405 sets forth the method for determining area background for soils. Subsection (a) sets forth the sampling requirements. Section 742.405(b) sets forth the two options available to the applicant for determining the area background level for inorganics. The first option is referred to as the statewide area background approach. This approach relies upon data previously compiled by the Agency concerning area background concentrations throughout the State, which is set forth in Appendix A, Table G. Under the statewide area background approach, the applicant must set the upper limit of the area background concentration for the site at the value of the concentrations of inorganic chemicals in background soils listed in Appendix A, Table G. The applicant s second option is to use another method which is statistically valid for the characteristics of the data set and which has been approved by the Agency.

Determination of Area Background for Groundwater. Section 742.410 sets forth the method for determining area background concentrations for groundwater. Subsection (a) sets forth the sampling requirements and is intended to ensure that the sampling points are of sufficient quantity and appropriately located so as to be representative of actual background concentrations. Section 742.410(b) sets forth the two options available to the applicant for determining background levels for groundwater. The first option is referred to as the Prescriptive Approach ; the second option is the use of another statistically valid approach which is appropriate for the data set and approved by the Agency.

Under the Prescriptive Approach, the upper limit of the area background concentration for the site is set at the Upper Tolerance Limit (UTL) for sample sets of ten samples or more, or at the maximum value of the sample set for sets of less than ten samples. The Prescriptive Approach establishes the method for determining the UTL of a normally distributed sample. If the sample set contains less than fifty (50) samples, the applicant must use the Shapiro-Wilke Test of Normality to determine whether the sample set is normally distributed. The Prescriptive Approach can only be used if the samples are determined to be normally distributed.

The Prescriptive Approach cannot be used if more than 15 percent of the groundwater sampling results for any chemical are less than the appropriate detection limit for that chemical. If 15 percent or less are less than the appropriate detection limit, a concentration equal to one-half the detection limit must be used for that chemical in the calculations. Additionally, the Prescriptive Approach cannot be used for determining area background for pH. For these exceptions and in any case, Section 742.410(b) concludes with the provision that another statistically valid approach may be used on a site-specific basis if approved by the Agency.

Pursuant to Section 742.415, area background concentrations can be used in two ways. First, an area background concentration can be used to support a request to exclude a chemical as a contaminant of concern from further remediation due to its presence as a result of background conditions. Second, an area background concentration can be used as the remediation objective for a contaminant of concern. For either of these to occur the applicant must submit the request to the Agency. Again, however, pursuant to Section 58.5(b)(3) of the Act, area background cannot be used in either manner if the Agency determines, in writing, that the background level poses an acute threat to human health or the environment taking into consideration the post-remedial land use of the site.

At hearing, three issues were raised regarding area background. The three issues are: 1) exclusion of a contaminant of concern based on area background; 2) substitution of area background for Tier 1 residential objectives if the naturally occurring background level of a contaminant of concern is greater than the Tier 1 residential level; and 3) the propriety of changing Appendix A, Table G to use the 50^{th} percentile values versus the 90^{th} percentile values from the Agency s area background database. For further discussion on each of these

issues, see pages 40-43, *supra*. The Board will adopt the area background requirements as proposed by the Agency and modified pursuant to its subsequent filings.

Subpart E: Tier 1 Evaluation

A Tier 1 evaluation compares the concentrations of contaminants of concern to established baseline remediation objectives which are set forth in Appendix B, Tables A through E. The Tier 1 objectives are numerical chemical concentrations that represent a level of contamination at or below which there are no human health concerns for the designated land use. The Tier 1 objectives for individual chemical contaminants do not exceed an excess cancer risk of 1 in 1,000,000 for carcinogens (also referred to as 1×10^{-6}), or a hazard quotient[3] of 1 for noncarcinogens. The pre-established remediation objectives under Tier 1 are based upon the SSL and the screening levels therein are designed to insure that contaminants of concern individually will not present a greater risk. However, in some instances where multiple contaminants are present at a site, the cumulative effect of similar-acting chemicals may cause the target risk of 1×10^{-6} or the hazard quotient of 1 to be exceeded. To correct this, the rules adopted today include a mixture rule which provides that remediation objectives developed under Tier 1 for the groundwater ingestion exposure route must take into account the cumulative effect of noncarcinogens affecting the same target organs at a site.

In order to allow consideration of the proposed land use for the site, different objectives are set forth for different receptor populations: residential, industrial/commercial, and construction workers. Where the remediation objectives are based on an industrial/commercial property use, institutional controls must be adopted in accordance with Subpart J to ensure that the land use is appropriately restricted. The applicant need not further evaluate an exposure route if all contaminants of concern are below Tier 1 values for that exposure route, with the one exception for groundwater remediation objectives.

The Tier 1 remediation objectives are set forth in Appendix B, Tables A through E. These tables set forth remediation objectives for 117 chemicals. The tables are generally divided into two groups: those applicable to soil remediation objectives, and those applicable to groundwater remediation objectives. The groundwater component and the soil component of the groundwater ingestion route are further divided into objectives for Class I or Class II groundwater.

Tier 1 Soil Remediation Objectives. Under Tier 1, the applicant must consider two different direct exposure routes for soil when establishing remediation objectives pursuant to the TACO approach: the inhalation exposure route and the ingestion exposure route.

---

[3] Hazard Quotient is defined as the ratio of a single substance exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period. The reference dose, which is derived for noncarcinogens as an acceptable daily chemical exposure, is that dose at which no harmful consequences occur. A hazard quotient greater than 1 signifies a potential adverse effect, since a value greater than one occurs when a chemical exposure is measured to be greater than the reference dose.

Additionally, the applicant must consider the soil component of the groundwater ingestion route. Because these objectives are considered sufficiently protective, the applicant need not examine the dermal contact exposure route under Tier 1. The Tier 1 soil remediation objectives are set forth in Appendix B, Tables A, B, C, and D. The mixture rule adopted today for similar-acting chemicals is not applicable to these remediation objectives.

Appendix B, Table A sets forth the soil remediation objectives based upon residential property use, for the soil ingestion exposure route, the inhalation exposure route, and the soil component of the groundwater ingestion exposure route. Where appropriate, Table A also sets forth the Acceptable Detection Limit (ADL).[4] Because the Tier 1 residential levels are based upon protection in a residential exposure scenario, they are considered sufficiently protective that it is not necessary to establish separate remediation objectives for construction workers.

Appendix B, Table B sets forth the Tier 1 soil remediation objectives based upon industrial/commercial property use. As for the residential remediation objectives in Table A, separate remediation objectives are established for the soil ingestion exposure route, the inhalation exposure route, and the soil component of the groundwater ingestion exposure route. For the soil ingestion exposure route and the inhalation exposure route, separate remediation objectives are established for two receptor populations: the industrial/commercial population and the construction worker population. For the soil component of the groundwater ingestion exposure route, separate remediation objectives are established for Class I and Class II groundwaters.

The Tier 1 objectives for the soil ingestion and inhalation pathways were derived using the SSL with modifications as necessary to comply with Illinois law. The SSL was developed by USEPA for use in the Superfund program as a mechanism for screening out sites which do not require further study or action. The screening levels in the SSL are soil concentrations at or below which there is no concern in the Superfund program that some type of further action is required. They were developed based on a conceptual site model of a one-half acre site, with contamination extending to the water table, upon which a future residence with a private well would be built. (December 2, 1996 Transcript at pages 52-54; Exh. 5 at 11.)

Again, the screening levels in the SSL are designed to insure that the contaminants of concern individually will not present a greater than 1 in a million excess cancer risk for carcinogens or have a hazard quotient greater than 1. Since the SSL is based on an anticipated residential use, the Tier 1 remediation objectives for the industrial/commercial and construction workers had to be calculated from the SSL equations using the different exposure assumptions appropriate for these populations.

---

[4]ADL is defined at Section 742.200 to mean the detectable concentration of a substance which is equal to the lowest appropriate Practical Quantitation Limit (PDL). PDL is defined as the lowest concentration that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method during routine laboratory operating conditions. See Section 742.200 for these definitions in their entirety.

The Tier 1 objectives for the soil component of the groundwater ingestion route were derived from two different sources. For organic chemical contaminants, the Tier 1 objectives were derived using SSL equations with separate objectives established for Class I and Class II groundwaters. For inorganics, the proposed Tier 1 objectives establish two alternative approaches to setting soil objectives for the soil component of the groundwater ingestion route. As proposed by the Agency, the first alternative is based on the Toxicity Characteristic Leaching Procedure (TCLP) test. The second alternative is to allow pH-specific remediation objectives. The Board notes that the rules as proposed by the Agency, do not contain any requirement that the TCLP test be used. Reference to this test is limited to footnote m in the Tier 1 tables at Appendix B, Tables A and B.

The TCLP method was carried over by the Agency from the Underground Storage Tank program. Under this approach, the remediation objective is the same as the Part 620 groundwater quality standard for the chemical of concern for the applicable groundwater classification. As proposed at First Notice, these remediation objectives were listed as mg/L concentrations for the TCLP test. The applicant must perform a TCLP analysis on a soil sample from the site and compare the concentration of the inorganic chemical of concern in the TCLP extract to the applicable groundwater standard.

Jenner & Block questioned the propriety of the TCLP in this context, and presented testimony in support of a different test, the Synthetic Precipitation Leaching Procedure (SPLP). This test has been adopted by the USEPA for determining compliance with remediation objectives. It is designed to mimic the pH of rainwater that percolates through a contaminated site. Jenner & Block gave several other reasons why it prefers to use the SPLP over the TCLP. (January 15, 1997 Transcript and January 16, 1997 Transcript at pages 237-250; Exh. 18 at 7.)

After studying the issue, the Board finds either test is acceptable. Accordingly, Section 742.510(a)(4) has been added which allows the use of the SPLP or the TCLP to evaluate the soil component of the groundwater ingestion exposure route. This language also removes the ambiguity in the Agency proposal due to the lack of any straightforward requirement that the TCLP test be used for the listed inorganics. Additionally, an applicant still may evaluate the soil component on the basis of the total amount of contaminant in the soil sample result. This alternative has been relocated to subsection (a)(5) of Section 742.510.

The second alternative for establishing soil objectives for the soil component of the groundwater ingestion allows the applicant to establish pH-specific remediation objectives appropriate for the conditions at the site. (Exh. 5 at 20.) In addition to inorganics, this alternative may be used to establish remediation objectives for certain ionizable organics. The pH-specific objectives for Class I and Class II groundwaters are set forth in Appendix B, Tables C and D, respectively. These alternative remediation objectives allow the applicant to elect to evaluate the soil component of the groundwater ingestion exposure route based on the total amount of contaminant in a soil sample result, rather than the TCLP or SPLP analysis. In order to use this alternative approach, the applicant must determine the soil pH at the site and then select the appropriate soil remediation objectives based on Class I and Class II

groundwaters. This method cannot be used if the soil pH is less than 4.5 or greater than 8.0. This alternative now appears at Section 742.510(a)(5) with minor modifications to the language originally proposed by the Agency.

The Agency proposed separate soil remediation objectives based on pH for identified ionizable organics or inorganics because the solubility of metals in water is highly dependent on pH of the solution. (See Section 742.505(a)(3)(C).) Generally, at lower pH, all metals are more soluble than at higher pH. To account for this phenomenon, the proposed standards have tables (Appendix B, Tables C and D) that list inorganic and ionizable organic compounds for pH values ranging from 4.5 to 8.0 in nine intervals of 0.25 increments. There are 15 metals and eight organic compounds listed in each table. There are separate tables for Class I and Class II groundwater.

Finally, pursuant to Section 742.510(a)(6), the applicant must review the soil remediation objectives determined for each remaining exposure routes, and select the most stringent of those remediation objectives, and then compare that one to the soil concentrations measured at the site. When using Appendix B, Table B for evaluating industrial/commercial properties, the remediation objectives for the ingestion and inhalation exposure routes shall be the more stringent of the industrial/commercial populations and the construction worker populations. If the soil remediation objective for a chemical is less than the ADL, the ADL shall serve as the remediation objective. Based upon this analysis, the applicant will be able to identify the applicable soil remediation objective under a Tier 1 evaluation.

Tier 1 Groundwater Remediation Objectives. Identifying the applicable groundwater remediation objective is more straightforward. Appendix B, Table E contains the groundwater remediation objectives for the groundwater component of the groundwater ingestion exposure route. The table contains separate values for Class I and Class II groundwaters and therefore the applicant must determine the Part 620 classification for groundwater at the site. The applicant must then compare the concentrations of groundwater contaminants at the site to the applicable Tier 1 groundwater remediation objectives set forth in Table E. Because this exposure route is based on direct ingestion of groundwater, an exposure route which is not impacted by the land use at the site, no distinction is made between residential and industrial/commercial use.

For any contaminants of concern not listed in Appendix B, Tables A through E, the applicant may request site-specific remediation objectives from the Agency, or propose site-specific objectives in accordance with 35 Ill. Adm. Code 620, Tier 3 at Subpart I of TACO, or both.

The Agency proposed, in its final comments, the addition of a new provision at Section 742.505(b)(3) to address the effect of mixture of similar-acting chemicals under Tier 1. The new provision, which applies only to remediation of Class I groundwater, states that for mixtures of similar-acting chemicals listed in Appendix A Tables E (noncarcinogens) and

Table F (carcinogens), the requirements of 35 Ill. Adm. Code 620.615 regarding mixture of chemicals need to be met at the point of human exposure.[5] (PC 10 at 11.)

Subsequent to filing its final comments, in a filing entitled Motion to File Instanter Additional Language , the Agency suggested the addition of certain procedures under Section 742.505(b)(3) to be used to show that mixtures of similar-acting chemicals in Class I groundwater do not present unacceptable risks to users of the groundwater. (February 25, 1997 Transcript at 1; PC 17; Exh. 1.)

The Agency s arguments on this issue convince the Board that a more limited version of the mixture rule is necessary at this time. A more detailed discussion of the arguments in support of a mixture rule and the Board s consideration of the same appears below at pages 46-50. At this time, the Board concludes that such a mixture rule, *for noncarcinogenic chemicals only*, is necessary to protect human health and the environment. Accordingly, the Board incorporates such a rule at Section 742.505(b) applicable only to groundwater remediation objectives.

Subpart F: Tier 2 General Evaluation

Under Tier 2, the applicant can develop soil and groundwater remediation objectives applying site-specific information to pre-established modeling equations. The Tier 2 equations are set forth in Appendix C, Tables A and C. These equations are from the SSL and the RBCA approaches. See Appendix C, Tables A and C, respectively for the equations to be used. The values to be used in the calculations, and the appropriate units are found at Appendix C, Tables B and D. Table B contains the values for use in the SSL equations, and Table D contains the values for the RBCA equations. These tables also contain the acceptable exposure factors for the residential, industrial/commercial and construction worker populations when the present and post-remediation land uses are evaluated. As in Tier 1, the remediation objectives in Tier 2 cannot exceed an excess cancer risk of 1 in 1,000,000 for carcinogens, or a hazard quotient of 1 for noncarcinogens. Additionally, as in Tier 1, there is a mixture rule requiring that the cumulative effect of similar-acting noncarcinogenic chemical be evaluated in developing remediation objectives. However, unlike Tier 1, this rule is applicable to soil as well as groundwater remediation objectives.

The rules generally applicable to a Tier 2 evaluation are set forth at Section 742.600. Similar to a Tier 1 analysis, the soil saturation and soil attenuation capacity restrictions found at Subpart B: Sections 742.215 and 742.220 apply. In other words, free product must be removed. See subsections (d)(1) and (3) of Section 742.600. Section 742.600 also instructs the applicant about how to choose the correct remediation objective if there is more than one exposure route requiring a remediation objective. This selection process is described at

---

[5]The Agency also added a provision at Section 742.805(c), which requires the consideration of the effect of mixtures of similar-acting chemicals in determining Tier 2 groundwater remediation objectives. Section 742.805(c) provides a cross-reference to the provisions of Section 742.505(b)(3). Section 742.805(c) is adopted today under Tier 2.

Section 742.600(e), (f), and (g), and presumes that the applicant has chosen to forgo the Tier 1 fixed numerical remediation objectives.

At the December 3, 1996 hearing, John Sherrill, a witness for the Agency, gave examples demonstrating when to use a Tier 1 or 2 remediation objective. For the purposes of illustration, the remediation objectives for benzene are used. The groundwater is Class I, none of the exposure routes are excluded and the numbers from Appendix B, Table A are used. The remediation objective for benzene for the ingestion route is 22 mg/kg, for the inhalation route is 0.8 mg/kg, and the migration to groundwater route is 0.03 mg/kg. The migration to groundwater remediation objective applies as the Tier 1 soil remediation objective because it is the most stringent out of the three values. If the calculated Tier 2 soil remediation objective for an exposure route is more stringent than the Tier 1 remediation objective for the same exposure route, then the Tier 1 remediation objective applies. In the hypothetical, within Tier 2, the applicant calculates a soil remediation objective of 0.02 mg/kg. The remediation objective would then be 0.03 mg/kg because it is less stringent than the calculated Tier 2 soil remediation objective.

If the calculated Tier 2 soil remediation objective for an exposure route is more stringent than one or more of the Tier 1 soil remediation objective(s) for a different exposure route, then the calculated Tier 2 soil remediation objective applies and the Tier 2 remediation objective for other exposure routes do not need to be calculated. For example, within Tier 2, the applicant calculates a migration to groundwater remediation objective of 0.1 mg/kg. The remediation objective would then be 0.1 because it is more stringent than the Tier 1 ingestion and inhalation remediation objectives (22 mg/kg and 0.8 mg/kg respectively).

If the calculated Tier 2 soil remediation objective is less stringent than one or more of the Tier 1 soil remediation objectives for the remaining exposure routes, then the other Tier 2 remediation objectives are calculated and the most stringent calculated Tier 2 value applies. Within Tier 2, the applicant calculates a migration to groundwater remediation objective of 1.2 mg/kg. This is less stringent than the inhalation soil remediation objective in Tier 1. So the applicant then calculates the Tier 2 ingestion and inhalation remediation objectives. The applicant calculates an ingestion remediation objective of 30 mg/kg and an inhalation remediation objective of 11 mg/kg. Since the Tier 2 migration to groundwater remediation objective is the most stringent (1.2 is less than 30 and 11), 1.2 mg/kg is the remediation objective.

As in Tier 1, the proposed land use for the site is considered in establishing Tier 2 soil remediation objectives. In a Tier 2 evaluation, the proposed land use for the site will determine the appropriate exposure factors contained in the applicable equation. The appropriate exposure factors for residential, industrial/commercial, and construction worker populations are set forth in Appendix C, Tables B and D. The established exposure factors can only be varied in a Tier 3 analysis. If a Tier 2 evaluation is based on an industrial/commercial property use, the construction worker scenario must also be evaluated. Additionally, the applicant must obtain an institutional control in accordance with the requirements of Subpart J.

Finally, the Agency requested that the mixture rule originally proposed for Tier 2 as a single rule be replaced with two separate sections, one addressing soil remediation objectives and the other addressing groundwater remediation objectives. The Board accepts these revisions as nonsubstantive. Accordingly, the Board deletes Section 742.610 and replaces it with a mixture rule for soil at Section 742.720 and for groundwater at Section 742.805. For further discussion of the mixture rules adopted for Tier 2, see pages 46-50 *supra*.

Subpart G: Tier 2 Soil Evaluation

Tier 2 provides the applicant with two options for establishing soil remediation objectives: reliance on the SSL equations or on the RBCA equations. Because the RBCA equations combine the soil ingestion, inhalation of vapors and particulates, and dermal contact exposure routes, while the SSL equations treat the soil ingestion, inhalation of volatiles, and inhalation of fugitive dust exposure routes separately, the applicant must choose only one of these approaches, and the two approaches cannot be combined. However, both methods treat the soil component of the groundwater exposure route separately, so the applicant can choose to use either method to calculate the remediation objectives for this exposure route, no matter which approach was used to establish the other soil objectives.

SSL Equations. The SSL equations are set forth in Appendix C, Table A. The parameters for these equations are set forth in Appendix C, Table B. The equations are divided into separate categories by exposure route: ingestion, inhalation of volatiles, inhalation of fugitive dust, and to groundwater.

Within each exposure route s set of equations, there are separate sets of equations for noncarcinogens and carcinogens. The equations for carcinogens reflect an expected excess cancer risk of 1 in 1,000,000, while the equations for noncarcinogens reflect a hazard quotient of 1. Within these categories, separate equations are set forth for residential, industrial/commercial, and construction worker populations. The different equations for each type of land use reflects the expected differences in the exposure factor, exposure duration, averaging time, and ingestion rate. Default values and parameters for these equations are listed in Appendix C, Table B.

RBCA Equations. Appendix C, Table C contains the RBCA equations used in Tier 2. The RBCA equations for establishing soil remediation objectives are separated into three categories. The first two categories examine the combined exposures of soil ingestion, inhalation of vapors and particulates, or dermal contact with soil, and ambient vapor inhalation (outdoor) route from subsurface soils. The third category is for the migration to groundwater pathway. Within each of these categories, separate equations are set forth for noncarcinogens and carcinogens. Since RBCA offers two different ways to evaluate the soil remediation objectives, the smaller, or more stringent, of the two values will be the remediation objective (either equation R1 or R7 for carcinogens and equation R2 or R8 for noncarcinogens).

Unlike the SSL approach, which sets forth separate equations for each exposure route for each type of land use, RBCA does not have separate equations for each type of land use. Instead, RBCA allows for differences in the type of land use to be reflected in the values of certain parameters. Because RBCA groups ingestion and inhalation into the same equations, one model is to be used in Tier 2 for the inhalation and ingestion exposure routes. Either the RBCA or SSL models can be used for the soil component of the groundwater exposure route.

The Board adopts the requirements originally proposed at Section 742.610 concerning the cumulative effect of noncarcinogenic chemicals for soil remediation objectives at Section 742.720. Appendix A, Table E sets forth groups of chemicals from Appendix B, Tables A and B, that have remediation objectives based on noncarcinogenic toxicity, and that affect the same target organ. If more than one chemical detected at the site affects the same target organ, the applicant must correct the initially calculated remediation value for each chemical in the group.

Subpart H: Tier 2 Groundwater Evaluation

Subpart H contains the procedures for developing Tier 2 groundwater remediation objectives. If the contaminants of concern exceed the applicable Tier 1 remediation objectives, an applicant has several choices. As preliminary to a Tier 1 analysis, the applicant can as a preliminary matter, demonstrate that the pathway is excluded, that the contamination is at or below the area background concentration in accordance with Subpart D, or conduct Tier 3 analysis. There are also two alternatives distinctive to groundwater remediation objectives available. An applicant can seek from the Board reclassification of the contaminated groundwater pursuant to 35 Ill. Adm. Code 620.260, or an adjusted standard pursuant to Section 28.1 of the Act. However, should an applicant choose to develop Tier 2 groundwater remediation objectives, the applicant must use RBCA Equation R26. Using this equation, the applicant can develop remediation objectives which exceed the applicable Part 620 groundwater standards at the site, but which will meet the applicable groundwater standards at the point of human exposure.

Pursuant to Section 742.805, before developing a Tier 2 groundwater remediation objective, the applicant must first identify the horizontal and vertical extent of the contamination, and, to the extent practicable, take remedial action to remove any free product. The applicant can then use RBCA Equation R26 to demonstrate that the applicable groundwater standards will be achieved at the point of human exposure. The basis and application of Equation R26 to predict impacts from remaining groundwater contamination are explained in Section 742.810.

Equation R26 predicts the concentration of a contaminant along the centerline of a plume, taking into account the three dimension dispersion and biodegradation. Using Equation R26, the applicant can demonstrate that, although the concentration of a contaminant exceeds the applicable Tier 1 objective at the source, the concentration at the point of human exposure will meet either the applicable Tier 1 groundwater remediation objective, or if no Tier 1 objective exists, the applicable Health Advisory concentration as determined in accordance with the procedures set forth in 35 Ill. Adm. Code 620, Subpart F. If the applicant determines

that the applicable Tier 1 objective will be exceeded at the point of human exposure, the applicant can back-calculate the concentration that must be achieved at the source in order for the compliance to be achieved.

In addition to demonstrating that the applicable Tier 1 objective will be achieved at the point of human exposure, in order to demonstrate compliance pursuant to Tier 2, the applicant must demonstrate that five additional requirements are satisfied. First, using Equation R26, the applicant must demonstrate that the concentration of any contaminant in groundwater within the minimum or designated maximum setback zone of an existing potable water supply well will meet the applicable Tier 1 groundwater objective or the Health Advisory concentration[6]. Second, the applicant must demonstrate that the source of the release is not located within the minimum or designated maximum setback zone of a potable water supply well. Third, the applicant must use Equation R26 to demonstrate that the concentration of any contaminant in groundwater discharging into surface water will meet the applicable water quality standard pursuant to 35 Ill. Adm. Code 302. Fourth, the applicant must demonstrate that any groundwater remediation objective established pursuant to this procedure does not exceed the water solubility for that contaminant. Finally, if the remediation relies on an engineered barrier, the applicant must demonstrate that an institutional control is in place requiring that the barrier remain in place. These requirements are set forth at Section 742.805 and illustrated at Appendix C: Illustration B.

During the public comment period, the Board received a public comment questioning whether the R26 equation in the RBCA guidelines has been properly adapted for use in establishing risk based remediation objectives under Tier 2. The commentator urged the Board to change the last *erf* (error function) term in the denominator of Equation R26 from 4 to 2. (PC 6.) The Agency supports the change. (PC 10 at 12-13; PC 22.)

The Board has reviewed the comments received on this issue and the various documents supporting the R26 Equation. A more detailed discussion of the comments in support and against changing Equation R26 at this time and the relevant guidance documents is set forth at pages 50-52, *supra*. Since the supporting documents indicate that the use of the incorrect number (4) for the vertical dispersion *erf* results in under-prediction of concentrations of contaminants along centerline of a plume, the Board will correct Equation R26 by changing the constant value for the *erf* relating to vertical dispersion from 4 to 2. Equation R15, which is essentially the same equation, is also changed where it appears in the rules.

Section 742.810 contains another provision regarding the distance between an existing potable water supply well and the source of contamination which was the subject of change proposed first by the Agency, and later in public comments by IERG and ISG. The Agency proposed in Errata Sheet No.1, in each subsequent errata sheet and in changes attached to its public comments, that Section 742.810(b)(1) be revised as follows:

---

[6] Health Advisory concentrations are established in accordance with 35 Ill. Adm. Code 620, Subpart F for contaminants that do not have a groundwater quality standard under Part 620, Subpart D.

> To demonstrate that no existing potable water supply well is adversely impacted, X shall be the distance from the down-gradient edge of the source of contamination at the site to the ~~nearest water supply well~~ minimum or maximum setback zone of an existing potable water supply well…

In response, IERG proposes that the word designated be inserted prior to the word maximum to convey that the minimum setback zone will be used unless a maximum setback zone is determined. Minimum setback zones are established pursuant to Section 14.2(g) of the Act and maximum setback zones are established on a site-specific basis. IPC and ISG state that with the addition of that one word the presumption is clear that either the minimum or maximum setback zone can be used, whichever is closer.

The Agency has no objection with the inclusion of the word designated prior to maximum . Again, the Agency did not give a reason for the change it proposed in Errata Sheet No. 1. Both believe that the minimum setback zone which is an established number in the Act or a maximum setback zone which is ascertained from procedures set out in the Act would be more correct to use given the purposes of setback zones. After reviewing the Agency s proposed language and the comments submitted by it and IERG, IPC, and ISG, the Board will add the word designated before the word maximum to provide the desired clarification.

In addition to the above change, the Board has modified the proposed language at Section 742.810(b)(1) to clarify the procedure for demonstrating that no existing potable water supply is adversely impacted by a remediation site. The Board notes that the initially proposed language did not have any limitations regarding the location of potable water supply wells. Essentially, the revisions to subsection (b)(1) require an applicant to calculate the distance X from the downgradient edge of the source to the point where the contaminant concentration is equal to the Tier 1 groundwater remediation objective or Health Advisory concentration. If there are any potable water supply wells located within the distance X downgradient of the source, then the applicable groundwater remediation objectives must be met at the edge of the minimum or designated maximum setback zone. If no potable water supply wells exist within the calculated distance X, then it can be determined that no potable water supply wells are adversely impacted.

Subpart I: Tier 3 Evaluation

Tier 3 allows the applicant to develop remediation objectives using alternative parameters not found in Tier 1 or Tier 2. It allows the applicant great flexibility in developing remediation objectives appropriate for a particular site based upon site-specific information, rather than relying on general categories of information. The options available under Tier 3 include: use of modified parameters in the Tier 2 equations, use of alternative models, conducting a site-specific risk assessment, use of probabilistic analysis and sophisticated fate and transport models, assessment of impractical remediation, and variation of the target risk level. If any contaminants of concern are found to exceed the remediation objectives developed using the Tier 3 analysis, the applicant would

be required to remediate the contamination until the objectives are achieved. The applicant must provide appropriate justification for the use and application of any alternative parameters, models, or analysis relied upon in a Tier 3 evaluation.

Under the Agency s proposal, Tier 1 remediation objectives and Tier 2 equations are based upon a one-in-a-million individual excess cancer risk for carcinogens and a hazard quotient of one for noncarcinogens. (Exh. 4 at 12 & 21.) The Agency s proposal allows for changes in the target risk levels under Tier 3. As proposed by the Agency in Errata Sheet No. 2, Section 742.900(d) clearly set forth that requests for changes in target risk levels at the point of human exposure level must be supported with a formal risk assessment conducted in accordance with Section 742.915.

A number of the participants representing the regulated community expressed concerns regarding the target risk levels. The main issue concerning the target risk levels is whether or not the regulations should allow the determination of remediation objectives based on target risk levels greater than 1×10^{-6} (carcinogens) or greater than hazard quotient of 1 (noncarcinogens) only under Tier 3, as proposed by the Agency, or allow such determinations under Tiers 1 and 2. They argue that the regulations do not comply with the Act because a range of target risk levels is not available, and they advocate that Tier 1 and 2 specifically allow for target risk levels greater than 1×10^{-6}. Their arguments in support of such an approach and the Agency s response are summarized below at pages 52-56.

These concerns gave rise to a discussion about the risk assessment which must be performed under Tier 3 to demonstrate a greater target risk level is protective of human health. The Agency and a number of the commentators offered lists of the factors they believe must be addressed in such a risk assessment. Ultimately, the Agency gleamed from those lists the four factors it believes critical in such a risk assessment. Those factors are: 1) the presence of sensitive populations; 2) the number of receptors potentially impacted; 3) the duration of risk at the differing target levels; and 4) the characteristics of the chemicals of concern. See Section 742.915(h).

The Board finds that the Agency s proposal provides a balanced approach for determining remediation objectives that are protective of human health. Allowing higher risk levels under Tiers 1 or 2, as proposed by some participants, could result in overall risk levels at sites with certain multiple contaminants to fall outside the acceptable range specified in Section 58.5 of the Act. The Board agrees with the Agency that any changes in risk levels must be supported by formal risk assessment under Tier 3. The Board also agrees that Section 742.915 needs to be modified to list the elements which must be addressed by such a risk assessment if the applicant is seeking to modify the target risk level. Accordingly, subsection (h) as proposed by the Agency is included in this Second Notice.

Pursuant to Section 58.5(d)(4) of the Act, an applicant can seek site-specific remediation objectives which exceed the Tier 1 remediation objectives, *i.e.*, the Board s groundwater quality standards at Part 620, under Tier 3. To obtain such an exception, the Act requires two demonstrations. First, the applicant must demonstrate that the exceedence of the groundwater quality standard has been minimized and the beneficial use of the groundwater has been returned,

and that any threat to human health has also been minimized. These two statutory requirements are incorporated verbatim into the rules at Section 742.900(c)(9). Since the right to exceed groundwater quality standards, adopted by the Board as the level at which human health is protected, is available only due to this statutory exception, it is most important that the demonstration to obtain such a right comply with the these statutory requirements.

Subpart J: Institutional Controls

Institutional controls are defined under the proposed rules as a legal mechanism for imposing a restriction on land use. The Agency testified that institutional controls are a fundamental part of the proposal, and are the key to assuring long-term protection of human health, while providing flexibility in developing practical, risk-based remediation objectives. (Exh. 3 at 1.) The applicant must obtain an institutional control whenever the applicant seeks to take any of the following measures, or any combination thereof: 1) restrict a property to industrial/commercial use; 2) establish remediation objectives based on a target cancer risk greater than 1 in 1,000,000; 3) establish a target hazard quotient greater than 1 for a noncarcinogen under a Tier 3 analysis; 4) rely on an engineered barrier; 5) set the point of human exposure at a location other than at the source; or 6) exclude exposure pathways under Subpart C.

Pursuant to Subpart J, the following types of institutional controls are recognized under these rules: 1) No Further Remediation Letters; 2) restrictive covenants, deed restrictions, and negative easements; 3) ordinances adopted and administered by a unit of local government; and 4) agreements between a property owner and a highway authority with respect to any contamination remaining under highways. The requirements for each of these categories are set forth in a separate section.

Whether an institutional control is transferable with the property was an issue raised at hearing. The Agency and interested participants agreed that it should be transferable. During the public comment period, the Board received several comments in support of transferability. The Board examined the issue and concludes that an institutional control is transferred with the property. Therefore, the Board adopts the following at Section 742.1000(d): An institutional control is *transferred* with the property. For further discussion of this issue, see pages 56-58, *supra*.

The requirements for a No Further Remediation Letter is set forth at Section 742.1005. As originally proposed at First Notice, this section included detailed conditions concerning the recording of No Further Remediation Letters, their effectiveness, and their voidance. However, in its Errata Sheet No. 3, the Agency proposed deleting these provisions, and leaving only the language in subsection (b) which states that a request for approval of a No Further Remediation Letter as an institutional control shall follow the requirements applicable to the remediation program under which the remediation is performed. The Board finds that the modification to Section 742.1005 in Errata Sheet No. 3 should be adopted. The TACO rules are intended to establish a method for deriving corrective action objectives for remedial programs. Specific provisions concerning the effectiveness and limitations on No Further Remediation Letters and other instruments memorializing a no further remediation determination by the Agency are more appropriately set forth in the specific programs pursuant to which the such a determination is made.

The requirements for restrictive covenants, deed restrictions, and negative easements are set forth at Section 742.1010. At hearing, the Agency testified that it anticipates that these measures will be used only in situations where a No Further Remediation Letter is not available, and that it is not necessary to obtain restrictive covenants, deed restrictions, or negative easements which duplicate conditions set forth in a No Further Remediation Letter that is appropriately recorded. Restrictive covenants, deed restrictions, and negative easements approved by the Agency in accordance with this Section must be appropriately recorded, together with the instrument memorializing the Agency s no further remediation determination, *e.g.*, a No Further Remediation Letter.

Section 742.1015 sets forth the requirements for ordinances used as an institutional control. The use of an ordinance as an institutional control is specifically limited to ordinances that effectively prohibit the installation of potable water supply wells in order to meet the requirements of Section 742.320(c) or 742.805(a)(3). Unless the Agency and the unit of local government have entered into a Memorandum of Understanding (MOU), this section places the burden on the owner or successor in interest for monitoring the local governments activities with respect to the ordinance. If the ordinance is modified, or if a variance or other site-specific request is granted that allows use of the groundwater at the site as a potable water supply, or if the terms of another institutionally control at the site are violated, the use of the ordinance as an institutional control can be voided.

In Errata Sheet No. 2, the Agency proposed that this Section be modified to provide that ordinances which do not prevent the unit of local government from installing or using such wells may still be relied upon as an institutional control, if the unit of local government enters into a MOU with the Agency and the MOU satisfies certain requirements designed to assure that the local government will protect the water supply from contamination left in place.

Section 742.1015 sets forth procedures for ordinances that ensures that neighboring landowners are placed on notice relative to contamination that may have moved towards or under their property. (Exh. 3 at 4.) In order to address concerns raised at hearings, the Agency made changes to Section 742.1015 in Errata Sheet No. 2. IPC has expressed concerns regarding those revisions. (PC 8 at 8.) IPC believes that the revisions are overly broad in requiring a MOU in all instances where the ordinance does not prohibit the unit of local government from installing new wells. In this regard, IPC notes that the revisions proposed by the Agency would preclude the use of a vast majority of existing ordinances which do not expressly prohibit the unit of local government from installing new wells, unless the government took the additional step of entering into an MOU with the Agency. IPC provides language changes that address its concerns.

The Agency clarified its position concerning the MOU in its additional comments. (PC 15 at 3-7.) The Agency notes that, from the standpoint of human health and safety, it is not reasonable for the ordinance to allow public water supply systems to tap groundwater where contamination above Tier 1 levels has been allowed to remain. However, the Agency contends that the regulations will not prohibit all public uses of affected groundwater. The Agency states that the proposed provisions resolve the conflicting principles by allowing the use of ordinances that expressly do not prohibit the installation of a public water supply well by a unit

of local government so long as they enter into a MOU with the Agency. The Agency believes that entering the MOU and abiding by the commitments contained therein will forewarn communities of the existence of contamination plumes and may prevent costly mistakes in siting, construction, and use of public potable water supply wells. (PC 15 at 7.)

The proposed requirements concerning the MOU at Section 742.1015(i) require the unit of local government to make a commitment to: maintain a registry of all sites within its boundaries which have received a No Further Remediation Letter and review the registry of sites prior to siting potable water supply well; consider if groundwater contamination from the sites on the registry may be present at potential well sites; and take appropriate protective measures if wells are sited in the vicinity of such locations.

Given the potential human health risk and the cost of groundwater remediation and installation of potable water supply wells, it makes sense to be forewarned about potential problems concerning a groundwater source. Moreover, as noted by the Agency, most of the existing ordinances were not enacted by considering environmental concerns. In this regard, the proposed regulation provides an opportunity to a unit of local government to adopt an ordinance based upon the consideration of environmental concerns. For these reasons, the Board proposes to adopt the changes proposed at Section 742.1015 and sections cross-referencing it at Sections 742.320(d) and 742.805(a)(3).

Finally, Section 742.1020 sets forth the requirements applicable to highway authority agreements used as an institutional control. When contamination level of the groundwater exceed the Tier 1 residential levels, the highway authority must agree to prohibit the use of groundwater under the highway right-of-way as a potable water supply. When the contamination of the soil under the highway right of way exceeds the Tier 1 residential level, the highway authority must agree to limit access to soil contamination, and in the event access is allowed, human health and the environment must be protected.

Subpart K: Engineered Barriers

An engineered barrier is defined in Section 742.200 as a barrier designed or verified using engineering practices that limits exposure to or controls migration of the contaminants of concern. Mr. King testified that, in addition to including man-made structures designed using engineering practices, engineered barriers could include native or *in-situ* materials if their effectiveness is verified using engineering practices. (Exh. 3 at 7) The use and maintenance of an engineered barrier must be accompanied by an institutional control in accordance with Subpart J. Furthermore, any no further remediation determination by the Agency based on the use of the engineered barrier must be conditioned upon maintenance of the engineered barrier, and the institutional control must address provisions for temporary breaches of the engineered barrier. Failure to maintain an engineered barrier in accordance with the terms of the no further remediation determination constitutes grounds for voidance of that determination.

Section 742.1105 sets forth the requirements for engineered barriers and limitations on their use in achieving remediation objectives. It makes clear that natural attenuation, access controls and point of use treatment do not fall within the definition of engineered barriers, and that engineered barriers cannot be relied upon in determining compliance with Tier 1 remediation objectives. Subsection (c) of this Section sets forth a list of engineered barriers accepted for each exposure route. For the soil component of the groundwater ingestion exposure route, these include caps constructed of clay, asphalt, or concrete, and permanent structures, such as buildings or highways. For the soil ingestion and inhalation exposure routes, the acceptable engineered barriers include clean soil at least three feet in depth, as well as caps and permanent structures. Finally, for the groundwater component, the acceptable engineered barriers include slurry walls and hydraulic control of groundwater. Subsection (d) of this Section makes it clear that the list of accepted measures is not intended to be exhaustive and that other methods will be accepted by the Agency if they are shown to be as effective as the listed options.

RESOLUTION OF MAJOR ISSUES

Subpart B: Definition of Residential Property and Compliance Demonstration for Two Exposure Routes

Section 742.200: Definition of Residential Property. As explained above, the Board modified the definition of residential property originally proposed by the Agency. That decision was made after considering the arguments raised by Gardner Carton & Douglas concerning the originally proposed definition, the revised definition proposed by Gardner Carton & Douglas, the Agency s disagreement with that revised definition, and the public comments about this definition received by the Board in the Site Remediation Program rulemaking, R97-11.

In this rulemaking, Gardner Carton & Douglas contends that the Agency s proposed definition needs to be modified to eliminate unnecessary confusion, and suggests the following. (Exh. 15 at 3.)

Residential Property means any real property that is used for habitation by individuals or ~~where children have the opportunity for exposure to contaminants through ingestion or inhalation at~~ any educational facilities, or playgrounds where soil ingestion or inhalation pathways for children are found to exist.

Gardner Carton & Douglas argues that it is critically important that this definition be clear and not subject to varying interpretations since the definition of residential property provides the basis for the imposition of differing cleanup standards. Further, Gardner Carton & Douglas asserts that the revisions it proposes are intended only for the purpose of clarification and are not intended to change the intent. (December 10, 1996 Transcript at page 53.)

The Agency objects to the revisions since the changes do not account for a complete exposure pathway. (Exh. 20 at 1.) The Agency contends that whether the pathway is complete is not clear under Gardner Carton & Douglas proposed revision, since the revision deletes the language ..have the opportunity for exposure to contaminants. Additionally, the Agency states that Gardner Carton & Douglas revisions are limited to what is found to exist at the time of the investigation and not what may occur in post-remediation uses. (Exh. 20 at 1.) Finally, the Agency notes that the Board upheld the Agency s definition of residential property in its First Notice opinion concerning the Site Remediation Program. (PC 10 at 4.) (See R97-11 Opinion of February 6, 1997 at pages 13-14.)

As noted by the Agency, the Board did not accept the revisions suggested by Gardner Carton & Douglas in its First Notice opinion concerning the Site Remediation Program. The Board found the revisions inappropriate for the reasons stated by the Agency. (Id.) However, in the First Notice opinion for the proposed Site Remediation Program, the Board expressed concerns regarding two other aspect of the Agency s proposed definition. First, the Board questioned whether the Agency s proposed definition reflects the statutory intent. Section 58.2 of the Act defines residential property as any real property that is used for habitation by individuals and other property uses defined by Board rules such as education, health care, child care and related uses. The Board observed that by equating playgrounds with related uses, the Agency may have constructed related uses too narrowly. Additionally, the Board also asked for clarification about the phrase by ingestion or inhalation in describing exposure to children.

Thereafter, the Board received several comments concerning this definition in the R97-11 rulemaking. After examining those comments and the definition closely, the Board concluded in R97-11 that the Agency s definitions required nine modifications. In sum, the Board concluded therein that the term playgrounds was too narrow, to encompass many areas where children regularly lay, and substituted it with the term outdoor recreational areas . The modifier outdoor precludes the term recreational areas from encompassing those recreational areas where there is little threat of exposure e.g. indoor recreational facilities. For an expanded discussion on the modified definition adopted by the Board, see the R97-11 Opinion for Second Notice, at pages 11-14 (April 17, 1997).

The definition adopted today by the Board in this rulemaking, as well as in the R97-11 rulemaking, reads:

> Residential Property MEANS ANY REAL PROPOERTY THAT IS USED FOR HABITATION BY INDIVIDUALS, or where children have an opportunity for exposure to contaminants through soil ingestion or inhalation at an educational facilities, health care facilities, child care facilities, or outdoor recreational areas.

Section 742.225: Compliance with Remediation Objectives. At Section 742.225(d), as originally proposed by the Agency, detailed compositing and averaging requirements were set forth for demonstrating compliance for the inhalation and soil ingestion exposure routes. At hearing, Gardner Carton & Douglas stated that the proposed compliance requirements at Section 742.225(d) were not consistent with the exposure route evaluation requirements set forth in Sections 742.310 and 742.315, which specify pathway exclusion requirements for the inhalation and soil ingestion exposure routes. (Exh. 15 at 4-5.) These requirements include a criterion based on the depth of contamination. Specifically, Section 742.310(b) provides that the concentration of any contaminant of concern within ten feet of the land surface or any man-made pathway shall not exceed the Tier 1 remediation objective under Subpart E for the inhalation exposure route, and Section 742.315(b) provides that the concentration of any contaminant of concern within three feet of the land surface shall not exceed the Tier 1 remediation objective under Subpart E for the ingestion of soil exposure route. Alternatively, both rules would allow the applicant to rely on an engineered barrier installed in accordance with Subpart K. (Section 742.310(b)(2) and 742.315(b)(2).) Gardner Carton & Douglas contends that the compliance requirements proposed at Section 742.225(d) do not incorporate these depth criteria and asserts that such criteria should be incorporated into the compliance requirements set forth in Section 742.225. (Exh. 15 at 5.)

In response to Gardner Carton & Douglas comments, the Agency proposed in Errata Sheet No. 2 that this Section be modified to allow greater flexibility for the applicant in developing a proposed sampling scheme. (January 15, 1997 Transcript at pages 103-110.) The Agency proposed that the specific sampling protocols at Section 742.222(d) be deleted and that a new provision be added that requires each applicant to submit a sampling plan for Agency approval based upon a site-specific evaluation. The prohibition against compositing of VOC samples is retained, as is the requirement that all samples be collected within the contaminated area. As a result of the changes to this subsection, the Agency also proposed deleting Section 742.225(f), because it originally provided for the use of an alternative method approved by the Agency, and Section 742.225(d) now incorporates the same flexibility.

The Board believes that Gardner Carton & Douglas testimony raised valid concerns regarding the proposed requirements at Section 742.225(d). Based on the Agency s initial testimony, if the contamination extends below one foot from the surface, then Section 742.225(d) would require soil sampling below one foot from the surface to show compliance for the inhalation and ingestion exposure routes. (December 10, 1996 Transcript at pages 208-218.) However, the Agency s proposed changes to Section 742.225(d) provide greater flexibility for the applicant to develop an appropriate sampling scheme for compositing or averaging soil samples when

determining compliance with objectives for these exposure routes. Even though the changes in Errata Sheet No.2 do not incorporate the depth criteria suggested by Gardner Carton & Douglas, they address Gardner Carton & Douglas concerns by allowing the applicant to submit a sampling plan based on site-specific conditions. The Board therefore accepts the Agency s proposed changes to Section 742.225(d) and finds no need for the additional changes suggested by Gardner Carton & Douglas. Furthermore, as a result of these amendments, the Board adopts the Agency s proposed deletion of Section 742.225(f).

Subpart C: Objections to General Criteria and Specific Criteria for Pathway Exclusions

Section 742.305: Objections to Point of Human Exposure as Compliance Point and Prohibition of Source Material Exhibiting Hazardous Characteristics. Jenner & Block contends that the proposed provisions, which are linked to stringent cleanup levels for risk of migration to groundwater in Tier 1 and include the requirement of an institutional control if any pathway is excluded, will create a form of environmental zoning. Jenner & Block suggested two changes to the general criteria for exclusion of pathways. The first concerns the location of the point of human exposure and the second concerns the applicability of the general exclusion criteria to the migration to groundwater pathway.

Concerning the location of the point of human exposure, Jenner & Block states that the proposed rules are based on the assumption that the point of human exposure is the source of the material and that using any other point of exposure would require a deed restriction. (Exh. 18 at 18.) Jenner & Block states that Agency s proposal under Subpart C assumes that there is someone with a groundwater well, drinking water directly from the source of contamination, and that individuals are at the source ingesting and inhaling vapors from the contamination. In this regard, Jenner & Block notes that an owner/operator under the Underground Storage Tank program may move the point of exposure up to 200 feet because that is a statutory point of compliance. As a result, Jenner & Block suggests that the Board set a point of compliance at the closer of the downgradient property line boundary or 200 feet from the source.

In response, the Agency urges the Board to adopt the requirements for pathway exclusions as proposed, including the proposed limits on contaminant concentration. The Agency notes that the proposed regulations under Tier 3 allow for pathway exclusion without any limits on contaminant concentrations. (See Section 742.300)

As noted by the Agency, the basic premise of pathway exclusion is effective control of the source, coupled with site conditions and an appropriate institutional control that effectively prohibits human exposure through a given pathway. The underlying assumption that the point of human exposure is at the source of the material is justified since the exclusion of a pathway under Section 742.Subpart C is intended to demonstrate that the site does not pose a threat to human health through that pathway. If the point of exposure is moved away from the source without engineered barriers and institutional controls, then the potential risk of exposure would still exist. Additionally, for those sites that do not qualify for pathway exclusion under Subpart C, the applicant may pursue pathway exclusion under Tier 3. (PC 10 at 6; Exh. 20 at 3.) Finally, the compliance point is not defined under the TACO regulations and it is more

appropriately addressed under the regulations pertaining to the specific remediation programs. The Board therefore does not make any changes concerning the compliance point.

Concerning its second issue, Jenner & Block argues that the general limits on pathway exclusions at Section 742.305(c) through (e), which require the applicant to insure that the contaminated soil remaining in place does not exhibit the hazardous characteristics of reactivity, corrosivity, or toxicity, do not relate to the risk of migration to groundwater pathway. Jenner & Block contends that these proposed limits potentially relate to the ingestion and inhalation pathways. Moreover, Jenner & Block asserts that these restrictions act as additional cleanup standards that every site must meet if it wishes to exclude any pathway, even one which is not affected by these three limitations. (Exh. 18 at 20.) Jenner & Block maintains that the limits on exclusions are inappropriately placed and that they should be proposed as independent remediation objectives.

The Agency urges that the Board not make any changes to Section 742.305. The Agency notes that pathway exclusion allows source material to be left in place if it is determined that the particular exposure route is not a concern. Therefore, the Agency believes that it is critical to place limits on how much contamination may be left behind under Subpart C. (PC 10 at 5.) The Agency did admit that should the source material fail these three criteria, there might not necessarily be an increased risk to groundwater. However, the Agency reiterated that if a source material fails these criteria, the material would be aggressively reactive and toxic. Furthermore, the Agency states that, if the limits are exceeded, it may be impossible to model the behavior of the contaminants, and the contaminants may pose unacceptable health risks including: serious dermal effects from even brief contact with contamination; absorption of contaminants through the skin into the blood stream; immediate danger to human health and life or organ damage (skin, lungs, kidneys) from exposure to high concentrations; immediate danger to skin and eyes from exposure to extreme pH ranges; and fires or explosions resulting from seepage of free product into basements, parking garages, or utility trenches. (PC 10 at 5.)

In addition, the Agency states that there is always a risk for unintentional or accidental exposure to contamination left in place should the engineered barriers and institutional controls fail, or should responsible persons not fulfill their obligations to perform ongoing maintenance. (Exh. 20 at 2.) The Agency contends that the limits proposed at Section 742.305 provide a ceiling or control mechanism to limit the level of exposure from high contaminant concentrations.

The Board does not agree with Jenner & Block that these three criteria are not applicable to the migration to groundwater pathway. Soils with a very low pH promote mobility of metals, which in turn may result in an increased threat of groundwater contamination. Additionally, the levels of the inorganic chemicals or their salts as measured using the TCLP test have a direct bearing on the migration to groundwater pathway since the regulations, for a number of inorganic chemicals, require the TCLP results to be compared with the Tier 1 remediation objectives for the migration to groundwater pathway in Part 742.Appendix B, Tables A and B. The Board therefore finds it reasonable to require the above

limits to be generally applicable to the evaluation of all exposure routes. However, as the Agency clarified, site-specific information will dictate how the Section 742.305 limits are addressed. (December 10, 1996 Transcript at pages 230-232.) Actual sampling may not be required if it is possible to address one or more of the limits on the basis of site characteristics. The Board therefore declines the suggestions made by Jenner & Block and adopts for second notice the general pathway exclusions requirements as proposed by the Agency at Section 742.305.

Sections 742.310, 742.315 and 742.320: Specific Requirements for Excluding Pathways. Jenner & Block raises three concerns about the specific criteria applicable to the pathway exclusion process. These issues concern: (1) the exceptions from the depth limitation requirements at Sections 742.310(b)(1) and 742.315(b)(1); (2) the requirements at Sections 742.310(b) and 742.315(b) for an institutional control in all instances where the contaminant levels exceed the allowable levels for inhalation or ingestion routes; and (3) the requirement at Section 742.320(d) that an ordinance be adopted by a unit of local government within 2500 feet of the source restricting use of groundwater.

First, Jenner & Block recommends that the regulations allow exceptions from the limit for contamination within the first three feet of the surface for the risk of ingestion pathway, and the first ten feet of the surface for the inhalation exposure route. In this regard, Jenner & Block asks that the regulations allow evaluation of deeper contamination within the 200-foot radius of the source. (Exh. 18 at 19.) The Agency did not specifically address Jenner & Block s concerns regarding depth limitations. However, the Agency s statement concerning Section 742.305 that Tier 3 is available to those sites where removal of all source contamination and free product is not achievable appears to touch upon this issue. (Exh. 20 at 3.)

The limitations that Jenner & Block refers to are set forth at Sections 742.310(b)(1) and 742.315(b)(1). For the inhalation exposure route, Section 742.310(b)(1) requires that the concentration of any contaminant of concern within 10 feet of land surface or any man-made pathway not to exceed the applicable Tier 1 remediation objectives. A similar requirement for the soil ingestion exposure route is set forth at Section 742.315(b)(1), with a depth limitation of 3 feet. If an applicant cannot show compliance within these depths, the applicant can seek to use an engineered barrier to exclude a pathway.

The depth criterion for the inhalation exposure route is drawn from the RBCA guidelines. The 10-foot thick layer of soil is intended to provide sufficient distance for attenuation of vapors to concentrations below levels of concern. (Exh. 13 at 9.) The depth limitation concerning ingestion is also drawn from the RBCA guidelines. The 3-foot soil thickness provides sufficient protection against contact and ingestion by people and allows for some mixing and disturbance of shallow soils over time. (Exh. 13 at 8.) In effect, the depth criteria under Subpart C are intended to protect human health.

According to the testimony given by the SRAC, Subpart C is intended to provide pathway exclusion procedures which are preliminary to any tier analysis. Therefore, the

pathway exclusion process is necessarily prescriptive in order to ensure that a qualifying site does not present risk to a receptor. (Exh. 12 at 7.). The Board agrees. The requirements are intended to ensure that, for a given pathway, a site which meets the applicable requirements does not pose a threat to human health. The exception proposed by Jenner & Block from the requirements under Subpart C would be contrary to this purpose and the safeguards the depth limitations provide. As noted by the Agency in regards to Section 742.305, should an applicant believe that such an exception is valid on a site specific basis, then the exception and its impact to human health is best evaluated under Tier 3. Section 742.300 provides for that type of analysis in lieu of the pathway exclusion process provided under Subpart C. For these reasons, the Board will not adopt Jenner & Block s recommendation to allow exceptions from the depth limitations of Section 742.310(b) and 742.315(b).

Next, Jenner & Block recommends that the institutional control provision at Sections 742.310 and 742.315 be modified. Specifically, Jenner & Block suggests that the Board delete the requirements at Sections 742.310(b) and 742.315(b) that require an institutional control in all instances where the contaminant levels exceed the allowable levels for inhalation or ingestion routes. Jenner & Block states that there would be little practical reason to require an institutional control for the inhalation route when contamination is located deeper than 10 feet from the surface or for ingestion route when contamination is located deeper than 3 feet. (Exh. 18 at 20-21.) Jenner & Block argues that the likely risk posed by deeper soils is related to construction workers and that such risks are addressed by Occupational Safety & Health Administration restrictions. (Exh. 18 at 21.)

In response, the Agency states that it does not understand Jenner & Block s concern. The Agency believes that the institutional control will provide future owners the information necessary to correctly manage the remaining contamination, and unless the necessary land use restriction, management, and access requirements are effectively imposed, the traditional process of remediating sites to meet the most restrictive use requirements would be required. (Exh. 20 at 7.)

We agree with the Agency that Jenner & Block s concern about the institutional controls is not clear. The pathway exclusion procedures of Subpart C are based on effective source control and an institutional control which, together, effectively prohibit human exposure through a given pathway. Absent an institutional control, it is not clear how the management requirements pertaining to remaining contamination would be implemented by future owners. This is especially critical since contamination remains in place. The Board believes that Jenner & Block has not justified its request to delete the institutional control requirements. Accordingly, the institutional control requirements at Sections 742.310 and 742.315 are adopted for second notice.

Finally, Jenner & Block expressed concern about the requirement at Section 742.320(d) that an ordinance be in place, *i.e.*, adopted by a unit of local government to prohibit the installation or use of potable water supply wells within 2500 feet of the source of the release. Jenner & Block states that this requirement is overly conservative since it includes communities located both upgradient and downgradient from the source. (Exh. 18 at 21.)

Jenner & Block proposes that the ordinance requirement be applied only to communities that are downgradient of the source with respect to the direction of groundwater flow. In this regard, Jenner & Block notes that the Agency s position is that the rule should also apply to upgradient because the direction of groundwater flow may change. (Exh. 18 at 22.)

At first, Jenner & Block s downgradient argument appears valid, since a contaminant plume, if present, generally moves along the direction of groundwater flow. However, to require ordinances only in communities located downgradient of the source, a detailed site hydrogeological characterization would be needed to ensure protection of the upgradient groundwater resource. Site characterization requirements are not addressed in TACO; instead, site characterization requirements are program specific. Therefore there is no assurance that the site characterization would provide sufficient detail to provide a clear picture of the site hydrogeological conditions. Considering that contamination may remain in place under Subpart C and that there is always a potential for changes in groundwater flow, the proposed requirement at Section 742.320(d) ensures that groundwater in the vicinity of the source will be excluded from potable uses. The Board therefore will not limit the applicability of this subsection to downgradient communities.

Subpart D: Three Issues Concerning Use and Determination of Area Background

Three issues were raised regarding area background at hearing. The three issues are: 1) exclusion of a contaminant of concern based on area background; 2) substitution of area background for Tier 1 residential objectives if the naturally occurring background level of a contaminant of concern is greater than Tier 1 residential level; and 3) the propriety of changing Appendix A, Table G to use the 50^{th} percentile values versus the 90^{th} percentile values from the Agency s area background database.

Section 742.415: Use of Area Background to Exclude a Contaminant. The first issue, excluding a contaminant of concern based on area background, was raised because in Errata Sheet No.2, the Agency deleted the originally proposed rule which allowed a contaminant of concern present as a result of area background to be excluded from further consideration. The Illinois Steel Group (ISG) disagreed with such a change, arguing that the Agency was interpreting the Act too narrowly. ISG contends that remediation objectives and cleaning up any contaminant which meets the statutory definition of area background is required only in the case of the two exceptions found in the Act: 1) at residential property, or 2) when the Agency makes a written finding that the regulated substance may cause an acute threat to human health. ISG wanted the new language in Errata Sheet No. 2 withdrawn and the original language returned. (PC 7 at 4.)

The first issue is resolved because the Agency has agreed that contaminants can be excluded if they are equal to or below area background levels subject to the two statutory limitations set from further consideration at Section 742.415. Section 742.415(b)(1) allows the exclusion of a contaminant of concern based upon the area background subject to the two statutory limitations found in Section 58.5 of the Act. Area background concentrations cannot be used to exclude a contaminant from further concern if (1) the Agency has made a finding

that the area background level poses an acute threat to human health or the environment, or (2) the area background level exceeds the residential remedial objective at residential property.

Section 742.415: Use of Area Background Concentration as Remediation Objective. The second issue was raised by Ms. Linda Huff who testified on behalf of the Site Remediation Coalition, represented by Gardner Carton & Douglas. In her pre-filed testimony, Ms.Huff stated that there are sites in Illinois where the area background of naturally occurring chemicals are greater than the Tier 1 residential remediation objectives listed in Appendix B, Table A. (Exh.15 at 11.) As an example she cited arsenic which has a Tier 1 value of 0.4 mg/kg and the area background level is 5.2 mg/kg for counties outside the metropolitan statistical areas and 7.2 mg/kg for counties inside the statistical areas. She believed that the rules as modified would require all sites that have an area background greater than the Tier 1 residential value would have to be limited to industrial/commercial uses. She also questioned how property currently being used as residential would be handled if this proposal is not changed. The proposed regulations now allow area background levels to replace Tier 1 remediation objectives which are less than area background levels for sites that are specified as something other than residential. In essence, Garner Carton & Douglas wants the Agency to allow area background levels to replace Tier 1 residential levels.

Regarding the use of area background concentrations in place of Tier 1 remediation objectives, the Agency states that the entire premise upon which its position is drawn stems from the statutory definition of area background[7]. (PC. 15 at 6-7.) The Agency concludes that even though area background is not limited to pristine conditions, contaminants of concern resulting solely from one release cannot be considered as background for another release, whether on-site or off-site. With regards to the limitation that land use should be limited to industrial/commercial sites where the area background levels are greater than the Tier 1 value, the Agency notes that the requirement is statutory. In order to clarify the proposed intent, the Agency has proposed, in its final comments, the addition of statutory language at Section 742.415(d) that prohibits the conversion of property s land use to residential land use if concentrations of contaminants of concern at the site exceeds the residential remediation objectives. The Agency also stated in its rebuttal that studies have established carcinogenic effects from naturally occurring levels of arsenic. Consequently, it would not allow the area background level to replace any Tier 1 residential remediation objective. The Agency cited Section 58.5(b)(2) in support of belief that background area levels cannot be substituted for residential values even if the substance was naturally occurring as urged by Gardner Carton & Douglas.

The Board agrees with the Agency that the Act prohibits background levels being substituted for residential levels but with one caveat. Section 58.5(b)(2) of the Act prohibits property being converted to residential property unless the residential remediation objective adopted by the Board is first achieved, but provides that property may be converted to residential use if an alternative risk-based remediation objective is achieved. Therefore, the

[7] Area Background is defined as the concentrations of regulated substances that are consistently present in the environment in the vicinity of a site that are the result of natural conditions or human activities, and not the result solely of releases at the site.

Board will adopt the language proposed by the Agency at Section 742.415(d) taken from Section 58.5(b)(2) of the Act. Finally, if the land use is restricted to something other than residential, an institutional control is required by the last sentence in Section 742.415(d).

Section 742.405: Choice of 50th Percentile Values for Statewide Background Levels. The third issue was raised in the second set of hearings because the Agency changed its original proposal. Initially a range of values was proposed based on the 90th percentile from the Agency s database. When determining the statewide area background. In Errata Sheet No. 2, the Agency changed its range to the 50th percentile because it does not believe that its database is sufficiently reliable for the values to be based on the 90th percentile. Gardner Carton & Douglas questioned the Agency s decision to use the 50th percentile values in Appendix A, Table G instead of the range that was initially proposed. Table G in Appendix A contains the concentration of inorganic chemicals in background soils. This change was made in the Agency s Errata Sheet 2. Gardner Carton & Douglas contends that the Agency did no analysis on the concentration distribution of area background, and cites several other states which use the 90th percentile for their area background.

The Agency responded within its rebuttal that using a range of values from the database is not dependable enough to replace any remediation objectives because: 1) of the anthropogenic effects on some samples; 2) the data set is not a product of a scientifically designed and statistically valid survey; 3) the samples came from numerous sites so there may be differing levels of quality assurance/quality control; and 4) most likely does not contain a uniform degree of diligence. (Exh. 20 at 4.) Therefore, the Agency chose to use the 50th percentile. In the Agency s additional comments, it further addresses issues brought up by Gardner Carton & Douglas on this topic. (PC 15 at 11.) In response to Gardner Carton & Douglas comments, the Agency again disagrees. The Agency reiterates that the inorganic background database is deficient in so many ways that it should not be considered reliable for establishing area background based on 90th percentile. (PC 15 at 17.)

Gardner Carton & Douglas cites a Massachusetts document about their background soil concentrations. The Agency states that within that document, the authors state that their samples mostly came from rural and suburban locations and that they have some concerns about elevated concentrations being considered as background. Therefore the Agency believes that using the median from its database is preferable to the 90th percentile because of the urban samples and other deficiencies. Finally, the Agency states that it would prefer Section 742.405(b)(1) and Appendix A, Table G be deleted and that site-specific information be the only method for determining area background concentrations if the Board chooses not to use the 50th percentile.

We are persuaded by the Agency s arguments that the database is not sufficiently reliable for the statewide area background level to be based upon a maximum value in the range versus the median value. The Board agrees with the Agency to use the 50th percentile instead the 90th percentile.

Subpart E: Two Alternatives for Setting Remediation Objectives for Inorganics

There are two alternatives for setting soil remediation objectives for the soil component of the groundwater exposure route. The first alternative is based upon the TCLP test (Method 1311). The Board modified this alternative to allow use of the SPLP test (Method 1312) in lieu of the TCLP test. The choice is the applicant s. The second alternative for establishing inorganic soil remediation objectives is based upon the total amount of contaminant in the soil sample instead of either the TCLP or SPLP test. These remediation objectives are pH specific and the appropriate soil remediation objective for Class I and Class II groundwater is to be selected from Appendix B, Tables C and D, respectively. This second alternative cannot be used if the soil pH is outside the range of 4.5 to 8.0. Based upon the following discussion, the Board decided to allow the use of the SPLP test, and to limit the use of the second alternative only to sites with soils having a pH within the 4.5 to 8.0 range only.

Section 742.510(a)(4): Use of the SPLP Test. The Agency supports its choice of TCLP for three main reasons. First, the TCLP test is widely available and used routinely. Second, the pH of the extract solution is appropriate for expected acid rain pH levels in Illinois. Third, the extraction solution has enough buffering capacity to maintain its acidity during the 18 hour static test. (PC 10 at 7.) The Agency states that the TCLP and the SPLP, the alternative procedure proposed by Jenner & Block, are very similar in nature. However, the Agency prefers the TCLP because the extraction solution used in the test is better buffered to preclude a dramatic pH change and is sufficiently low that the static extraction will not occur at unrealistically high pH levels after it is attenuated by the alkalinity of the soil at the start of the test. (PC 10 at 10.) The Agency s testimony also indicates that it decided to propose this approach since the Board had previously upheld this procedure in the original underground storage tank regulation, R94-2(A). (Exh. 5 at 20.)

Jenner & Block testified that the TCLP test is designed to mimic the highly acidic conditions that occur in a municipal sanitary landfill. Further, Jenner & Block maintains that the test was developed to assess whether wastes could be safely placed in a municipal landfill and co-mingled with typical municipal waste streams in a highly acidic environment. Jenner & Block also asserts that TCLP extraction solution is far more acidic than typical acid rain, and points out that a contaminated site is exposed to rain water and not landfill leachate and therefore a test that best mimics actual conditions at a contaminated site should be adopted. (Exh. 18 at 6.)

Consequently, Jenner & Block recommends that the Board adopt SPLP, the test that USEPA promulgated for determining compliance with cleanup objectives. Further, Jenner & Block asserts that the USEPA rejects the use of TCLP test for risk assessment at any site other than a municipal landfill. (Id.) For these reasons, Jenner & Block urges the Board adopt the SPLP test which assumes that rain water, not laboratory grade acid falls from the sky, as a more appropriate testing method for testing methods for metals. (Exh. 18 at 7.)

The TCLP test is generally used to determine if a waste is hazardous or to characterize a waste to determine proper disposal. The TCLP procedure assesses risk to groundwater when potentially hazardous toxic characteristic waste is co-disposed with solid waste in sanitary

landfills. The Agency proposes to use the TCLP test to assess whether certain metals in contaminated soils meet the Tier 1 remediation objectives. The TCLP test and SPLP test are essentially similar, differing only in the nature of the extraction fluid employed in the test. The TCLP uses a more acidic extraction fluid than the SPLP, since TCLP is attempting to mimic acidic conditions in a municipal landfill. Regarding this, the USEPA technical assistance document for TCLP notes that:

> When determining whether to use the TCLP for risk assessment it is important to remember that the TCLP simulates worst case management of hazardous waste in a landfill. Much caution must be used before the TCLP data are used in risk assessment because the TCLP conditions rarely reflect actual site conditions. EPA s Science Advisory Board Report Outlines many limitation of using the TCLP for risk assessment at industrial sites. The [USEPA s Science Advisory] Board recommends developing leachate tests which are appropriate to site condition.

(PC 3 at 2-9.)

When the Board adopted the use of the TCLP procedure in the original underground storage tank rulemaking, R94-2 (A), it stated that the use of this method in the context of the site remediation must be evaluated further. (Second Notice Opinion, R94-2(A)(August 11, 1994) at 26). Based on the discussion above, the Board will allow the SPLP test as an acceptable alternative to the TCLP test. The SPLP (Method 1312) is a USEPA promulgated method and it is essentially similar to the TCLP (Method 1311). The USEPA technical support document identifies the limitations involved in using the TCLP. According to it, the TCLP is designed to mimic the conditions within a sanitary landfill where low pH conditions exist as a result of anaerobic decomposition of wastes. On the other hand the SPLP is intended to mimic the pH of rain water that percolates through a contaminated site and thus, leaching the inorganic metals from the soil. The SPLP method appears well suited for use in risk-based analysis, and since it is also a USEPA promulgated method, its availability and cost should be comparable to that of the TCLP. To provide for this alternative, language is added at Section 742.510(a)(4) of the rules proposed for Second Notice. This change also serves to clarify that TCLP method is an acceptable method for establishing soil remediation objectives for migration to groundwater. See Section 742.510(a)(4).

Section 742.510(a)(5): Soil Remediation Objectives Limited to pH Range. The Agency and Gardner Carton & Douglas disagree about the range of the pH values limiting the use of the second alternative to establishing soil objectives for the groundwater ingestion pathway. The Agency states that the pH range of 4.5 to 8.0 is supported by the SSL. The Agency states that it does not believe that it is scientifically appropriate to extrapolate beyond the data that was set forth in the USEPA SSL document because there can be dramatic changes over a narrow pH range. In response to Gardner Carton & Douglas comment, the Agency provided justification based on the USDA soil database. Based on the USDA database, the Agency further states that only a small proportion of sites (5%) would fall outside the range

already covered by Section 742.510(a)(5). The Agency believes that it is not burdensome to defer those sites to a Tier 3 analysis. (Exh. 20 at 9.)

Gardner Carton & Douglas believes that the information upon which the Agency is relying does not address urban areas. Gardner Carton & Douglas notes that the Agency s justification for considering the proposed pH range of 4.5 to 8.0 to be appropriate is based on the characterization of shallow agricultural soil. Gardner Carton & Douglas further notes that the acreage of the State is about 35.5 million acres, while the Agency s soil survey data covers 34.04 million acres. Gardner Carton & Douglas infers that there are over one million acres not represented in the Agency s data. Gardner Carton & Douglas asserts that the remediation experience in the urban locations suggests that pH conditions in urban soils routinely exist above 8.0. Gardner Carton & Douglas also points out that the soil survey of DuPage and parts of Cook County show pH range up to 8.4. Gardner Carton & Douglas states that its consultant, Huff and Huff, Inc., has listed seven projects that it conducted where soil pH that ranges over 8.0 was encountered. Gardner Carton & Douglas provided an extensive discussion to conclude that at higher pH (between 8 and 11), metals such as copper, nickel and cadmium precipitate out of solution and are therefore less mobile in the soil. For these seasons, Gardner Carton & Douglas believes that the pH range should be expanded to include higher pH levels. (PC 9 at 21-24)

We agree with the Agency that the SSL data supports the proposed pH range of 4.5 to 8.0. We note that the USEPA guidance documents do not address ranges for soils with pH greater than 8.0. The Agency s position indicates that the proposed rule would cover the 95% of the sites and remaining 5% could develop remediation objectives under Tier 3. Developing site specific remediation levels under Tier 3 at those sites where the soils have pH value of greater than 8.0 seems at an appropriate course of action. We are not persuaded by Gardner Carton & Douglas arguments. Gardner Carton & Douglas tries to differentiate between urban soils and agricultural soils. It assumes that over one million acres not covered by the Agency s data are all urban areas. Gardner Carton & Douglas appears to conclude that the urban soils have pH over 8.0, yet, it has not provided any scientific literature in support of this hypothesis. The only fact supported by the record is that pH increases with increasing depth of soil. (PC 9, Attachment B.) Ms. Huff cites seven instances where the pH range was over 8.0; however, she does not identify the total number of sites from which the seven sites were chosen. Without such information, it is impossible to determine the relative occurrence of pH greater than 8.0.

To conclude, the pH range of 4.5 to 8.0 is well supported by the record. Therefore, this limitation upon the use of Appendix B, Tables C and D shall remain. We note that for sites that have pH value greater than 8.0, site-specific remediation objectives may be established under Tier 3.

Sections 742.505(b)(3) and 742. 610: Cumulative Effect of Similar-Acting Chemicals.[8] The Agency s initial proposal required the consideration of the noncarcinogenic effect of mixtures of similar-acting chemicals under the Tier 2 evaluation. The Agency relied on the SSL to support the proposed requirements pertaining to mixtures. In this regard, the Agency notes that the SSL recommends that cumulative effect of chemicals that affect the same target organs must be addressed, since the objectives are calculated to pose no more than a 1 in 1,000,000 risk or hazard quotient of 1 for individual carcinogen or noncarcinogen, respectively[9]. (Exh. 5 at 28-29.) The Agency states that if there are multiple chemicals at a site that affect the same target organ, then the potential exists to exceed an acceptable exposure for that target organ.

For carcinogens, the Agency states that the proposal affords a built-in protection. Even if there are ten carcinogens at a site that affect the same target organ, the cumulative cancer risk for a particular target organ if each chemical is present at its Tier 1 or Tier 2 remediation objective is 1 in 100,000, or midway within the acceptable risk range[10] of 1 in 10,000 to 1 in 1,000,000. (Exh. 5 at 29.)

However for noncarcinogens, the Agency states that there is no built-in safeguard for cumulative risks, since there is no corresponding range of acceptable hazard quotients. Therefore, if even two chemicals affecting the same target organ are present at their remediation objective, the cumulative hazard quotient could be 2.0. (Exh. 5 at 29.) In light of this, the Agency s initial proposal addressed only noncarcinogenic effects.

As initially proposed, the requirements of Section 742.610 would have applied only under Tier 2 evaluation when determining soil and groundwater remediation objectives for noncarcinogenic chemicals. Regarding Tier 1, the Agency testified that even though there is no built in safeguards for noncarcinogens, the consideration of the effects of similar-acting chemicals is not a concern due to the built in conservatism of the Tier 1 remediation objectives. (Exh. 5 at 29.) However, in its final comments, the Agency clarified that the consideration of the effect of mixture of similar-acting chemicals is unnecessary only with regards to Tier 1 soil remediation objectives. (PC 10 at 11.)

Accordingly, the Agency proposed the addition of a new provision at Section 742.505(b)(3) that requires the evaluation of the effect of similar-acting chemicals in determining the Tier 1 groundwater remediation objectives. (PC 10 at 11.) This provision, which applies only to Class I groundwater remediation, requires the consideration of the both *carcinogenic and noncarcinogenic* effects of similar-acting chemicals in determining Tier 1 groundwater remediation objectives. The Agency states that since it has taken a position that Part 742 should rely on the State s groundwater quality standards as closely as possible, the

---

[8]As adopted for Second Notice, this section has been modified and now appears at Section 742.720 and 742.805(c).

[9]Tier 1 values and Tier 2 equations are based upon a one-in-a-million individual excess cancer risk for carcinogens and a hazard quotient of one for non-carcinogens. (Exh. 4 at 12 & 21.)

[10]The acceptable risk range is set forth at Section 58.5 of the Act.

additional provision accounts for Class I groundwater. (PC 10 at 11.) However, the Agency does not provide any rational for requiring the evaluation of carcinogenic effect of mixture of similar-acting carcinogenic chemicals in determining groundwater remediation objectives.

The changes proposed in Errata Sheet No. 3 also clarify the scope of the proposed requirements for mixture of similar-acting chemicals under Tier 2. These changes include moving Section 742.610 requirements to Section 742.720 and the addition of a separate provision under Section 742.805 to address remediation objectives for soil and groundwater, respectively. So, in effect, the changes proposed by the Agency require the effect of mixtures of similar-acting chemicals to be considered as follows:

Tier	Soil RO*	Groundwater RO**
1	NA	Yes
2	Yes	Yes

* - Noncarcinogenic effect
** - Carcinogenic and noncarcinogenic effect only for Class 1 groundwater

The SRAC, IERG, ISG and IPC strongly urge the Board not to accept the proposed changes. IERG believes that the new addition at Section 742.505(b)(3) makes Tier 1 not user friendly. (PC 4.) The SRAC states that it is unnecessary to address mixtures of similar-acting chemicals for carcinogens and noncarcinogens in groundwater under Tier 1 and Tier 2. In this regard, SRAC contends that Tier 1 remediation objectives and Tier 2 formulae have safety factors built into them which will necessarily result in very conservative remediation objectives. The SRAC believes that the conservative nature of the remediation objectives and the manner in which they are used adequately assure equivalent protection should mixtures of similar-acting chemicals be present within a given exposure pathway. (PC 21 at 6.)

IERG states that the complexity of site specific conditions and the need to search through the appendices makes Tier 1 no longer straight forward or user friendly as it was designed to be. ISG and IPC also state that Tier 1 tables are intended to be used as look-up tables to determine appropriate remedial values. (PC 7 & 8.) They contend that with the new reference to Section 620.615 that is no longer possible. Both ISG and IPC state that the Agency never brought this subject up within the hearings, and they note that any discussions the Agency had with the SRAC is not on the record. Additionally, ISG and IPC state that Section 620.615 do not directly specify how the remediation objectives are to be determined. (PC 7 & 8.)

In its additional comments, IPC gives an example of how the proposed new provision may have a significant impact on UST sites. (PC 20.) At UST sites two of the BETX compounds, ethylbenzene and toluene, target the liver and the kidney. Under the proposed changes, all UST sites with groundwater issues would have to be evaluated using the new equation. This may render Tier 1 to be unavailable for most UST sites.

As noted above, the main concern regarding the proposed changes relates to the evaluation of the effect of mixtures of similar-acting chemicals under Tier 1. If the Board accepts the proposed changes, then the process of determining Tier 1 groundwater remediation objectives would require an additional step beyond the Tier 1 look-up tables if: the contaminants of concern include mixtures of two or more similar-acting chemicals listed in Appendix A, Table E and Table F; and Class I groundwater is contaminated by such chemicals.

The additional step involves the correction of the remediation objective for each chemical in the mixture to account for the cumulative effect. The Agency has provided two optional procedures for performing this additional analysis under Section 742.505(b)(3)(C) (which is now at Section 742.505(b)(3).) These procedures, which are essentially the same as those that were initially proposed under Tier 2 evaluation, are described below by considering a hypothetical site contaminated with BETX.

It is assumed that BETX are present at concentrations equal to their respective Tier 1 remediation objectives, namely, Benzene - 0.005 mg/L, Ethylbenzene - 0.7 mg/L, Toluene - 1.0 mg/L, Xylenes - 10 mg/L. According to Appendix A, Table E, Ethylbenzene and Toluene, which are noncarcinogens, affect the same target organs, *i.e.* kidney and liver. Therefore, their remediation objectives must be corrected for cumulative effects. The first option at Section 742.505(b)(3) requires the calculation of weighted average as follows:

$$W_{AVE} = \frac{x_1}{CUO_{x_1}} + \frac{x_2}{CUO_{x_2}} + \ldots\ldots + \frac{x_a}{CUO_{x_a}}$$

$$W_{AVE} = \frac{1.0}{1.0} + \frac{0.7}{0.7}$$

$$W_{AVE} = 2$$

---

where,

$x_1, x_2, \ldots$ = concentration of contaminants

W_{ave} = weighted average

$CUO_{x1}, CUOx_{x2}, \ldots$ = Tier 1 remediation objective

According to Section 742.505(b)(3), remediation objectives are met if W_{ave} is less than or equal to 1. If the W_{ave} value is greater than 1, more remediation must be carried out until the W_{ave} is less than or equal to 1.

Alternatively, the procedure under Section 742.505(b)(3) may be used to address cumulative effect. Under this procedure, the individual remediation objective is divided by the number of chemicals detected in groundwater that affect specific target organs or organ

system. For the hypothetical site, as noted above Ethylbenzene and Toluene affect kidney and liver. Therefore, the individual remediation objective must be divided by two. Thus, the corrected remediation objectives now become 0.5 mg/L and 0.35 mg/L for Toluene and Ethylbenzene, respectively. As shown below, the corrected remediation objectives are acceptable since their weighted average is equal to one.

$$W_{AVE} = \frac{0.5}{1.0} + \frac{0.35}{0.7}$$

$$W_{AVE} = 1$$

The above illustration shows that if similar-acting chemicals are present in Class I groundwater underlying a remediation site, the Tier 1 remediation objectives in Appendix B, Tables E may not be used without accounting for the cumulative effect. In light of this, the commentators contention that the Tier 1 tables are no longer user friendly is true. Especially, for the UST sites where BETX are the common contaminants of concern.

However, as noted earlier, the Agency justifies proposed changes concerning noncarcinogenic effect of similar-acting substances on the basis of hazard quotient which is protective of human health. The individual remediation objectives for noncarcinogens are based upon a hazard quotient of 1. Further, the cumulative effect of a mixture of two or more similar-acting chemicals at their respective remediation objectives could result in a hazard quotient greater than 1, thus, posing a threat to human health. The provision proposed by the Agency would ensure that the hazard quotient for a mixture of similar-acting chemicals to be less than or equal to 1.

Even though the new provision proposed by the Agency appears to be justified with regard to the noncarcinogenic effect of mixtures of similar-acting chemicals, there are a few issues that remain unresolved because the Agency submitted the new language at the close of the hearings and comment period. First, the Agency has not explained why it is necessary to consider the effect of similar-acting chemicals in determining Tier 1 *groundwater remediation objectives* in light of its position that Tier 1 remediation objectives are very conservative. In this regard, the Agency states that consideration of the effect similar-acting chemicals is unnecessary when determining Tier 1 *soil remediation objectives*. Second, the Agency also does not provide an explanation as to why both carcinogenic and noncarcinogenic effects of mixtures of similar-acting chemicals must be considered in determining groundwater remediation objectives, whereas only noncarcinogenic effect needs to evaluated in determining soil remediation objectives. The Agency asserted that even if multiple carcinogens are present at their respective remediation objectives the cumulative risk would be within the acceptable risk range. However, this rationale appears to be equally applicable to groundwater remediation objectives.

The Board finds that the record does not contain adequate information to decide whether or not to adopt all the new provisions concerning mixtures of similar-acting chemicals. In light of this, the Board decided to open a new docket to consider the merits of

the proposed changes. However, for purposes of this docket, the issue of similar-acting chemicals needs to be addressed, since based upon the information before us, the Tier 1 groundwater remediation objectives for such chemicals may not be protective of human health. This is illustrated by the example given above concerning a site with BETX present. Therefore, on an interim basis, the Board adopts the changes proposed pertaining only to the noncarcinogenic effect of mixtures of similar-acting chemicals in groundwater objectives under Tier 1. Under Tier 2, the Board accepts the Agency s proposed language concerning the cumulative effect of noncarcinogens under Tier 2 for soil and groundwater remediation objectives, reformatted into two separate rules. This rule was originally proposed by the Agency on September 16, 1996, and through the course of the hearings no participants objected to these requirements. However, the Board does not adopt the Agency proposal that the mixture rule be applied to both carcinogenic and noncarcinogenic contaminants in groundwater under Tiers 1 and 2. Instead, the Board reserves this issue for Docket B as discussed at the outset of this opinion.

Subpart H: Correction RBCA Equations R26 and R15

RBCA Equations R26 and R15 are used by an applicant to demonstrate that the concentration of any contaminant in groundwater will meet the applicable remediation objectives in two situations. First, they are used to demonstrate that the contaminant concentration in groundwater within the minimum or designated maximum setback zone of an existing potable water supply well will meet the applicable Tier 1 groundwater objective or the Health Advisory concentration. Second, they are used to demonstrate that any groundwater discharging into surface water meets the applicable water quality standard pursuant to 35 Ill. Adm. Code 302.

Mr. Scott R. Green, a consultant from Conestoga-Rovers & Associates with over 12 years of environmental consulting experience, pointed out an error within the ASTM RBCA equation R26 (Appendix C, Table C). (PC. 6.) He notes that in the last *erf* (error function) term in the denominator of Equation R26, the constant 4 must be a 2 with their pre-established site conditions. This error was pointed out to Mr. Green by Mr. Michael J. Ungs, a principal scientist from Tetra Tech, Inc. with over 10 years of experience. Mr. Ungs actually found the mistake in 1996 when ASTM published RBCA guidelines. The ASTM guidance document credits this equation to a 1987 paper authored by Patrick A. Domenico[11]. Within Domenico s 1987 paper, Equation R26 can have either a 4 or a 2 depending upon site conditions. ASTM used a 4 for site conditions that warrant a 2. Mr. Ungs notes that in other written works by Domenico (a 1985 paper and a 1990 textbook)[12], a value 2 is used in the *erf term* instead of 4.

---

[11]Domenico, P. 1987. An Analytical Model for Multidimensional transport of a decaying contaminant species. Journal of Hydrology, Vol. 91, pp. 49-58.

[12]Domenico, P. and G. Robbins. 1985. A New Method of Contaminant Plume Analysis. Ground Water, Vol. 23, No. 4, pp. 476-485.
Domenico, P. and F. Schwartz. 1990. Physical and Chemical Hydrogeology. John Wiley & Sons. New York, page 824.

Mr. Ungs has informed ASTM about the apparent error, but ASTM will not consider any changes to the equation until the RBCA guidelines (ASTM E-1739-95) comes up for review.

In its public comments, the Agency agrees that that the Equation R26 should be changed from the original ASTM model. (PC 10 and 22.) The Agency states that the vertical dispersion assumption made in the model will be violated if Equation R26 is used in situations where upward vertical dispersion is restricted by a water table or an impermeable geologic layer. (PC 22 at 2.) The Agency notes that it ran Equation R26 to predict concentration of Benzene with both 2 and 4 in the last *erf* for three distances. The modeling runs indicate that using number 2 instead of 4 results in predicted concentrations approximately twice as much as the concentrations when using 4 for each distance. The Agency advocates that the Board make the change in equation R26.

IPC and ISG believe because this matter was brought up during the public comment period and not the hearings, that the change should not be made because there has been no opportunity for examination and rebuttal. Clayton Environmental agrees with IPC and ISG that the Board should not make the change at this time. (PC 19.) In their additional comments, IPC and the SRAC state that Equation R26 should be changed only when it has been changed nationally by ASTM. (PC 20 and PC 21.)

The Equation R26 is used to model the contaminant concentration along the centerline of a plume. The two *erf* terms in the equation predict dispersion in lateral and vertical planes. The equation adopted by the Board is as follows:

$$C(x) = C_{source} \bullet \exp\left[\left(\frac{X}{2\alpha_x}\right) \bullet \left(1 - \sqrt{1 + \frac{4\lambda \bullet \alpha_x}{U}}\right)\right] \bullet erf\left[\frac{Sw}{4 \bullet \sqrt{\alpha_y \bullet X}}\right] \bullet erf\left[\frac{Sd}{2 \bullet \sqrt{\alpha_z \bullet X}}\right]$$

In the equation originally proposed by the Agency, the value in the last *erf* term was 4. Using the number 4 as the last *erf* term, which accounts for dispersion in the vertical plan is incorrect. Since Equation R26 is a groundwater equation, the contamination is within the aquifer or at least at the water table. The upward vertical direction is limited in distance. The contaminant is not going to seep back into the soil. There cannot be infinite dispersion in the vertical direction because of the restricted upward distance. Thus, using the number 4 in the last *erf* denominator under-predicts the concentration of the contaminant at the centerline of a plume at any distance downgradient. The correct form of the Domenico equation uses 2 in the denominator to account for the lack of dispersion in the upward vertical direction.

Based on a review of all the comments and attachments, the Board concludes that the value of the constant in the *erf* relating to vertical dispersion in the proposed Equation R26 is not applicable when applied to most sites. Review of the written works of Domenico (see footnotes) indicates that if the upper surface of the contaminant plume is restricted so as to provide only downward vertical dispersion, the last *erf* value must be 2. Apparently, when

ASTM incorporated the equation from Domenico s 1987 paper it did not give consideration to vertical dispersion being limited by water table or a confining layer. In light of this, Equation R26 is an incorrect application of Domenico s equation.

The Board choose to change the equation now rather than await a correction by ASTM for two reasons. First, if the correction is not implemented now, sites may be remediated to a level less than protective of human health. Second, the need for this correction concerns the mechanics of the equation, not the methodology. The methodology remains unchanged from that originally proposed by the Agency after discussion with the SRAC prior to submitting its proposal. That the need for this correction only arose during the First Notice public comment period is regretful, but does demonstrate the effectiveness of First Notice. In this regard, the Board notes that we have made similar corrections to certain equations in the ASTM guidelines in: In the Matter of: *Regulation of Petroleum Leaking Underground Storage Tanks*, R94-2 Second Notice (August 11, 1994) at pages 32 and 86.

Finally, since Equation R15 is the same equation, it is also corrected. We note that under Tier 3 an applicant can request that the Agency approve an *erf* value of 4 when site conditions warrant its use, *i.e.*, there is upward vertical dispersion.

Subpart I: Target Risk Level under Tier 1, Tier 2 and Tier 3 Evaluations

Section 742.915: Modifying Target Risk under Tier 3. In public comments, many of the participants sought to allow risk levels greater than a target risk level of 10^{-6} for industrial/commercial properties under Tiers 1 and 2, as well as Tier 3. The Agency objected on the grounds that Tier 2 is premised upon RBCA and SSL equations which also established the pre-determined values under Tier 1. The Agency disagrees with those commentators seeking such a relaxation arguing that the TACO process is for the most part premised on the target risk level being 10^{-6}, and any modification of the same should be demonstrated by a Tier 3 evaluation. The Agency does not believe that the beginning target risk level under Tiers 1 or 2 should be anything greater than 1×10^{-6} because, at a minimum, this allows for the cumulative effect of multiple contaminants without any other adjustment.

As stated above, the Board agrees with the Agency that the individual remediation objectives established pursuant to Tiers 1 and 2 for industrial/commercial property, as well as residential property, should not be greater than 1×10^{-6}. Section 58.5(d) of the Act allows for the cumulative effect to be factored in automatically since it provides a range of 1×10^{-6} and 1×10^{-4} for target risk. However, we agree with the Agency and the commentators that Tier 3 should allow for modifications of the target risk level, and that the requirements for such a demonstration should be articulated in the Tier 3 rules. The following is a more detailed discussion of this issue and the modifications proposed to define the requirements for a target risk modification under Tier 3.

Both Gardner Carton & Douglas and Jenner & Block contend that the General Assembly intended the adoption of different risk levels for residential and industrial/commercial sites. In this regard, Section 58.5(d) provides in pertinent part:

> .For carcinogens, soil and groundwater remediation objectives shall be established at exposures that represent an excess upper-bound lifetime risk between 1 in 10,000 and 1 in 1,000,000 as appropriate for the post remedial action use, except that remediation objectives protecting residential use shall be based on exposures that represent an excess upper-bound lifetime risk of 1 in 1,000,000

Gardner Carton & Douglas contends that the Agency failed to recognize the distinction made by the General Assembly between residential properties and other industrial sites.

Gardner Carton & Douglas believes that the Agency s position on using a risk level of 1×10^{-6} for carcinogens is too conservative. Gardner Carton & Douglas states that using 1×10^{-6} is more restrictive than the intent of the Title XVII and what USEPA and other states use. Gardner Carton & Douglas also asserts that Section 58.5(d) of the Act allows exposure risks between 1×10^{-4} to 1×10^{-6} depending on the post remedial use and that the proposed regulations violate that provision of the Act. Gardner Carton & Douglas wants the Agency to consider allowing the use of risk levels greater than 1×10^{-6} for certain industrial/commercial sites. Gardner Carton & Douglas cites a letter from Ann Wentz, of USEPA Underground Storage Tank Section, to Doug Clay at the Agency, suggesting that the Agency take into account higher risk standards for industrial sites. (PC 3.)

Jenner & Block agrees with Gardner Carton & Douglas that risk levels should be changed for industrial/commercial sites to 10^{-5}. (PC No. 18.) Jenner & Block also contends that the General Assembly adopted different risk levels for residential and industrial/commercial sites. Jenner & Block argues that industrial/commercial sites have other programs to protect workers from exposure such as worker right to know laws, the Occupational Safety and Hazard Act, and other state and local programs. Jenner & Block also provided a list of other states who have adopted or proposed using a risk level of 1×10^{-5} for one or more programs. Jenner & Block advocates that, at a minimum, Tier 2 industrial/commercial sites should be allowed to shift the risk level as a standard matter, contending that if industrial/commercial sites are not allowed to use a greater risk level, they will incur increased cleanup costs or cleanup process costs to conduct expensive risk assessments.

IERG agrees with the Agency s position regarding the use of the target risk levels. (PC 4 at 8.) IERG believes that allowing the risk levels to be changed only under Tier 3 by using the risk assessment framework set forth in Section 742.915 is appropriate. However, IERG states that the risk assessment framework fails to establish some of the factors that should be considered when proposing or evaluating requests for changes in target risk levels. (PC 4 at 9.) IERG suggests the inclusion of the following additional requirement under Section 742.915 that provides additional guidance to the regulated community when submitting such requests:

> h) For requests modifying the target risk consistent with Section 742.900(d), submittals may consider factors including, but not limited, to the following:

1) The probability of actual impact on receptors;
2) The presence of potential, rather than actual, receptors;
3) The number of receptors potentially impacted;
4) The duration of risk at the differing target levels; and
5) The impracticality or cost of remediation to achieve differing target levels.

(PC 8 at 5.)

ISG believes that within Tiers 2 and 3 the target risk level should be 1 x 10^{-5} for non-residential property. ISG states that ASTM, USEPA, and other states use a target risk level of 1 x 10^{-5} in their programs. However, ISG agrees with IERG that the Agency s decision to allow the change of target risk within Tier 3 with an appropriate risk assessment is acceptable. ISG suggests that addition of the following provision to Section 742.915 to clarify the risk assessment methodology:

h) Proposals seeking to modify the target risk consistent with Section 742.900(d) may address factors including but not limited to one or more of the following: the probability of actual impact on receptors, the presence of sensitive populations, the number of receptors potentially impacted, the duration of risk at the differing target levels, characteristics of the chemical of concern, and the technical impracticality or cost of remediation to achieve differing target risk levels.

IPC states that shifting the target risk from 1 x 10^{-6} to 1 x 10^{-4} is a valid approach to considering remedial objectives under Tier 3 and should not be automatically discounted. (PC. 8 at 6.) Further, IPC maintains that since the determination of a shift in target risk is placed in Tier 3 so that it may be given a more thorough Agency review, the Board should consider identifying criteria which can be used in making this decision. In this regard, IPC provides language for an additional subsection under Section 742.915 that is essentially the same as the additional language proposed by ISG and quoted above.

Clayton Environmental also agrees that the use of a greater than a 1 x 10^{-6} risk level should be available for industrial/commercial sites. Clayton Environmental contends that other states have accepted 1 x 10^{-4} as target risk levels for industrial/commercial property. Clayton s rationale is that the SSL and RBCA equations are inherently conservative, which results in overestimating the risk from contaminants left in the soil. Finally, Clayton asks that the Tier 3 regulations outline the procedures for demonstrating that a greater target risk level at a particular site. (PC 19 at 3 and 4.)

First, the Agency strongly disagrees with Gardner Carton & Douglas position that the proposed regulations do not comply with Title XVII of the Act. The Agency maintains that the proposed Part 742 regulations allow for a total risk greater than 1 x 10^{-6} because the regulations take into account the cumulative effects of mixtures of similar-acting chemicals, and since most sites contain more than one contaminant that may have the same effects, multiple pathways and multiple contaminants are generally an issue. The Agency notes that Gardner Carton & Douglas never mentions apportionment and cumulative factors. (PC 15 at

9.) Next, the Agency objects to the claims by Gardner Carton & Douglas that the General Assembly mandated different risk levels for residential and industrial sites. The Agency argues that Title XVII neither provides for changing the risk level in Tiers 1 or 2, nor specify how risk ranges are to be used. The Agency insists that the General Assembly mandated distinct treatment, but it did not specify how that was to be accomplished. The Agency feels that the proposed regulations fulfill this mandate by the different exposure rates and exposure duration within the tiered approach to identifying risk based remediation objectives. Furthermore, if the Tier 2 numbers were allowed to use a target cancer risk of 1×10^{-5} or 1×10^{-4}, then the cumulative risk could be 1×10^{-4} or 1×10^{-3} which is unacceptable.

Concerning the differing risk levels for industrial/commercial sites advocated by Jenner & Block, the Agency states that different exposures have already been considered for industrial/commercial sites, and consequently the industrial/commercial sites have different values for certain variables in the SSL equations and their own set of Tier 1 numbers. The Agency stands by its position that someone working at a site should be afforded the same protection as someone who might live there. The Agency also notes that recently, Oregon and New Jersey agreed with Illinois in testifying in a hearing in front of the U.S. House of Representatives on Superfund reauthorization issues that they use a 10^{-6} risk goal. (PC 15 at 14.) Regarding Gardner Carton & Douglas claims that the USEPA Risk Assessment Guidance for Superfund (RAGS) does not mandate the use of 1×10^{-6} risk levels at all sites, the Agency asserts that RAGS requires a complete risk assessment at every site which is allowable in Tier 3. (PC 9 at 8-9.)

In response to concerns expressed by IERG, ISG and IPC, the Agency states, in its additional comments, that it has no objections to including additional language under Section 742.915. (PC 15 at 3.) However, the Agency has made certain changes to the additional language submitted by these participants. First, the Agency explained that it deleted the phrase the probability of actual impact on receptors , since the phrase implies a probabilistic risk assessment is necessary. The Agency notes that USEPA has found that a probabilistic risk assessment is very difficult to use in a regulatory context. Next, the Agency also believes that the technical impracticality or cost of remediation to achieve differing target risk level should not be included because this is already covered under Section 742.920. The Agency suggests the following be added at Section 742.915(h):

> h) Proposals seeking to modify the target risk consistent with Section 742.900(d) shall address the following factors:
>
> 1) the presence of sensitive populations;
> 2) the number of receptors potentially impacted;
> 3) the duration of risk at the differing target levels; and
> 4) the characteristics of the chemical of concern.

In sum, the Agency stands by its position that a target risk level greater than 1×10^{-6} or a hazard quotient greater than 1 may be used in Tier 3 after doing a risk assessment in accordance with Section 742.915. The Agency also argues using the same risk level for

residential and industrial/commercial property under Tier 1 and Tier 2. The Agency asserts that just because someone is working at a site instead of living there that they should not be subject to a less protective risk level.

The Board finds that the Agency s proposal is based on the concept of providing the same level protection to an individual working at a site and to an individual residing at a site under Tier 1 and Tier 2. As the Agency argued, the proposed regulations do provide for differing remediation objectives for industrial/commercial sites under Tier 1 or Tier 2 by considering different exposure factors. The Agency is also correct in arguing that the proposed regulations address the additive effect of mixtures of similar-acting chemicals that renders the overall target risk level to be higher than $1x10^{-6}$ at a number of sites contaminated with multiple chemicals.

Finally, the Agency s proposal allows for the consideration of higher target risk levels for carcinogens or hazard quotient greater than 1 for noncarcinogens under Tier 3. Section 742.900 requires any requests for changes in risk levels to be supported by a formal risk assessment performed in accordance with Section 742.915. By doing so, the proposal ensures that a decision to approve such changes will be based on a thorough evaluation of all relevant factors.

Subpart J: Transfer of Institutional Controls

In their public comments, ISG and IPC raised a concern that institutional controls be transferable. (PC 7 at 10-11 and PC 8 AT 8, respectively). They would like some clarifying language added to Section 742.1000 to insure that these instruments are transferable. They propose to add a subsection (d) which would say: Institutional controls are transferable with the property to which they apply . They state that this issue was brought up in the January 15, 1997 hearing and that the Agency agreed that institutional controls are transferable. They also noted that a change with respect to engineered barriers in Section 742.1100(d) was made to allow the transfer of the responsibility for maintaining engineered controls, which are required to be memorialized in the applicable institutional controls.

The City of Chicago agrees with ISG and IPC. (PC 13 at 3.) The Agency also agrees and has no objection to add the above language to the proposed regulations. (PC 15 at 3.)

The Board notes that institutional controls must be recorded in the chain of title and therefore run with the land. As a result, a transferee of a remediation site subject to an institutional control takes its interest subject to the institutional control, and no action is necessary to transfer the institutional control to the transferee. This is confirmed by Section 58.10(d), which states that a No Further Remediation Letter (which may contain institutional controls) shall apply in favor of various entities, including a successor-in-interest of the owner of the site; an heir or devisee of the owner of the site; a transferee of the owner of the site, whether the transfer was by sale, bankruptcy proceeding, partition, dissolution by marriage, settlement or adjudication of any civil action, charitable gift or bequest; and various other entities. If the terms of an institutional control are violated, an No Further Remediation letter

is voidable whether or not a subsequent owner agreed to accept transfer of the institutional control.

This is further confirmed by Section 58.10(e) of the Act, that states that specific acts that may result in voidance of an NFR Letter include the failure of the owner, operator, RA, *or any subsequent transferee* to operate or maintain preventive or engineering controls or comply with a groundwater monitoring plan, if applicable . . . . (415 ILCS 5/58.10(e)(2) (emphasis supplied).)

Therefore, the Board does not believe that it is necessary to insert the language suggested by ISG and others to allow for example, the transfer of an institutional control from a seller to a purchaser. That transfer occurs by operation of law, and accordingly the Board has added a provision that Institutional controls are transferred with the property to which they apply. (35 Ill. Adm. Code 742.1000(d).) For the same reason, the Board has stricken a portion of Section 742.1100(d) (in Subpart K) regarding engineered barriers:

> A no further remediation determination based upon the use of engineered barriers shall require effective maintenance of the engineered barrier. The maintenance requirements shall be included in an institutional control under Subpart J. ~~and are to be maintained by the owner of the site. This responsibility shall be transferable with the property.~~

The stricken language is not necessary because the maintenance requirements, which must be contained in an institutional control, run with the land, just as does the institutional control.

The Board notes that nothing in the Act precludes private arrangements between transferors and transferees regarding the maintenance of institutional controls. For example, a purchaser and seller may agree that the seller will retain responsibility for maintaining an engineered barrier, and that the seller indemnify the purchaser for any damages resulting from the seller s failure to maintain the engineered barrier. Alternatively, it may be in a seller s interest to obtain a covenant from the purchaser that the purchaser will maintain an engineered barrier and will indemnify the seller from any damages resulting from the purchaser s failure to maintain the engineered barrier. In addition, nothing in the Act prohibits an owner from contracting with a consulting engineering firm for the maintenance of an engineered barrier. If the terms of the institutional control are violated, however, a No Further Remediated Letter or no further remediation determination is voidable, regardless of the private arrangements among those with an interest in the property.

Determination of Class II Groundwater and other Groundwater Issues

The Agency proposed that the Board adopt procedures about how an applicant is to demonstrate that the groundwater beneath a site is not Class I groundwater so that the remediation objectives are designed to meet the Class II groundwater quality objectives. There was little discussion about Appendix D on the record. However, Jenner & Block did raise two issues related to groundwater. First, Jenner & Block questioned the need to filter groundwater samples. Second, Jenner & Block asked that the Board define to which

groundwater class straddling groundwaters should be assigned. All three topics are discussed below.

Appendix D: Procedures for Determination of Class II Groundwater. The Board has examined the language proposed at Appendix D which describes in great detail the procedures and criteria an applicant should use to determine and demonstrate that groundwater beneath the site is Class II groundwater. The Board finds that these procedures, in fact, are rules. While they may be helpful to applicants using TACO, the Board cannot adopt such rules in an appendix. Furthermore, the Board cannot adopt rules which define which groundwaters are Class II groundwaters without conducting rulemaking on this issue which did not occur in this docket because the Agency offered no explanation of the procedures proposed at Appendix D. Finally, such rules are more appropriately considered in the context of Part 620. The Board would welcome a proposal for rules such as these by the Agency.

Use of Unfiltered Groundwater Samples. In the first set of hearings, Jenner & Block asked the Agency whether groundwater samples should have to be filtered. The Agency responded that it would be a site specific or a program specific determination. Filtering groundwater samples would remove any particulate matter that may have contaminants of concern adhered to it. The Agency believes that since the Department of Public Health does not require residential wells to be filtered, any sites that would be designated residential property which plans to have a well would not necessarily be fully protected.

Mr. Ray Reott of Jenner & Block provided testimony on this subject. He cites 35 Ill. Adm. Code Section 620.510(b) which addresses the use of filtering of samples for analysis of metals. Mr. Reott states that the Agency s witnesses in hearings for the Part 620 rulemaking endorsed filtering groundwater samples prior to metals analysis. (Exh. 18 at 11.) USEPA has acknowledged that it is the dissolved metals which pose the most health risk. The Agency states in its rebuttal and public comment that there are situations where samples will be filtered because of high turbidity making the water unpalatable. There are also situations where groundwater is not restricted. Therefore requiring groundwater samples to be filtered would not be an accurate representation for all sites. If determination of whether to filter or not was done on a case by case basis then every site would be investigated properly.

After reviewing the testimony and comments, the Board agrees with the Agency. Filtering groundwater samples should be a site-specific or a program-specific determination. Although the water quality criteria is based on filtered samples and the USEPA states that drinking water suitability samples must be filtered before analysis, there is always a possibility that the site in the future will not have restrictions concerning groundwater. Therefore, the Board finds no need to amend the TACO rules or the Part 620 rules.

Straddling Groundwater Units. The requirement for classification of groundwater are set forth at 35 Ill Adm. Code 620. The Part 620 rules classify groundwater into four classes. Class I is designated as potable resource groundwater, Class II is general resource groundwater, Class III is special resource groundwater and Class IV is other groundwater. Based on Part 620 rules, the proposed regulations set forth a procedure to classify groundwater

as Class II in Appendix D. Jenner & Block expressed concerns regarding the proposed procedures to classify Class II groundwater. There is a boundary of 10 feet below surface beyond which all groundwater is designated to be Class I groundwater if certain hydrogeological characteristics are met. Jenner & Block s concern revolves around this 10 foot boundary line.

Jenner & Block interprets the Part 620 rules to mean that there can be no Class I groundwater within 10 feet of surface, and proposes that the Board consider a proportionally based classification system. If the majority of a water bearing unit lies within 10 feet below the surface but crosses the 10 foot boundary line, then the water bearing unit would be classified as Class II groundwater. Conversely, if the majority of a water bearing unit lies below the10 foot boundary line but crosses the 10 foot line, then the water bearing unit would be classified as Class I groundwater. Alternatively, Jenner & Block proposes that the Board consider a classification scheme based on the location of screens within the well. Under this scheme, all new wells would be screened that lie entirely above the 10 foot boundary line for Class II groundwater or entirely below the 10 foot boundary line for Class I groundwater. The crux of this scheme is to collect all of the water either above the 10 feet boundary and compare its quality with Class II standards or below 10 foot boundary line and compare its quality to Class I standards.

The Agency has not specifically addressed this issue in any of its comments. However, the following discussion about proposed Appendix D reflects the Agency s position:

> Although it may be possible, it is unrealistic to try to designate two distinct classes of groundwater within the same saturated hydrogeological unit. But, if the person conducting the remediation can demonstrate that by cleaning the groundwater within ten feet of the surface to Class II specifications will not degrade the groundwater greater than 10 feet below the ground surface above Class I standards, the Agency may approve both Class I and II standards in accordance with the location of the groundwater.
>
> (December 10, 1996 Transcript at pages 149-167.)

Mr. Reott's assertion that "groundwater within 10 feet of the surface cannot be Class I groundwater is erroneous. The issue of "straddling groundwater" is not new. The Board resolved this issue in most certain terms when it adopted the groundwater quality standards under In the Matter of: *Groundwater Quality Standards*, R89-14(B). (November 7, 1991) The criteria for groundwater classification is established at 35 Ill Adm. Code 620.Subpart B. Specifically, Class I groundwater criteria is set forth at Section 620.210. In order to address the issue of straddling groundwater, the Board added a note under Section 620.210:

> Board Note: Any portion of the thickness associated with the geologic materials as described in subsections 620.210(a)(2), (a)(3) or (a)(4) should be designated as Class I: Potable Resource Groundwater if located 10 feet or more below the land surface.

35 Ill. Adm. Code 620.210

This note clearly states that there can be Class I groundwater above the ten foot boundary line, if it is associated with a geologic unit containing Class I groundwater. The Board explained this point in its accompanying opinion as follows:

> As a further observation on the "10-foot" rule, the Board notes that the question has been raised whether potable groundwaters found below 10 feet but located in geologic units that meets one of the thickness criteria only because part of the unit is at a less than 10 feet, would still be considered Class I water (R3 at 300). The Board intends that the answer to this question is "yes".

(R89-14(B), (November 7, 1991) at page 12.)

Clearly, the Board resolved the issue of straddling when it adopted the groundwater classification system under Part 620. Accordingly, the Board finds no need to amend the TACO or Part 620 rules to address this issue.

SUMMARY

The Board hereby orders the new Part 742 to Second Notice for review by the Joint Committee on Administrative Rules. The Board has examined the substantive issues concerning the proposal by the Agency and the record develop during First Notice, and accepts many of the modifications proposed by the Agency and participants. The Board has reserved one issue for a separate Docket B. That issue is to what extent the mixture rule adopted today should be extended to insure that risk based remediation objectives determined using TACO are protective of human health. The Board concludes that the rules set forth in the attached order provide a tiered approach for assessing risk to human health when determining remediation objectives and the methodologies acceptable for doing so on a site-specific bases. The Board further finds that these rules are economically reasonable and technically feasible.

ORDER

The Board hereby directs that the second notice of the following revised proposal be submitted to the Joint Committee on Administrative Rules.

TITLE 35: ENVIRONMENTAL PROTECTION
SUBTITLE G: WASTE DISPOSAL
CHAPTER I: POLLUTION CONTROL BOARD
SUBCHAPTER f: RISK BASED CLEANUP OBJECTIVES

PART 742
TIERED APPROACH TO CORRECTIVE ACTION OBJECTIVES

SUBPART A: INTRODUCTION

SUBPART B: GENERAL

SUBPART C: EXPOSURE ROUTE EVALUATIONS

SUBPART D: DETERMINING AREA BACKGROUND

SUBPART E: TIER 1 EVALUATION

SUBPART F: TIER 2 GENERAL EVALUATION

SUBPART G: TIER 2 SOIL EVALUATION

SUBPART H: TIER 2 GROUNDWATER EVALUATION

SUBPART I: TIER 3 EVALUATION

SUBPART J: INSTITUTIONAL CONTROLS

SUBPART K: ENGINEERED BARRIERS

Section
742.1100 Engineered Barriers~~General~~
742.1105 Engineered Barrier Requirements

742.APPENDIX A General
Table A Soil Saturation Limits (C_{sat}) for Chemicals Whose Melting Point is Less Than 30^0C
Table B Tolerance Factor (K)
Table C Coefficients $\{A_{N-I+1}\}$ for W Test of Normality, for N=2(1)50
Table D Percentage Points of the W Test for N=3(1)50
Table E ~~SSL~~ Chemicals with Noncarcinogenic Toxic Effects on Specific Target Organs/Organ Systems or Similar Modes of Action
Table F Chemicals with Carcinogenic Toxic Effects on Specific Target Organs/Organ Systems or Similar Modes of Action
Table ~~F~~ G ~~Range of~~ Concentrations of Inorganic Chemicals in Background Soils
~~Illustration~~ILLUSTRATION A Developing Soil Remediation Objectives Under the Tiered Approach
~~Illustration~~ILLUSTRATION B Developing Groundwater Remediation Objectives Under the Tiered Approach
742.APPENDIX B Tier 1 Tables and Illustrations
Table A Tier 1 Soil Remediation Objectives for Residential Properties
Table B Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties
Table C pH Specific Soil Remediation Objectives for Inorganics and Ionizing Organics for the ~~Migration to Groundwater~~Soil Component ~~Portion~~ of the Groundwater Ingestion Route (Class I Groundwater)
Table D pH Specific Soil Remediation Objectives for Inorganics and Ionizing Organics for the ~~Migration to Groundwater~~Soil Component ~~Portion~~ of the Groundwater Ingestion Route (Class II Groundwater)
Table E Tier 1 Groundwater Remediation Objectives for the ~~Direct Ingestion of the~~ Groundwater Component ~~Portion~~ of the Groundwater Ingestion Route
Table F Values Used to Calculate the Tier 1 Soil Remediation Objectives for the ~~Migration to Groundwater~~ Soil Component ~~Portion~~ of the Groundwater Ingestion Route
~~Illustration~~ILLUSTRATION A Tier 1 Evaluation
742.APPENDIX C Tier 2 Tables and Illustrations
Table A SSL Equations
Table B SSL Parameters
Table C RBCA Equations
Table D RBCA Parameters
Table E Default Physical and Chemical Parameters
Table F Methods for Determining Physical Soil Parameters
Table G Error Function (erf)
Table H Q/C Values by Source Area

AUTHORITY: Implementing Sections 22.4, 22.12, Title XVI, and Title XVII and ~~57 57.17 and 58.1 58.12 and~~authorized by Sections 27, 57.14, and 58.5 of the Environmental Protection Act [415 ILCS 5/22.4, 22.12, Title XVI and Title VII~~ 57 57.17, 57.14 and 58.5~~] (see P.A. 88-496, effective September 13, 1993 and P.A. 89-0431, effective December 15, 1995).

SOURCE: Adopted at 21 Ill. Reg. _____ , effective _____.

NOTE: Capitalization indicates statutory language.

SUBPART A: INTRODUCTION

Section 742.100 Intent and Purpose

a) This Part sets forth procedures for ~~use in~~ evaluating the risk to human health posed by environmental conditions and ~~in~~ developing remediation objectives ~~for remediation that assure such risks~~ that achieve acceptable risk levels.

b) The purpose of these procedures is to provide for the adequate protection of human health and the environment based on the risks to human health posed by environmental conditions while incorporating site related information~~,~~. ~~to the extent practicable, which may allow for more cost-effective site remediation.~~

Section 742.105 Applicability

a) Any person, including a person required to perform investigation pursuant to the Illinois Environmental Protection Act (415 ILCS 5/1 et seq.) (Act), may elect to proceed under this Part to the extent allowed by State or federal law and regulations and the provisions of this Part. A person proceeding under this Part may do so to the extent such actions are consistent with the requirements of the program under which site remediation is being addressed.

b) This Part is ~~intended~~ to be used in conjunction with ~~following~~ the procedures and requirements applicable to the following programs:

1) Leaking Underground Storage Tanks (35 Ill. Adm. Code 731 and 732);

2) Site Remediation Program (35 Ill. Adm. Code 740); and

3) RCRA Part B Permits and Closure Plans (35 Ill. Adm. Code 724 and 725).

c) The procedures in this Part may not be used if their use would delay response action ~~when timeliness is critical~~ to address imminent and substantial threats to human health and the environment. This Part may only be used after actions to address such threats have been completed.

d) ~~Consistent with the regulation of other programs, and as approved by the Agency, this Part may be used to develop remediation objectives to protect surface water, sediments, or ecological concerns.~~This Part may be used to develop remediation objectives to protect surface waters, sediments, or ecological concerns, when consistent with the regulations of other programs, and as approved by the Agency.

e) A no further remediation determination issued by the Agency prior to the effective date of this Part pursuant to Section 4(y) of the Act or one of the programs listed in subsection (b) of this Section that approves completion of remedial action relative to a release shall remain in effect in accordance with the terms of ~~the~~ that determination.

f) Site specific groundwater remediation objectives determined under this Part for contaminants of concern may exceed the groundwater quality standards established pursuant to the rules promulgated under the Illinois Groundwater Protection Act (415 ILCS 55/1 *et seq.*) as long as done in accordance with Sections 742.805(a) and 742.900(c)(9). (415 ILCS 5/58.5(d)(4))~~[415 ILCS 55]~~.

~~BOARD NOTE: Sections 58.5 and 57.7 of the Act authorize the use of groundwater remediation objectives for contaminants of concern that are greater than the groundwater quality standards established pursuant to the Illinois Groundwater Protection Act and rules promulgated thereunder.~~

~~g) The Agency's issuance of a "No Further Remediation" determination pursuant to the requirements applicable to the program under which the remediation is performed shall be considered, while the determination is in effect, *prima facie* evidence that the contaminants of concern at the site do not, relative to groundwater, cause or tend to cause water pollution under Section 12 (a) of the Act or create a water pollution hazard under Section 12(d) of the Act.~~

g)~~h)~~ Where contaminants of concern include polychlorinated biphenyls (PCBs), a person may need to evaluate the applicability of regulations adopted under the Toxic Substances Control Act. (15 U.S.C. 2601) (1976)~~.~~

Section 742.110 Overview of Tiered Approach

a) This Part presents an approach ~~to~~ for developing~~ment of~~ remediation objectives (see Appendix A, Illustrations A and B) that include~~s~~ an option for exclusion of pathways from further consideration, use of area background concentrations as remediation objectives, and three tiers for selecting applicable remediation objectives. An understanding of human exposure routes is necessary to properly conduct an evaluation under this approach. In some cases, applicable human exposure route(s) can be excluded from further consideration prior to any tier evaluation. ~~The option of~~ Sselecting which tier or combination of tiers ~~shall~~ to be used to develop remediation objectives ~~will be~~ is dependent on the site-specific conditions and remediation goals. Tier 1 evaluations and Tier 2 evaluations are not prerequisites to conducting Tier 3 evaluations.

b) ~~Tier 1.~~A Tier 1 evaluation compares the concentration of contaminants detected at a site to the corresponding remediation objectives for residential and industrial/commercial properties contained in Appendix B, Tables A, B, C, D, and E. To complete a Tier 1 evaluation, the extent and concentrations of the contaminants of concern, the groundwater class, the land use classification, human exposure routes at the site, and, if appropriate, soil pH must be known. If remediation objectives are developed based on industrial/commercial property use, then institutional controls under Subpart J are required.

c) ~~Tier 2.~~A Tier 2 evaluation uses the risk based equations from the Soil Screening Level (SSL) and Risk Based Corrective Action (RBCA) approaches' ~~risk-based equations~~ listed in Appendix C, Tables A and C, respectively. In addition to the information that is required for a Tier 1 evaluation, site-specific information is used to calculate Tier 2 remediation objectives. As in Tier 1, Tier 2 evaluates residential and industrial/commercial properties only. ~~Tier 2 remediation objectives are equally protective of human health based on identified risks and site-specific conditions at the site. Tier 2 also considers the use of institutional controls or engineered barriers and institutional controls in accordance with Subparts J and K.~~ If remediation objectives are developed based on industrial/commercial property use, then institutional controls under Subpart J are required.

d) ~~Tier 3.~~A Tier 3 evaluation allows alternative parameters and factors, not available under a Tier 1 evaluation or a Tier 2 evaluation, to be considered when developing remediation objectives. ~~A Tier 3 evaluation can be simple or complex depending on the remediation method and the site conditions.~~Remediation objectives developed for conservation and agricultural properties can only be developed under Tier 3.

e) Remediation objectives may be developed using area background concentrations or any of the three tiers may be used if the evaluation is conducted in accordance with applicable requirements in Subparts D through I. When contaminant

concentrations do not exceed ~~area background concentrations or~~ remediation objectives developed under one of the tiers or area background procedures under Subpart D, further evaluation under any of the other tiers is not required.

Section 742.115 Key Elements

To develop remediation objectives under this Part, the following key elements shall be addressed.

a) Exposure Routes

1) This Part identifies the following as potential exposure routes to be addressed:

A) Inhalation;

B) Soil ~~I~~ingestion;

C) Groundwater ~~I~~ingestion; and

D) Dermal contact with soil.

2) The evaluation of exposure routes under subsections (a)(1)(A),(a)(1)(B), and (a)(1)(C) of this Section is required for all sites when developing remediation objectives or excluding exposure pathways. Evaluation of the dermal contact exposure route is required for use of RBCA equations in Appendix C, Table C or use of formal risk assessment under Section 742.915.

3) The groundwater ingestion exposure route is comprised of two components ~~portions~~:

A) Migration from soil to ~~G~~groundwater (~~S~~soil ~~C~~component); and

B) Direct ~~I~~ingestion of ~~G~~groundwater (~~G~~groundwater ~~C~~component).

b) Contaminants of Concern

The contaminants of concern to be remediated depend on the following:

1) The materials and wastes managed at the site;

2) The extent of the no further remediation determination being requested from the Agency pursuant to a specific program; and

3) The requirements applicable to the specific program, as listed at Section 742.105(b) ,under which the remediation is being performed.

c) Land Use

The present and post-remediation uses of the site where exposures may occur shall be evaluated. The land use of a site, or portion thereof, shall be classified as one of the following:

1) Residential property;

2) Conservation property;

3) Agricultural property; or

4) Industrial/commercial property.

Section 742.120 Site Characterization

Characterization of the extent and concentrations of contamination at a site shall be performed before beginning development of remediation objectives. The actual steps and methods taken to characterize a site are determined by the requirements applicable to the specific program under which site remediation is being addressed.

SUBPART B: GENERAL

Section 742.200 Definitions

Except as stated in this Section, or unless a different meaning of a word or term is clear from the context, the definition of words or terms in this Part shall be the same as that applied to the same words or terms in the Act.

"Act" means the Illinois Environmental Protection Act ~~[~~(415 ILCS 5/1 et seq.)~~]~~.

"ADL" means Acceptable Detection Limit, which is the detectable concentration of a substance which is equal to the lowest appropriate Practical Quantitation Limit (PQL) as defined in this Section.

"Agency" means the Illinois Environmental Protection Agency.

"Agricultural Property" means any real property for which its present or post-remediation use is for ~~planned to consist of the~~ growing ~~of~~ agricultural crops for food or feed either as harvested crops, cover crops, or as pasture. This definition includes, but is not limited to, properties used for confinement or grazing of livestock or poultry and for silviculture operations. Excluded from this definition are farm residences, farm outbuildings, and agrichemical facilities.

"Area Background" means CONCENTRATIONS OF REGULATED SUBSTANCES THAT ARE CONSISTENTLY PRESENT IN THE ENVIRONMENT IN THE VICINITY OF A SITE THAT ARE THE RESULT OF NATURAL CONDITIONS OR HUMAN ACTIVITIES, AND NOT THE RESULT SOLELY OF RELEASES AT THE SITE. (Section 58.2 of the Act)
"ASTM" means the American Society for Testing and Materials.

"Board" means the Illinois Pollution Control Board.

"Cancer Risk" means a unitless probability of an individual developing cancer from a defined exposure rate and frequency.

"Cap" means a barrier designed to prevent the infiltration of precipitation or other surface water, or impede the ingestion or inhalation of contaminants.

"Carcinogen" means A CONTAMINANT THAT IS CLASSIFIED AS (1) A CATEGORY A1 OR A2 CARCINOGEN BY THE AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS; ~~OR~~ (2) A CATEGORY 1 OR 2A/2B CARCINOGEN BY THE WORLD HEALTH ORGANIZATION'S INTERNATIONAL AGENCY FOR RESEARCH ON CANCER; ~~OR~~ (3) A "HUMAN CARCINOGEN" OR "ANTICIPATED HUMAN CARCINOGEN" BY THE UNITED STATES DEPARTMENT OF HEALTH AND HUMAN

SERVICE NATIONAL TOXICOLOGICAL PROGRAM; OR (4) A CATEGORY A OR B1/B2 CARCINOGEN BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY IN the INTEGRATED RISK INFORMATION SYSTEM OR A FINAL RULE ISSUED IN A FEDERAL REGISTER NOTICE BY THE USEPA. (Section 58.2 of the Act)

"Class I Groundwater" means groundwater that meets the Class I: Potable Resource Groundwater criteria set forth in 35 Illinois Administrative Code 620.

"Class II Groundwater" means groundwater that meets the Class II: General Resource Groundwater criteria set forth in 35 Illinois Administrative Code 620.

"Conservation Property" means any real property for which present or post-remediation use is primarily for wildlife habitat.

"Construction Worker ~~Population~~" means a ~~situation where~~ persons who ~~are~~ is engaged on a temporary basis to perform work involving invasive construction activities including, but not limited to, personnel performing demolition, earth-moving, building, and routine and emergency utility installation or repair activities.

"Contaminant of Concern" or "Regulated Substance of Concern" means ANY CONTAMINANT THAT IS EXPECTED TO BE PRESENT AT THE SITE BASED UPON PAST AND CURRENT LAND USES AND ASSOCIATED RELEASES THAT ARE KNOWN TO THE person conducting a remediation BASED UPON REASONABLE INQUIRY. (Section 58.2 of the Act)

"Engineered Barrier" means a barrier designed or verified using engineering practices that limits exposure to or controls migration of the contaminants of concern.

"Exposure Route" means the transport mechanism by which a contaminant of concern reaches a receptor.

"Free Product" means a contaminant that is present as a non-aqueous phase liquid for chemicals whose melting point is less than 30^{o} C (e.g., liquid not dissolved in water).

"GROUNDWATER" MEANS UNDERGROUND WATER WHICH OCCURS WITHIN THE SATURATED ZONE AND GEOLOGIC MATERIALS WHERE THE FLUID PRESSURE IN THE PORE SPACE IS EQUAL TO OR GREATER THAN ATMOSPHERIC PRESSURE. (Section 3.64 of the Act)

"Groundwater Quality Standards" means the standards for groundwater as set forth in 35 Illinois Administrative Code 620.

"Hazard Quotient" means the ratio of a single substance exposure level during a specified time period to a reference dose for that substance derived from a similar exposure period.

"Highway" means ANY PUBLIC WAY FOR VEHICULAR TRAVEL WHICH HAS BEEN LAID OUT IN PURSUANCE OF ANY LAW OF THIS STATE, OR OF THE TERRITORY OF ILLINOIS, OR WHICH HAS BEEN ESTABLISHED BY DEDICATION, OR USED BY THE PUBLIC AS A HIGHWAY FOR 15 YEARS, OR WHICH HAS BEEN OR MAY BE LAID OUT AND CONNECT A SUBDIVISION OR PLATTED LAND WITH A PUBLIC HIGHWAY AND WHICH HAS BEN DEDICATED FOR THE USE OF THE OWNERS OF THE LAND INCLUDED IN THE SUBDIVISION OR PLATTED LAND WHERE THERE HAS BEEN AN ACCEPTANCE AND USE UNDER SUCH DEDICATION BY SUCH OWNERS, AND WHICH HAS NOT BEEN VACATED IN PURSUANCE OF LAW. THE TERM "HIGHWAY" INCLUDES RIGHTS OF WAY, BRIDGES, DRAINAGE STRUCTURES, SIGNS, GUARD RAILS, PROTECTIVE STRUCTURES AND ALL OTHER STRUCTURES AND APPURTENANCES NECESSARY OR CONVENIENT FOR VEHICULAR TRAFFIC. A HIGHWAY IN A RURAL AREA MAY BE CALLED A "ROAD", WHILE A HIGHWAY IN A MUNICIPAL AREA MAY BE CALLED A "STREET". (Illinois Highway Code, 605 ILCS 5/2-202)

"Highway Authority" means THE DEPARTMENT of Transportation WITH RESPECT TO A STATE HIGHWAY; THE COUNTY BOARD WITH RESPECT TO A COUNTY HIGHWAY OR A COUNTY UNIT DISTRICT ROAD IF A DISCRETIONARY FUNCTION IS INVOLVED AND THE COUNTY SUPERINTENDENT OF HIGHWAYS IF A MINISTERIAL FUNCTION IS INVOLVED; THE HIGHWAY COMMISSIONER WITH RESPECT TO A TOWNSHIP OR DISTRICT ROAD NOT IN A COUNTY UNIT ROAD DISTRICT; OR THE CORPORATE AUTHORITIES OF A MUNICIPALITY WITH RESPECT TO A MUNICIPAL STREET. (Illinois Highway Code, 605 ILCS 5/2-213)

"Human Exposure Pathway" means a physical condition which may allow for a risk to human health based on the presence of all of the following: contaminants of concern; an exposure route; and a receptor activity at the point of exposure that could result in contaminant of concern intake.

"Industrial/Commercial Property" means any real property that does not meet the definition of residential property, conservation property, or agricultural property.

"Infiltration" means the amount of water entering into the ground as a result of precipitation.

"Institutional Control" means a legal mechanism for imposing a restriction on land use, as described in Subpart J.

"Man-Made Pathways" means CONSTRUCTED physical conditions THAT MAY ALLOW FOR THE TRANSPORT OF REGULATED SUBSTANCES INCLUDING, BUT NOT LIMITED TO, SEWERS, UTILITY LINES, UTILITY VAULTS, BUILDING FOUNDATIONS, BASEMENTS, CRAWL SPACES, DRAINAGE DITCHES, OR PREVIOUSLY EXCAVATED AND FILLED AREAS. (Section 58.2 of the Act)

"Natural Pathways" means NATURAL physical conditions that may allow FOR THE TRANSPORT OF REGULATED SUBSTANCES INCLUDING, BUT NOT LIMITED TO, SOIL, GROUNDWATER, SAND SEAMS AND LENSES, AND GRAVEL SEAMS AND LENSES. (Section 58.2 of the Act)

"Negative Easement" means a right ~~in~~ of the owner of the dominant or benefitted estate or property to restrict the property rights of the owner of the servient or burdened estate or property.

"Person" means an INDIVIDUAL, TRUST, FIRM, JOINT STOCK COMPANY, JOINT VENTURE, CONSORTIUM, COMMERCIAL ENTITY, CORPORATION (INCLUDING A GOVERNMENT CORPORATION), PARTNERSHIP, ASSOCIATION, STATE, MUNICIPALITY, COMMISSION, POLITICAL SUBDIVISION OF A STATE, OR ANY INTERSTATE BODY INCLUDING THE UNITED STATES GOVERNMENT AND EACH DEPARTMENT, AGENCY, AND INSTRUMENTALITY OF THE UNITED STATES. (Section 58.2 of the Act)

"Point of Human Exposure" means the point(s) at which human exposure to a contaminant of concern may reasonably be expected to occur. The point of human exposure is at the source, unless an institutional control limiting human exposure for the applicable exposure route has been or will be in place, in which case the point of human exposure will be the boundary of the institutional control. Point of human exposure may be at a different location than the point of compliance.

"PQL" means Practical Quantitation Limit or e~~E~~stimated q~~Q~~uantitation l~~L~~imit, which is the lowest concentration that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method during routine laboratory operating conditions in accordance with "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods", EPA Publication No. SW-846, incorporated by reference in Section 742.210. When applied to filtered water samples, PQL includes the m~~M~~ethod d~~D~~etection l~~L~~imit or e~~E~~stimated d~~D~~etection l~~L~~imit in accordance with the applicable method revision in: "Methods for the Determination of Organic Compounds in Drinking Water", Supplement II", EPA Publication No. EPA/600/4-88/039; "Methods for the Determination of Organic

Compounds in Drinking Water, Supplement III", EPA Publication No. EPA/600/R-95/131, all of which are incorporated by reference in Section 742.210.

"RBCA" means Risk Based Corrective Action as defined in ASTM E-1739-95, as incorporated by reference in Section 742.210.

"RCRA" means the Resource Conservation and Recovery Act of 1976 (as amended). (42 U.S.C. Sec. 6921 et seq.)

"Reference Concentration (RfC)" means an estimate of a daily exposure, in units of milligrams of chemical per cubic meter of air (mg/m^3), to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a portion of a lifetime (up to approximately seven years, subchronic) or for a lifetime (chronic).

"Reference Dose (RfD)" means an estimate of a daily exposure, in units of milligrams of chemical per kilogram of body weight per day (mg/kg/d), to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a portion of a lifetime (up to approximately seven years, subchronic) or for a lifetime (chronic).

"Regulated Substance" means ANY HAZARDOUS SUBSTANCE AS DEFINED UNDER SECTION 101(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (P.L. 96-510) AND PETROLEUM PRODUCTS INCLUDING CRUDE OIL OR ANY FRACTION THEREOF, NATURAL GAS, NATURAL GAS LIQUIDS, LIQUEFIED NATURAL GAS, OR SYNTHETIC GAS USABLE FOR FUEL (OR MIXTURES OF NATURAL GAS AND SUCH SYNTHETIC GAS). (Section 58.2 of the Act)

"Residential Property" MEANS ANY REAL PROPERTY THAT IS USED FOR HABITATION BY INDIVIDUALS, OR ~~properties~~ where children have the opportunity for exposure to contaminants through soil ingestion or inhalation at educational facilities, health care facilities, child care facilities, or outdoor recreational areas ~~playgrounds~~.

"Restrictive Covenant or Deed Restriction" means a provision placed in a deed limiting the use of the property and prohibiting certain uses. (Black's Law Dictionary, 5th Edition)

"Right of Way" means THE LAND, OR INTEREST THEREIN, ACQUIRED FOR OR DEVOTED TO A HIGHWAY. (Illinois Highway Code, 605 ILCS 5/2-217)

"Site" means ANY SINGLE LOCATION, PLACE, TRACT OF LAND OR PARCEL OF PROPERTY, OR PORTION THEREOF, INCLUDING CONTIGUOUS PROPERTY SEPARATED BY A PUBLIC RIGHT-OF-WAY. (Section 58.2 of the Act)

"Slurry Wall" means a man-made barrier made of geologic material which is constructed to prevent or impede the movement of contamination into a certain area.

"Soil Saturation Limit (C_{sat})" means the contaminant concentration at which soil pore air and pore water are saturated with the chemical and the adsorptive limits of the soil particles have been reached.

"Solubility" means a chemical specific maximum amount of solute that can dissolve in a specific amount of solvent (groundwater) at a specific temperature.

"SPLP" means Synthetic Precipitation Leaching Procedure (Method 1312) as published in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", USEPA Publication number SW-846, as incorporated by reference in Section 742.210.

"SSL" means Soil Screening Levels as defined in USEPA's Soil Screening Guidance: User's Guide and Technical Background Document, as incorporated by reference in Section 742.210.

"Stratigraphic Unit" means a site-specific geologic unit of native deposited material and/or bedrock of varying thickness (e.g., sand, gravel, silt, clay, bedrock, etc.). A change in stratigraphic unit is recognized by a clearly distinct contrast in geologic material or a change in physical features within a zone of gradation. For the purposes of this Part, a change in stratigraphic unit is identified by one or a combination of differences in physical features such as texture, cementation, fabric, composition, density, and/or permeability of the native material and/or bedrock.

"TCLP" means Toxicity Characteristic Leaching Procedure (Method 1311) as published in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," ~~U.S.EPA~~USEPA Publication number SW-846, as incorporated by reference in Section 742.210.

"Total Petroleum Hydrocarbon (TPH)" means the additive total of all petroleum hydrocarbons found in an analytical sample.

"Volatile Organic Compounds (VOCs)" means organic chemical analytes identified as volatiles as published in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," ~~U.S.EPA~~USEPA Publication number SW-846 (incorporated by reference in Section 742.210), method numbers 8010, 8011,

8015, 8020, 8021, 8030, 8031, 8240, 8260, 8315, and 8316. For analytes not listed in any category in those methods, those analytes which have a boiling point less than 200^0C and a vapor pressure greater than 0.1 Torr (mm Hg) at 20^0C.

Section 742.205 Severability

If any provision of this Part or its application to any person or under any circumstances is adjudged invalid, such adjudication shall not affect the validity of this Part as a whole or any portion not adjudged invalid.

Section 742.210 Incorporations by Reference

a) The Board incorporates the following material by reference:

ASTM. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, (215) 299-5400

ASTM D 2974-87, Standard Test Methods for Moisture, Ash and Organic Matter of Peat and Other Organic Soils, approved May 29, 1987, (reapproved 1995).

ASTM D 2488-93, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), approved September 15, 1993.

ASTM D 1556-90, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, approved June 29, 1990.

ASTM D 2167-94, Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method, approved March 15, 1994.

ASTM D 2922-91, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth), approved December 23, 1991.

ASTM D 2937-94, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method, approved June 15, 1994.

ASTM D 854-92, Standard Test Method for Specific Gravity of Soils, approved November 15, 1992.

ASTM D 2216-92, Standard Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock, approved June 15, 1992.

ASTM D 4959-89, Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method, approved June 30, 1989 (reapproved 1994).

ASTM D 4643-93, Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method, approved July 15, 1993.

ASTM D 5084-90, Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter, approved June 29, 1990.

ASTM D 422-63, Standard Test Method for Particle-Size Analysis of Soils, approved November 21, 1963 (reapproved 1990).

ASTM D 1140-92, Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 μm) Sieve, approved November 15, 1992.

ASTM D 3017-88, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth), approved May 27, 1988.

ASTM D 4525-90, Standard Test Method for Permeability of Rocks by Flowing Air, approved May 25, 1990.

ASTM D 2487-93, Standard Test Method for Classification of Soils for Engineering Purposes, approved September 15, 1993.

ASTM E 1527-93, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, approved March 15, 1993. Vol. 11.04.

ASTM E 1739-95, Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, approved September 10, 1995.

Barnes, Donald G. and Dourson, Michael. (1988). Reference Dose (RfD): Description and Use in Health Risk Assessments. *Regulatory Toxicology and Pharmacology*. 8, 471-486.

GPO. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20401, (202) 783-3238.

USEPA Guidelines for Carcinogenic Risk Assessment, 51 Fed. Reg. 33992-34003, (September 24, 1986).

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," ~~U.S.EPA~~USEPA Publication number SW-846 (Third Edition, November~~,~~ 1986), as amended by Updates I and IIA (Document Number 955-001-00000-1)(contact ~~U.S.EPA~~USEPA, Office of Solid Waste, for Update IIA).

"Methods for the Determination of Organic Compounds in Drinking Water", EPA Publication No. EPA/600/4-88/039 (December 1988 (Revised July 1991)).

"Methods for the Determination of Organic Compounds in Drinking Water, Supplement II", EPA Publication No. EPA/600/R-92/129 (August 1992).

"Methods for the Determination of Organic Compounds in Drinking Water, Supplement III", EPA Publication No. EPA/600/R-95/131 (August 1995).

IRIS. Integrated Risk Information System, National Center for Environmental Assessment, U.S. Environmental Protection Agency, 26 West Martin Luther King Drive, MS-190, Cincinnati, OH~~hio~~ 45268. (513) 569-7254.

"Reference Dose (RfD): Description and Use in Health Risk Assessments", Background Document 1A~~,~~ (March 15, 1993).

"EPA Approach for Assessing the Risks Associated with Chronic Exposures to Carcinogens", Background Document 2~~,~~ (January 17, 1992).

Nelson, D.W., and L.E. Sommers. 1982. Total carbon, organic carbon, and organic matter. In: A.L. Page (ed.), *Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. 2nd Edition*, ~~p.p~~ pp. 539-579, American Society of Agronomy. Madison, WI.

NTIS. National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4600.

"Dermal Exposure Assessment: Princip~~a~~les and Applications", EPA Publication No. EPA/600/8-91/011B~~,~~ (January 1992).

"Exposure Factors Handbook", EPA Publication No. EPA/600/8-89/043~~,~~ (July 1989).

"Risk Assessment Guidance for Superfund, Vol. I; Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors", OSWER Directive 9285.6-03~~,~~ (March 1991).

"Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites," EPA Publication No. EPA/600/8-85/002 (February 1985), PB 85-192219.

"Risk Assessment Guidance for Superfund, Volume I; Human Health Evaluation Manual (Part A)", Interim Final, EPA Publication No. EPA/540/1-89/002, (December 1989).

"Risk Assessment Guidance for Superfund, Volume I; Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment Interim Guidance", Draft, (August 18, 1992).

"Soil Screening Guidance: Technical Background Document", EPA Publication No. EPA/540/R-95/128, PB96-963502 (May 1996).

"Soil Screening Guidance: User's Guide", EPA Publication No. EPA/540/R-96/018, PB96-963505 (April 1996).

"Superfund Exposure Assessment Manual", EPA Publication No. EPA/540/1-88/001, (April 1988).

RCRA Facility Investigation Guidance, Interim Final, developed by USEPA (EPA 530/SW-89-031), 4 volumes, (May 1989).

b) CFR (Code of Federal Regulations). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (202) 783-3238:

40 CFR 761.120 (1993).

c) This Section incorporates no later editions or amendments.

Section 742.215 Determination of Soil Attenuation Capacity

a) The concentrations of organic contaminants of concern remaining in the soil shall not exceed the attenuation capacity of the soil, as determined under subsection (b) of this Section.

b) The soil attenuation capacity is not exceeded if:

1) The sum of the organic contaminant residual concentrations analyzed for the purposes of the remediation program for which the analysis is performed, at each discrete sampling point, is less than the natural organic carbon fraction of the soil. If the information relative to the concentration of other organic contaminants is available, such information shall be

included in the sum. The natural organic carbon fraction (f_{oc}) shall be either:

A) A default value of 6000 mg/kg for soils within the top meter and 2000 mg/kg for soils below one meter of the surface; or

B) A site-specific value as measured by ASTM D2974-87, Nelson and Sommers, or by SW-846 Method 9060: Total Organic Carbon, as incorporated by reference in Section 742.210;~~.~~

2) The total petroleum hydrocarbon concentration is less than the natural organic carbon fraction of the soil as demonstrated using a method approved by the Agency. The method selected shall be appropriate for the contaminants of concern to be addressed; or

3) Another method, approved by the Agency, shows that the soil attenuation capacity is not exceeded.

Section 742.220 Determination of Soil Saturation Limit

a) For any organic contaminant that has a melting point below 30^0C, the remediation objective for the inhalation exposure route developed under Tier 2 or Tier 3 shall not exceed the soil saturation limit, as determined under subsection (c) of this Section.

b) For any organic contaminant, the remediation objective under Tier 2 or Tier 3 for the ~~migration to groundwater portion~~ soil component of the groundwater ingestion exposure route shall not exceed the soil saturation limit, as determined under subsection (c) of this Section.

c) The soil saturation limit shall be:

1) The value listed in Appendix A, Table A for that specific contaminant;

2) A value derived from Equation S29 in Appendix C, Table A; or

3) A value derived from another method approved by the Agency.

Section 742.225 Demonstration ~~Determination~~ of Compliance with Remediation Objectives

Compliance is achieved if each sample result does not exceed that respective remediation objective unless a person elects to proceed under subsections (c), (d) and (e) of this Section.

a) Compliance with groundwater remediation objectives developed under Subparts D through F and H through I shall be demonstrated ~~determined~~ by comparing the contaminant concentrations of discrete samples at each sample point to the applicable groundwater remediation objective. Sample points shall be determined by the program under which remediation is performed.

b) Unless the person elects to composite samples or average sampling results as provided in subsections (c) and (d) of this Section, compliance with soil remediation objectives developed under Subparts D through G and I shall be demonstrated ~~determined~~ by comparing the contaminant concentrations of discrete samples to the applicable soil remediation objective.
~~Compliance is achieved if each sample result does not exceed that respective remediation objective.~~

1) Except as provided in subsections (c) and (d) of this Section, compositing of samples is not allowed.

2) Except as provided in subsection (c) and (d) of this Section, averaging of sample results is not allowed.

3) Notwithstanding subsections (c) and (d) of this Section, compositing of samples and averaging of sample results is not allowed for the construction worker population.

4) The number of sampling points required to demonstrate compliance is determined by the requirements applicable to the program under which remediation is performed.

c) If a person chooses to composite soil samples or average soil sample results to demonstrate ~~determine~~ compliance relative to the ~~migration to groundwater~~ soil component of the groundwater ingestion exposure route, the following requirements apply:

1) A minimum of two sampling locations for every 0.5 acre of contaminated area is required, with discrete samples at each sample location obtained at every two feet of depth, beginning at six inches below the ground surface and continuing through the zone of contamination. Alternatively, a sampling method may be approved by the Agency based on an appropriately designed site-specific evaluation. Samples obtained at or below the water table shall not be used in compositing or averaging.

2) For contaminants of concern other than volatile organic contaminants:

A) Discrete samples from the same boring may be composited.

B) Discrete sample results from the same boring may be averaged.

3) For volatile organic contaminants:

A) Compositing of samples is not allowed.

B) Discrete sample results from the same boring may be averaged.

d) ~~If a person chooses to composite soil samples or average soil sample results to determine compliance relative to the inhalation exposure route or the soil ingestion exposure route, the following requirements apply:~~

~~1) Unless an alternative method is approved by the Agency, a minimum of twenty-four (24) aliquots per 0.5 acre, to be collected within the area of contamination, is required. No more than 6 aliquots of equal volume shall be composited into one sample. Samples composited must be located proximate to each other. Each discrete sample shall be obtained at a depth of one foot or less.~~

~~2) Unless an alternative method is approved by the Agency based on an appropriately designed site-specific evaluation, for contaminants of concern other than volatile organic contaminants:~~

~~A) Each 0.5 acre portion of contaminated area of a site may be divided into quadrants of equal size and shape. The samples within the quadrant may be composited.~~

~~B) Averaging of sample results taken from separate quadrants is not allowed.~~

~~3) For volatile organic contaminants compositing of samples is not allowed. Discrete sample results from the same quadrant may be averaged.~~

If a person chooses to composite soil samples or average soil sample results to demonstrate compliance relative to the inhalation exposure route or ingestion exposure route, the following requirements apply:

1) A person shall submit a sampling plan for Agency approval, based upon a site-specific evaluation;

2) For volatile organic compounds, compositing of samples is not allowed; and

3) All samples shall be collected within the contaminated area.

e) ~~For purposes of calculating~~When averaging under this Section, if no more than 50 percent of sample results are reported as "non-detect", "no contamination", "below detection limits", or similar terms, such results shall be included in the averaging calculation as one-half of the reported analytical detection limit for the contaminant. If more than 50 percent of sample results are "non-detect", another statistically valid procedure ~~acceptable~~ approved ~~to~~ by the Agency may be used to determine an average.

~~f) A person may propose an alternative method for determining compliance with remediation objectives.~~

Section 742.230 Agency Review and Approval

a) Documents and requests filed with the Agency under this Part shall be submitted in accordance with the procedures applicable to the specific program under which remediation is performed.

b) Agency review and approval of documents and requests under this Part shall be performed in accordance with the procedures applicable to the specific program under which the remediation is performed ~~(e.g., 35 Ill. Adm. Code 732, Subpart E for petroleum leaking underground storage tanks)~~.

SUBPART C: EXPOSURE ROUTE EVALUATIONS

Section 742.300 Exclusion of Exposure Route ~~General~~

a) This Subpart sets forth requirements to demonstrate that an actual or potential impact to a receptor or potential receptor from a contaminant of concern can be excluded from consideration from one or more exposure routes. ~~As an alternative to the use of the requirements in this Part, a person may use the procedures for evaluation of exposure routes under Tier 3 as set forth in Section 742.925.~~ If an evaluation under this Part demonstrates the applicable requirements for excluding an exposure route are met, then the exposure route is excluded from consideration and no remediation objective(s) need be developed for that exposure route.

~~a~~b) No exposure route may be excluded from consideration until characterization of the extent and concentrations of contaminants of concern at a site has been performed. The actual steps and methods taken to characterize a site shall be determined by the specific program requirements under which the site remediation is being addressed.

~~b) The inhalation exposure route may be excluded from consideration if the requirements of Sections 742.305 and 742.310 are met.~~

c) As an alternative to the use of the requirements in this Part, a person may use the procedures for evaluation of exposure routes under Tier 3 as set forth in Section 742.925.~~The soil ingestion exposure route may be excluded from consideration if the requirements of Sections 742.305 and 742.315 are met.~~

~~d) The groundwater ingestion exposure route may be excluded from consideration if the requirements of Sections 742.305 and 742.320 are met.~~

Section 742.305 Contaminant Source and Free Product Determination

No exposure route shall be excluded from consideration relative to a contaminant of concern unless the following requirements are met:

a) The sum of the concentrations of all organic contaminants of concern shall not exceed the attenuation capacity of the soil as determined under Section 742.215;

b) The concentrations of any organic contaminants of concern remaining in the soil shall not exceed the soil saturation limit as determined under Section 742.220;

c) Any soil which contains contaminants of concern shall not exhibit any of the characteristics of reactivity for hazardous waste as determined under 35 Ill. Adm. Code 721.123;

d) Any soil which contains contaminants of concern shall not exhibit a pH less than or equal to 2.0 or greater than or equal to 12.5, as determined by SW-846 Method 9040B:pH Electrometric for soils with 20 percent or greater aqueous (moisture) content or by SW-846 Method 9045C:Soil pH for soils with less than 20 percent aqueous (moisture) content as incorporated by reference in Section 742.210; and

e) Any soil which contains contaminants of concern in the following list of inorganic chemicals or their salts shall not exhibit any of the characteristics of toxicity for hazardous waste as determined by 35 Ill. Adm. Code 721.124, or an alternative method approved by the Agency: arsenic, barium, cadmium, chromium, lead, mercury, selenium, or silver.

Section 742.310 Inhalation Exposure Route

The inhalation exposure route may be excluded from consideration if:

a) The requirements of Sections 742.300 and 742.305 are met; and

b) An institutional control, in accordance with Subpart J, is in place that meets the following requirements:

1) ~~Requires compliance with the requirements of subsection (c) of this section, and~~The concentration of any contaminant of concern within ten feet of the land surface or ~~within ten feet of~~ any man-made pathway shall not exceed the Tier 1 remediation objective under Subpart E for the inhalation exposure route; or

2) An engineered barrier, as set forth in Subpart K and approved by the Agency, is in place; and

3) Requires safety precautions for the construction worker ~~populations~~ if the Tier 1 construction worker remediation objectives are exceeded. ~~(e.g., use of appropriate personal protective equipment, if applicable).~~

~~c1) The concentration of any contaminant of concern within ten feet of the land surface or within ten feet of any man-made pathway shall not exceed the Tier 1 remediation objective under Subpart E for the inhalation exposure route; or~~

~~2) An engineered barrier, as set forth in Subpart K and approved by the Agency, is in place.~~

Section 742.315 Soil Ingestion Exposure Route

The soil ingestion exposure route may be excluded from consideration if:

a) The requirements of Sections 742.300 and 742.305 are met; and

b) An institutional control, in accordance with Subpart J, is in place that meets the following requirements:

1) ~~Requires compliance with the requirements of subsection (c) of this section and~~The concentration of any contaminant of concern within three feet of the land surface shall not exceed the Tier 1 remediation objective

under Subpart E for the ingestion of soil exposure route; or

2) An engineered barrier, as set forth in Subpart K and approved by the Agency, is in place; and

3~~2~~) Requires safety precautions for the construction worker ~~population~~ if the Tier 1 construction worker remediation objectives are exceeded. ~~(e.g., use of appropriate personal protective equipment, if applicable).~~

~~c1) The concentration of any contaminant of concern within ten feet of the land surface or within ten feet of any man-made pathway shall not exceed the Tier 1 remediation objective under Subpart E for the inhalation exposure route; or~~

~~2) An engineered barrier, as set forth in Subpart K and approved by the Agency, is in place.~~

Section 742.320 Groundwater Ingestion Exposure Route

The groundwater ingestion exposure route may be excluded from consideration if:

a) The requirements of Sections 742.300 and 742.305 are met;

b) ~~To the maximum extent practicable,~~ The corrective action measures have been completed to remove any free product to the maximum extent practicable.

~~b~~c) The source of the release is not located within the minimum or designated maximum setback zone ~~as a potable water supply well nor~~ or within a regulated recharge area of a potable water supply well;

d) As demonstrated in accordance with Section 742.1015~~Subpart J~~, for any area within 2500 feet from the source of the release, an ordinance adopted by a unit of local government is in place that effectively prohibits the installation of potable water supply wells (and the use of such wells)~~;~~. ~~under Section 742.1015 of this Part; the use of groundwater as a potable supply of water, except at points of withdrawal by the unit of local government, is in place;~~

~~d~~ e) As demonstrated using Equation R26, in Appendix C, Table C, in accordance with Section 742.810, the concentration of any contaminant of concern in groundwater within the minimum or designated maximum setback zone of an existing potable water supply well will meet the applicable Tier 1 groundwater remediation objective; and

~~e~~ f) As demonstrated using Equation R26, in Appendix C, Table C, in accordance with Section 742.810, the concentration of any contaminant of concern in groundwater

discharging into a surface water will meet the applicable surface water quality standard under 35 Ill. Adm. Code 302.

SUBPART D: DETERMINING AREA BACKGROUND

Section 742.400 Area Background ~~General~~

This Subpart provides procedures for determining area background concentrations for contaminants of concern. Except as described in Section 742.415(c) and (d) of this Subpart, area background concentrations may be used as remediation objectives for contaminants of concern at a site.

Section 742.405 Determination of Area Background for Soil

a) Soil sampling results shall be obtained for purposes of determining area background levels in accordance with the following procedures:

1) For volatile organic contaminants, sample results shall be based on discrete samples;

2) Unless an alternative method is approved by the Agency, for contaminants other than volatile organic contaminants, sample results shall be based on discrete samples or composite samples. If a person elects to use composite samples, each 0.5 acre of the area to be sampled shall be divided into quadrants and 5 aliquots of equal volume per quadrant shall be composited into 1 sample;

3) Samples shall be collected from similar depths and soil types, which shall be consistent with the depths and soil types in which maximum levels of contaminants ~~maxima~~ are found in the areas of known or suspected releases; and

4) Samples shall be collected from areas of the site or adjacent to the site that are unaffected by known or suspected releases at or from the site. If the sample results show an impact from releases at or from the site, then the sample results shall not be included in determining area background levels under this Part.

b) Area background shall be determined according to one of the following approaches ~~procedures~~:

1) Statewide Area Background Approach:

A) The ~~maximum value of the range of~~ concentrations of inorganic chemicals in background soils listed in Appendix A, Table ~~F~~ G may

be used as the upper limit of the area background concentration for the site. The first column to the right of the chemical name presents ~~the range of concentrations of~~ inorganic chemicals in background soils for counties within Metropolitan Statistical Areas. Counties within Metropolitan Statistical Areas are identified in Appendix A, Table ~~F~~ G, Footnote a. Sites located in counties outside Metropolitan Statistical Areas shall use the ~~range of~~ concentrations of inorganic chemicals in background soils shown in the second column to the right of the chemical name.

B) Soil area background concentrations determined according to this statewide area background approach shall be used as provided in Section 742.415(b) of this Part~~(1)~~. For each parameter whose sampling results demonstrate concentrations above those in Appendix A, Table ~~F~~ G, the person shall develop appropriate soil remediation objectives in accordance with this Part, or may determine area background in accordance with ~~the procedures specified in~~ subsection (b)(2) of this Section.

2) A statistically valid approach for determining area background concentrations appropriate for the characteristics of the data set, and approved by the Agency.

Section 742.410 Determination of Area Background for Groundwater

a) Groundwater sampling results shall be obtained for purposes of determining area background in accordance with the following procedures:

1) Samples shall be collected from areas of the site or adjacent to the site that are unaffected by releases at the site;

2) The background monitoring wells, ~~as determined in consultation with the Agency,~~ shall be sufficient in number to account for the spatial and temporal variability, size, and number of known or suspected off-site releases of contaminants of concern, and the hydrogeological setting of the site;

3) The samples shall be collected in consecutive quarters for a minimum of one year for each well unless ~~or~~ another sample schedule is approved by the Agency;

4) The samples shall be collected from the same stratigraphic unit(s) as the groundwater contamination at the site; and

5) The background monitoring wells shall be located hydraulically upgradient from the release(s) of contaminants of concern, unless a person demonstrates to the Agency ~~approves~~ that the upgradient location is undefinable or infeasible.

b) Area background shall be determined according to one of the following approaches~~procedures~~:

1) Prescriptive Approach:

A) If more than 15 percent of the groundwater sampling results for a chemical obtained in accordance with Section 742.410(a) are less than the appropriate detection limit for that chemical, the Prescriptive Approach may not be used for that chemical. If 15 percent or less of the sampling results are less than the appropriate detection limit, a concentration equal to one-half the detection limit shall be used for that chemical in the calculations contained in this Prescriptive Approach.

B) The groundwater sampling results obtained in accordance with Section 742.410(a) shall be used to determine if the sample set is normally distributed. The Shapiro-Wilk Test of Normality shall be used to determine whether the sample set is normally distributed, if the sample set for the background well(s) contains 50 or fewer ~~less~~ samples~~, to determine whether the sample set is normally distributed~~. Values necessary for the Shapiro-Wilk Test of Normality shall be determined using Appendix A, Tables ~~E and F~~ C and D. If the computed value of W is greater than the 5 percent Critical Value in Appendix A, Table D, the sample set shall be assumed to be normally distributed, and the Prescriptive Approach is allowed. If the computed value of W is less than 5 percent Critical Value in Appendix A, Table D, the sample set shall be assumed to not be normally distributed, and the Prescriptive Approach shall not be used.

C) If the sample set contains at least ten sample results, the Upper Tolerance Limit (UTL) of a normally distributed sample set may be calculated using the mean (x) and standard ~~derration~~ deviation(s), from:

$$UTL = x + (K \bullet s),$$

where K = the one-sided normal tolerance factor for estimating the 95 percent upper confidence limit of the 95th percentile of a normal

distribution. Values for K shall be determined using Appendix A, Table B.

D) If the sample set contains at least ten sample results, the UTL shall be the upper limit of the area background concentration for the site. If the sample set contains less than ten sample results, the maximum value of the sample set shall be the upper limit of the area background concentration for the site.

E) This Prescriptive Approach shall not be used for determining area background for the parameter pH.

2) Another statistically valid approach for determining area background concentrations appropriate for the characteristics of the data set, and approved by the Agency.

Section 742.415 Use of Area Background Concentration~~s~~

a) A person may request that area background concentration~~s~~ determined pursuant to Sections 742.405 and 742.410 be used according to the provisions of ~~Section 742.415(b)~~subsection (b) of this Section. Such request shall address the following:

1) The natural or man-made pathways of any suspected off-site contamination reaching the site;

2) Physical and chemical properties of suspected off-site contaminants of concern reaching the site; and

3) The location and justification of all background sampling points.

b) Except as specified in ~~Section 742.415~~ subsections (c) and (d) of this Section, an area background concentration~~s~~ may be used as follows:

1) ~~If determined under Sections 742.405 or 742.410, to~~ To support a request to exclude a chemical as a contaminant of concern from further consideration for remediation at a site due to its presence as a result of background conditions; or

2) ~~If determined under Sections 742.405 or 742.410, as~~ As a remediation objective~~s~~ for a contaminant~~s~~ of concern at a site in lieu of an ~~remediation~~ objective~~s~~ developed pursuant to the other procedures of this Part.

c) An a~~A~~rea background concentration~~s~~ shall not be used IN THE EVENT THAT THE AGENCY HAS DETERMINED IN WRITING THAT THE BACKGROUND LEVEL FOR A REGULATED SUBSTANCE POSES AN

ACUTE THREAT TO HUMAN HEALTH OR THE ENVIRONMENT AT THE SITE WHEN CONSIDERING THE POST-REMEDIAL ACTION LAND USE. (Section 58.5(b)(3) of the Act)

d) IN THE EVENT THAT THE CONCENTRATION OF A REGULATED SUBSTANCE OF CONCERN ON THE SITE EXCEEDS A REMEDIATION OBJECTIVE ADOPTED BY THE BOARD FOR RESIDENTIAL LAND USE, THE PROPERTY MAY NOT BE CONVERTED TO RESIDENTIAL USE UNLESS SUCH REMEDIATION OBJECTIVE OR AN ALTERNATIVE RISK-BASED REMEDIATION OBJECTIVE FOR THAT REGULATED SUBSTANCE OF CONCERN IS FIRST ACHIEVED. If the land use is restricted, there shall be an institutional control in place in accordance with Subpart J. (Section 58.5(b)(2) of the Act)

SUBPART E: TIER 1 EVALUATION

Section 742.500 Tier 1 Evaluation Overview ~~Introduction~~

a) A Tier 1 evaluation compares the concentration of each contaminant~~s~~ of concern detected at a site to the baseline remediation objectives provided in Appendix B, Tables A, B, C, D, and E. Use of Tier 1 remediation objectives requires only limited site-specific information: concentrations of contaminants of concern, groundwater classification, land use classification, and, if appropriate, soil pH. (~~s~~See Appendix B, Illustration A).

b) Although Tier 1 allows for differentiation between residential and industrial/commercial property use of a site, an institutional control under Subpart J is ~~are~~ required where remediation objectives are based on an industrial/commercial property use.

c) Any given exposure route is not a concern if the concentration~~s~~ of each contaminant~~s~~ of concern detected at the site is ~~are all~~ below the Tier 1 value~~s~~ of that given route. In a such case~~s~~, no further evaluation of that route is necessary.

Section 742.505 Tier 1 Soil and Groundwater Remediation Objectives

a) Soil

1) Inhalation Exposure Route

A) The Tier 1 soil remediation objectives for this exposure route based upon residential property use are listed in Appendix B, Table A.

B) The Tier 1 soil remediation objectives for this exposure route based upon industrial/commercial property use are listed in Appendix B, Table B. Soil remediation objective determinations relying on this table require use of institutional controls in accordance with Subpart J.

2) Ingestion Exposure Route

A) The Tier 1 soil remediation objectives for this exposure route based upon residential property use are listed in Appendix B, Table A.

B) The Tier 1 soil remediation objectives for this exposure route based upon industrial/commercial property use are listed in Appendix B, Table B. Soil remediation objective determinations relying on this table require use of institutional controls in accordance with Subpart J.

3) ~~Migration to Groundwater~~ Soil Component ~~Portion~~ of the Groundwater Ingestion Route

A) The Tier 1 soil remediation objectives for this exposure route based upon residential property use are listed in Appendix B, Table A.

B) The Tier 1 soil remediation objectives for this exposure route based upon industrial/commercial property use are listed in Appendix B, Table B.

C) The pH-dependent Tier 1 soil remediation objectives for identified ionizable organics or inorganics for the ~~migration to groundwater~~ soil component ~~portion~~ of the groundwater ingestion exposure route (based on the total amount of contaminants present in the soil sample results and groundwater classification) are provided in Appendix B, Tables C and D.

D) Values used to calculate the Tier 1 soil remediation objectives for this exposure route are listed in Appendix B, Table F.

4) Evaluation of the dermal contact with soil exposure route is not required under Tier 1.

b) Groundwater

1) The Tier 1 groundwater remediation objectives for the ~~direct ingestion of~~ groundwater component ~~portion~~ of the groundwater ingestion route are listed in Appendix B, Table E.

2) The Tier 1 groundwater remediation objectives for this exposure route are given for Class I and Class II groundwaters, respectively.

3) The Class I groundwater remediation objectives set forth in Appendix B, Table E shall be corrected for cumulative effect of mixtures of similar-acting noncarcinogenic chemicals in accordance with the methodologies set forth in either subsection (A) or (B), if more than one chemical listed in Appendix A, Table E is detected at a site and if such chemicals affect the same target organ (*i.e.*, has the same critical effect as defined by the RfD):

A) Calculate the weighted average using the following equations:

$$W_{ave} = \frac{x_1}{CUO_{x_1}} + \frac{x_2}{CUO_{x_2}} + \frac{x_3}{CUO_{x_3}} + \ldots + \frac{x_a}{CUO_{x_a}}$$

where:

W_{ave}= Weighted Average

x_1 through x_a = Concentration of each individual contaminant at the location of concern. Note that, depending on the target organ/mode of action, the actual number of contaminants will range from 2 to 14.

CUO_{x_a} = A Tier 1 remediation objective each x_a from Appendix B, Table E.

ii) If the value of the weighted average calculated in accordance with the equations above is less than or equal to 1.0, then the remediation objectives are met for those chemicals.

ii) If the value of the weighted average calculated in accordance with the equations above is greater than 1.0, then additional remediation must be carried out until the level of contaminants remaining in the remediated area have a weighted average calculated in accordance with the equation above less than or equal to one;

B) Divide each individual chemical's remediation objective by the number of chemicals in that specific target organ group that were detected at the site. Each of the contaminant concentrations at the site is then compared to the remediation objectives that have been adjusted to account for this potential additivity

Section 742.510 Tier 1 Remediation Objectives Tables

a) Soil remediation objectives are listed in Appendix B, Tables A, B, C, and D.

1) Appendix B, Table A is based upon residential property use.

A) The first column to the right of the chemical name lists soil remediation objectives for the soil ingestion exposure route.

B) The second column lists the soil remediation objectives for the inhalation exposure route.

C) The third and fourth columns list soil remediation objectives for the ~~migration to groundwater~~ soil component ~~portion~~of the groundwater ingestion exposure route for the respective classes of groundwater:

i) Class I groundwater; and

ii) Class II groundwater.

D) The final column lists ~~is~~ the Acceptable Detection Limit (ADL), only where applicable.

2) Appendix B, Table B is based upon industrial/commercial property use.

A) The first and third columns to the right of the chemical name list the soil remediation objectives for the soil ingestion exposure route based on two receptor populations:

i) Industrial/commercial~~population~~; and

ii) Construction worker~~population~~.

B) The second and fourth columns to the right of the chemical name list the soil remediation objectives for the inhalation exposure route based on two receptor populations:

i) Industrial/commercial~~population~~; and

ii) Construction worker~~population~~.

C) The fifth and sixth columns to the right of the chemical name list the soil remediation objectives for the ~~migration to groundwater~~

soil component ~~portion~~of the groundwater ingestion exposure route ~~based on TCLP analyses~~ for two classes of groundwater:

i) Class I groundwater; and

ii) Class II groundwater.

3) Appendix B, Tables C and D set forth pH specific soil remediation objectives for inorganic and ionizing organic chemicals for the soil component of the groundwater ingestion route.

A) Table C sets forth remediation objectives based on Class I groundwater and Table D sets forth remediation objectives based on Class II groundwater.

B) The first column in Tables C and D lists the chemical names.

C) The second through ninth columns to the right of the chemical names list the pH based soil remediation objectives.

4) For the inorganic chemicals listed in Appendix B, Tables A and B, the soil component of the groundwater ingestion exposure route shall be evaluated using TCLP (SW846 Method 1311) or SPLP (SW 846 Method 1312), incorporated by reference at Section 742.210 unless a person chooses to evaluate the soil component on the basis of the total amount of contaminant in a soil sample result in accordance with subsection (a)(5) of this Section.

5~~3~~) For those inorganic and ionizing organic chemicals listed in Appendix B, Tables C and D, if a person elects to evaluate the ~~migration to groundwater portion~~ soil component of the groundwater ingestion exposure route based on the total amount of contaminant in a soil sample result (rather than TCLP or SPLP analysis), the person shall determine the soil pH at the site and then select the appropriate soil remediation objectives based on Class I and Class II groundwaters ~~using~~ from Tables C and D, respectively. If the soil pH is less than 4.5 or greater than 8.0, then Tables C and D cannot be used.

4~~6~~) Unless one or more exposure routes are excluded from consideration under Subpart C, the most stringent soil remediation objective of the exposure routes (*i.e.*, soil ingestion exposure route, inhalation exposure route, and ~~migration to groundwater~~ soil component ~~portion~~of the groundwater ingestion exposure route) shall be compared to the concentrations of soil contaminants of concern measured at the site. When using Appendix B, Table B to select soil remediation objectives for the ingestion exposure

route and inhalation exposure route, the remediation objective shall be the more stringent soil remediation objective of the industrial/commercial populations and construction worker populations.

~~5~~7) Confirmation sample results may be averaged or soil samples may be composited in accordance with Section 742.225.

~~6~~8) If a soil remediation objective for a chemical is less than the ADL, the ADL shall serve as the soil remediation objective.

b) Groundwater remediation objectives for the ~~direct ingestion of~~ groundwater component ~~portion~~ of the groundwater ingestion exposure route are listed in Appendix B, Table E. However, Appendix B, Table E must be corrected for cumulative effect of mixtures of similar-acting noncarcinogenic chemicals as set forth in Section 742.505(b)(3).

1) The first column to the right of the chemical name lists groundwater remediation objectives for Class I groundwater, and the second column lists the groundwater remediation objectives for Class II groundwater.

2) To use Appendix B, Table E of this Part, the Part 620 classification for groundwater at the site shall be determined. The concentrations of groundwater contaminants of concern at the site are compared to the applicable Tier 1 groundwater remediation objectives for the ~~direct ingestion of~~ groundwater component ~~portion~~of the groundwater ingestion exposure route in Appendix B, Table E. ~~Appendix D describes the procedures to be used in determining whether groundwater is Class II.~~

c) For contaminants of concern not listed in Appendix B, Tables A, B, and E, a person may request site-specific remediation objectives from the Agency or propose site-specific remediation objectives in accordance with 35 Ill. Adm. Code 620, Subpart I of this Part, or both.

SUBPART F: TIER 2 GENERAL EVALUATION

Section 742.600 Tier 2 Overview ~~Introduction~~

a) Tier 2 remediation objectives are developed through the use of equations which allow site-specific data to be used. (~~s~~See Appendix C, Illustrations A and B). The equations, identified in Appendix C, Tables A and C may be used to develop Tier 2 remediation objectives.

b) Tier 2 evaluation is only required for contaminants of concern and corresponding exposure routes (except where excluded from further consideration under Subpart C) exceeding the Tier 1 remediation objectives. When conducting Tier 2

evaluations, the values used in the calculations must have the appropriate units of measure as identified in Appendix C, Tables B and D.

c) Any development of remediation objectives using site-specific information or equations outside the Tier 2 framework shall be evaluated under Tier 3.

d) Any development of a remediation objective under Tier 2 shall not use a target hazard quotient greater than one at the point of human exposure or a target cancer risk greater than 1 in 1,000,000 at the point of human exposure.

~~d~~ e) In conducting a Tier 2 evaluation, the following conditions shall be met:

1) For each discrete sample, the total soil contaminant concentration of either a single contaminant or multiple contaminants of concern shall not exceed the attenuation capacity of the soil as provided in Section 742.215.

2) Remediation objectives for noncarcinogenic compounds which affect the same target organ, organ system or similar mode of action shall meet the requirements of Section 742.720~~610~~

3) The soil remediation objectives based on the inhalation and ~~migration to groundwater~~ the soil component ~~portion~~of the groundwater ingestion exposure routes shall not exceed the soil saturation limit as provided in Section 742.220.

~~e~~ f) If the calculated Tier 2 soil remediation objective for an applicable exposure route is more stringent than the corresponding Tier 1 remediation objective, then the Tier 1 remediation objective applies.

~~f~~ g) If the calculated Tier 2 soil remediation objective for an exposure route is more stringent than the Tier 1 soil remediation objective(s) for the other exposure routes, then the Tier 2 calculated soil remediation objective applies and Tier 2 soil remediation objectives for the other exposure routes are not required.

~~g~~ h) If the calculated Tier 2 soil remediation objective is less stringent than one or more of the soil remediation objectives for the remaining exposure routes, then the Tier 2 values are calculated for the remaining exposure route(s) and the most stringent Tier 2 calculated value applies.

Section 742.605 Land Use

a) Present and post-remediation land use is evaluated in a Tier 2 evaluation. Acceptable exposure factors for the Tier 2 evaluation for residential, industrial/commercial, and construction worker populations are provided in the far right column of both Appendix C, Tables B and D. Use of exposure factors

different from those in Appendix C, Tables B and D must be approved by the Agency as part of a Tier 3 evaluation.

b) If a Tier 2 evaluation is based on an industrial/commercial property use, then:

1) Construction worker populations shall also be evaluated; and

2) Institutional controls are required in accordance with Subpart J.

~~Section 742.610 Chemicals with Cumulative Noncarcinogenic Effects~~

~~Appendix A, Table E lists the groups of chemicals from Appendix B, Tables A and B that have remediation objectives based on noncarcinogenic toxicity and that affect the same target organ. If more than one chemical detected at a site affects the same target organ (i.e., has the same critical effect as defined by the RfD), the initially calculated remediation value for each chemical in the group shall be corrected for cumulative effects by one of the following two methods:~~

~~a) Calculate the weighted average using the following equations:~~

$$W_{ave} = \frac{x_1}{CUO_{x_1}} + \frac{x_2}{CUO_{x_2}} + \frac{x_3}{CUO_{x_3}} + \ldots + \frac{x_a}{CUO_{x_a}}$$

~~where:~~

~~W_{ave} = Weighted Average~~

~~x_1 through x_a = Concentration of each individual contaminant at the location of concern. Note that, depending on the target organ/mode of action, the actual number of contaminants will range from 2 to 14.~~

~~CUO_{x_a} = A Tier 2 remediation objective must be developed for each x_a.~~

~~If the value of the weighted average calculated in accordance with the equations above is less than or equal to 1.0, then the remediation objectives are met for those chemicals.~~

~~If the value of the weighted average calculated in accordance with the equations above is greater than 1.0, then additional remediation must be carried out until the level of contaminants remaining in the remediated area have a weighted average calculated in accordance with the equation above less than or equal to one;~~

~~b) Divide each individual chemical's remediation objective by the number of chemicals in that specific target organ group that were detected at the site. Each of the~~

~~contaminant concentrations at the site is then compared to the remediation objectives that have been adjusted to account for this potential additivity. For the noncarcinogenic contaminants listed in Appendix A, Table E, a respective soil remediation objective need be no lower than the respective value listed in Appendix B, Tables A or B.~~

Section 742.~~615~~610 Chemical and Site Properties

a) Physical and Chemical Properties of Contaminants

Tier 2 evaluations require information on the physical and chemical properties of the contaminants of concern. The physical and chemical properties used in a Tier 2 evaluation are contained in Appendix C, Table E. If the site has contaminants not included in this table, a person may request the Agency to provide the applicable physical and chemical input values or may propose input values under Subpart I. If a person proposes to apply values other than those in Appendix C, Table E, or those provided by the Agency, the evaluation shall be considered under Tier 3.

b) Soil and Groundwater Parameters

1) A Tier 2 evaluation requires examination of soil and groundwater parameters. The parameters that may be varied, and the conditions under which these parameters are determined as part of Tier 2, are summarized in Appendix C, Tables B and D. If a person proposes to vary site-specific parameters outside of the framework of these tables, the evaluation shall be considered under Tier 3.

2) To determine site-specific physical soil parameters, a minimum of one boring per 0.5 acre of contamination shall be collected. This boring must be deep enough to allow the collection of the required field measurements. The site-specific physical soil parameters must be determined from the portion of the boring representing the stratigraphic unit(s) being evaluated. For example, if evaluating the ~~migration to groundwater~~soil component ~~portion~~of the groundwater ingestion exposure route, two samples from the boring will be required:

A) A sample of the predominant soil type for the vadose zone; and

B) A sample of the predominant soil type for the saturated zone.

3) A site-specific SSL dilution factor (used in developing soil remediation objectives based upon the protection of groundwater) may be determined by substituting site information in Equation S22 in Appendix C, Table A. To make this demonstration, a minimum of three ~~(3)~~ monitoring wells shall

be used to determine the hydraulic gradient. As an alternative, the default dilution factor value listed in Appendix C, Table B may be ~~is~~used. If monitoring wells are used to determine the hydraulic gradient, the soil taken from the borings shall be visually inspected to ensure there are no significant differences in the stratigraphy. If there are similar soil types in the field, one boring shall be used to determine the site-specific physical soil parameters. If there are significant differences, all of the borings shall be evaluated before determining the site-specific physical soil parameters for the site.

4) Not all of the parameters identified in Appendix C, Tables B and D need to be determined on a site-specific basis. A person may choose to collect partial site-specific information and use default values as listed in Appendix C, Tables B and D for the rest of the parameters.

~~5) Appendix D describes the procedures to be used in determining whether groundwater is Class II.~~

SUBPART G: TIER 2 SOIL EVALUATION

Section 742.700 Tier 2 Soil Overview

a) Tier 2 remediation objectives are developed through the use of models which allow site-specific data to be considered. Appendix C, Tables A and C list equations that shall be used under a Tier 2 evaluation to calculate soil remediation objectives prescribed by SSL and RBCA models, respectively. (S~~s~~ee also Appendix C, Illustration A).

b) Appendix C, Table A lists equations that are used under the SSL model. (S~~s~~ee also Appendix C, Illustration A). The SSL model has equations to evaluate the following human exposure routes:

1) Soil ingestion exposure route;

2) Inhalation exposure route for:

A) Volatiles;

B) Fugitive dust; and

3) ~~Migration to groundwater~~Soil component ~~portion~~of the groundwater ingestion exposure route.

c) Evaluation of the dermal exposure route is not required under the SSL model.

d) Appendix C, Table C lists equations that are used under the RBCA model. (Ssee also Appendix C, Illustration A). The RBCA model has equations to evaluate human exposure based on the following:

1) The combined exposure routes of inhalation of vapors and particulates, soil ingestion, and dermal contact with soil;

2) The ambient vapor inhalation (outdoor) route from subsurface soils;

3) Migration to groundwaterSoil component portionof the groundwater ingestion route; and

4) Groundwater ingestion exposure route.

e) The equations in either Appendix C, Tables A or C may be used to calculate remediation objectives for each contaminant of concern under Tier 2, if the following requirements are met:

1) The Tier 2 soil remediation objectives for the ingestion and inhalation exposure routes shall use the applicable equations from the same approach (i.e., SSL equations in Appendix C, Table C).

2) The equations used to calculate soil remediation objectives for the migration to groundwater soil component portionof the groundwater ingestion exposure route are not dependent on the approach utilized to calculate soil remediation objectives for the other exposure routes. For example, it is acceptable to use the SSL equations for calculating Tier 2 soil remediation objectives for the ingestion and inhalation exposure routes, and the RBCA equations for calculating Tier 2 soil remediation objectives for the migration to groundwatersoil component portionof the groundwater ingestion exposure route.

3) Combining equations from Appendix C, Tables A and C to form a new model is not allowed. In addition, Appendix C, Tables A and C must use their own applicable parameters identified in Appendix C, Tables B and D, respectively.

f) In calculating soil remediation objectives for industrial/commercial property use, applicable calculations shall be performed twice: once using industrial/commercial population default values and once using construction worker population default values. The more stringent soil remediation objectives derived from these calculations must be used for further Tier 2 evaluations.

g) Tier 2 data sheets provided by the Agency shall be used to present calculated Tier 2 remediation objectives, if required by the particular program for which remediation is being performed.

h) The RBCA equations which rely on the parameter Soil Water Sorption Coefficient (k_s) can only be used for ionizing organics and inorganics by substituting values for k_s from Appendix C, Tables I and J, respectively. This will also require the determination of a site-specific value for soil pH.

Section 742.705 Parameters for Soil Remediation Objective Equations

a) Appendix C, Tables B and D list the input parameters for the SSL and RBCA equations, respectively. The first column lists each symbol as it is presented in the equation. The next column defines the parameters. The third column shows the units for the parameters. The fourth column identifies where information on the parameters can be obtained (i.e., field measurement, applicable equation(s), reference source, or default value). The last column identifies how the parameters can be generated. ~~A discussion of each parameter group follows.~~

b) Default Values

Default values are numerical values specified for use in the Tier 2 equations. The fourth column of Appendix C, Tables B and D denotes if the default values are from the SSL model, RBCA model, or some other source. The last column of Appendix C, Tables B and D lists the numerical values for the default values used in the SSL and RBCA equations, respectively.

c) Site-specific Information

Site-specific information is a parameter measured, obtained, or determined from the site to calculate Tier 2 remediation objectives. The fourth column of Appendix C, Tables B and D identifies those site-specific parameters that may require direct field measurement. For some parameters, numerical default inputs have been provided in the last column of Appendix C, Tables B and D to substitute for site-specific information. In some cases, information on the receptor or soil type is required to select the applicable numerical default inputs. Site-specific information includes:

1) Physical soil parameters identified in Appendix C, Table F. The second column identifies the location where the sample is to be collected. Acceptable methods for measuring or calculating these soil parameters are identified in the last column of Appendix C, Table F;

2) ~~Engineered barriers or institutional controls~~Institutional controls or engineered barriers,~~which can affect the target cancer risk~~. pursuant to

Subparts J and K, describe applicable institutional controls and engineered barriers under a Tier 2 evaluation.; and

3) Land use classification~~Receptor classification (i.e., residential, industrial/commercial, and construction worker populations)~~.

d) Toxicological-specific Information

1) Toxicological-specific information is used to calculate Tier 2 remediation objectives for the following parameters if applicable:

A) Oral Chronic Reference Dose (RfD_o, expressed in mg/kg-d);

B) Oral Subchronic Reference Dose (RfD_s, expressed in mg/kg-d, shall be used for construction worker remediation objective calculations);

C) Oral Slope Factor (SF_o, expressed in $(mg/kg\text{-}d)^{-1}$);

D) Inhalation Unit Risk Factor (URF expressed in $(ug/m^3)^{-1}$);

E) Inhalation Chronic Reference Concentration (RfC, expressed in mg/m^3);

F) Inhalation Subchronic Reference Concentration (RfC_s, expressed in mg/m^3, shall be used for construction worker remediation objective calculations);

G) Inhalation Chronic Reference Dose (RfD_i, expressed in mg/kg-d);

H) Inhalation Subchronic Reference Dose (RfD_{is}, expressed in mg/kg-d, shall be used for construction worker remediation objective calculations); and

I) Inhalation Slope Factor (SF_i, expressed in $(mg/kg\text{-}d)^{-1}$);

2) Toxicological information can be obtained from IRIS, as incorporated by reference in Section 742.210, or the program under which the remediation is being performed.

e) Chemical-specific Information

Chemical-specific information used to calculate Tier 2 remediation objectives is listed in Appendix C, Table E.

f) Calculations

Calculating numerical values for some parameters requires the use of equations listed in Appendix C, Tables A or C. The parameters that are calculated are listed in Appendix C, Tables B and D.

Section 742.710 SSL Soil Equations

a) This Section sets forth the equations and parameters used to develop Tier 2 soil remediation objectives for the three exposure routes using the SSL approach.

b) Soil Ingestion Exposure Route

1) Equations S1 through S3 form the basis for calculating Tier 2 remediation objectives for the soil ingestion exposure route using the SSL approach. Equation S1 is used to calculate soil remediation objectives for noncarcinogenic contaminants. Equations S2 and S3 are used to calculate soil remediation objectives for carcinogenic contaminants for residential populations and industrial/commercial and construction worker populations, respectively.

2) For Equations S1 through S3, the SSL default values cannot be modified with site-specific information.

~~3) For Equations S2 and S3, the only parameter that can be modified is the target cancer risk. A target cancer risk of more than 1 in 1,000,000 may be used if the applicable exposure routes have been managed through the use of institutional controls. The remaining parameters in Equations S2 and S3 are default values, and the corresponding numerical values in Appendix C, Table B must be used to calculate the Tier 2 SSL ingestion exposure route remediation objectives.~~

c) Inhalation Exposure Route

1) Equations S4 through S16, S26, and S27 are used to calculate Tier 2 soil remediation objectives for the inhalation exposure route using the SSL approach. To address this exposure route, volatiles must be evaluated separately from fugitive dust using their own equations set forth in subsections (c)(2) and (c)(3) of this Section, respectively.

2) Volatiles

A) Equations S4 through S10 are used to calculate Tier 2 soil remediation objectives for volatile contaminants based on the inhalation exposure route. Equation S4 is used to calculate soil

remediation objectives for noncarcinogenic volatile contaminants in soil for residential and industrial/commercial populations. Equation S5 is used to calculate soil remediation objectives for noncarcinogenic volatile contaminants in soil for construction worker populations. Equation S6 is used to calculate soil remediation objectives for carcinogenic volatile contaminants in soil for residential and industrial/commercial populations. Equation S7 is used to calculate soil remediation objectives for carcinogenic volatile contaminants in soil for construction worker populations. Equations S8 through S10, S27, and S28 are used for calculating numerical values for some of the parameters in Equations S4 through S7.

B) For Equation S4, a numerical value for the Volatilization Factor (VF) can be calculated in accordance with subsection (c)(2)(F) of this Section. The remaining parameters in Equation S4 have either SSL default values listed in Appendix C, Table B or toxicological-specific information (i.e., RfC), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

C) For Equation S5, a numerical value for the Volatilization Factor adjusted for Agitation (VF') can be calculated in accordance with subsection (c)(2)(G) of this Section. The remaining parameters in Equation S5 have either SSL default values listed in Appendix C, Table B or toxicological-specific information (i.e., RfC), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

D) For Equation S6, a numerical value for VF can be calculated in accordance with subsection (c)(2)(F) of this Section. The remaining parameters in Equation S6 have either default values listed in Appendix C, Table B or toxicological-specific information (i.e., URF), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

E) For Equation S7, a numerical value for VF' can be calculated in accordance with subsection (c)(2)(G) of this Section. The remaining parameters in Equation S7 have either default values listed in Appendix C, Table B or toxicological-specific information (i.e., URF), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

F) The VF can be calculated for residential and ~~commercial/industrial~~ industrial/commercial populations using one of the following

equations based on the information known about the contaminant source and receptor population:

i) Equation S8, in conjunction with Equation S10, is used to calculate VF assuming an infinite source of contamination~~.~~ or

ii) If the area and depth of the contaminant source are known or can be estimated reliably, mass limit considerations may be used to calculate VF using Equation S26.

G) The VF' can be calculated for the construction worker populations using one of the following equations based on the information known about the contaminant source:

i) Equation S9 is used to calculate VF' assuming an infinite source of contamination~~.~~ or

ii) If the area and depth of the contaminant source are known or can be estimated reliably, mass limit considerations may be used to calculate VF' using Equation S27.

3) Fugitive Dust

A) Equations S11 through S16 are used to calculate Tier 2 soil remediation objectives using the SSL fugitive dust model for the inhalation exposure route. Equation S11 is used to calculate soil remediation objectives for noncarcinogenic contaminants in fugitive dust for residential and industrial/commercial populations. Equation S12 is used to calculate soil remediation objectives for noncarcinogenic contaminants in fugitive dust for construction worker populations. Equation S13 is used to calculate soil remediation objectives for carcinogenic contaminants in fugitive dust for residential and industrial/commercial populations. Equation S14 is used to calculate soil remediation objectives for carcinogenic contaminants in fugitive dust for construction worker populations. Equations S15 and S16 are used for calculating numerical quantities for some of the parameters in Equations S11 through S14.

B) For Equation S11, a numerical value can be calculated for the Particulate Emission Factor (PEF) using Equation S15. This equation relies on various input parameters from a variety of sources. The remaining parameters in Equation S11 have either SSL default values listed in Appendix C, Table B or toxicological-

specific information (i.e., RfC), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

C) For Equation S12, a numerical value for the Particulate Emission Factor for Construction Worker (PEF') can be calculated using Equation S16. The remaining parameters in Equation S12 have either SSL default values listed in Appendix C, Table B or toxicological-specific information (i.e., RfC), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

D) For Equation S13, a numerical value for PEF can be calculated using Equation S15. The remaining parameters in Equation S13 have either default values listed in Appendix C, Table B or toxicological-specific information (i.e., URF), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

E) For Equation S14, a numerical value for PEF' can be calculated using Equation S16. The remaining parameters in Equation S14 have either default values listed in Appendix C, Table B or toxicological-specific information (i.e., URF), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

d) ~~Migration to Groundwater~~Soil Component ~~Portion~~of the Groundwater Ingestion Exposure Route

The Tier 2 remediation objective for the ~~migration to groundwater~~ soil component ~~portion~~of the groundwater ingestion exposure route can be calculated using one of the following equations based on the information known about the contaminant source and receptor population:

1) Equation S17 is used to calculate the remediation objective assuming an infinite source of contamination.

A) The numerical quantities for four parameters in Equation S17, the Target Soil Leachate Concentration (C_w), Soil-Water Partition Coefficient (K_d) for non-ionizing organics, Water-Filled Soil Porosity (θ_w), and Air-Filled Soil Porosity (θ_a) are calculated using Equations S18, S19, S20, and S21, respectively. Equations S22, S23, S24, and S25 are also needed to calculate numerical values for Equations S18 and S21. The pH-dependent K_d values for ionizing

organics can be calculated using Equation S19 and the pH-dependent K_{oc} values in Appendix C, Table I.

B) The remaining parameters in Equation S17 are Henry's Law Constant (H'), a chemical specific value listed in Appendix C, Table E and Dry Soil Bulk Density (ρ_b), a site-specific based value listed in Appendix C, Table B.

C) The default value for GW_{obj} is the Tier 1 groundwater objective. For chemicals for which there is no Tier 1 groundwater remediation objective, the value for GW_{obj} shall be the Health Advisory concentration determined according to the procedures specified in 35 Ill. Adm. Code 620, Subpart F. ~~As an alternative to using the Tier 1 groundwater remediation objectives or Health Advisories, a target risk for carcinogens greater than 1 in 1,000,000 may be used to calculate GW_{obj} using Equation S23, and a Target Hazard Quotient greater than 1.0 may be used to calculate GW_{obj} using the procedures of Subpart I, if approved institutional controls are in place as may be required in Subpart J.~~ As an alternative to using Tier 1 groundwater remediation objectives or Health Advisory concentrations, GW_{obj} may be developed using Equations R25 and R26, if approved institutional controls are in place as required in Subpart J.

2) If the area and depth of the contaminant source are known or can be estimated reliably, mass limit considerations may be used to calculate the remediation objective for this exposure route using Equation S28. The parameters in Equation S28 have default values listed in Appendix C, Table B.

Section 742.715 RBCA Soil Equations

a) This Section presents the RBCA model and describes the equations and parameters used to develop Tier 2 soil remediation objectives.

b) Ingestion, Inhalation, and Dermal Contact

1) The two sets of equations in subsections (b)(2) and (b)(3) of this Section shall be used to generate Tier 2 soil remediation objectives for the combined ingestion, inhalation, and dermal contact with soil exposure route.

2) Combined Exposure Routes of Soil Ingestion, Inhalation of Vapors and Particulates, and Dermal Contact with Soil

A) Equations R1 and R2 form the basis for deriving Tier 2 remediation objectives for the set of equations that evaluates the combined exposure routes of soil ingestion, inhalation of vapors and particulates, and dermal contact with soil using the RBCA approach. Equation R1 is used to calculate soil remediation objectives for carcinogenic contaminants. Equation R2 is used to calculate soil remediation objectives for noncarcinogenic contaminants. Soil remediation objectives for the ambient vapor inhalation (outdoor) route from subsurface soils must also be calculated in accordance with the procedures outlined in subsection (b)(3) of this Section and compared to the values generated from Equations R1 or R2. The smaller value (i.e., R1 and R2 compared to R7 and R8, respectively) from these calculations is the Tier 2 soil remediation objective for the combined exposure routes of soil ingestion, inhalation, and dermal contact with soil.

B) In Equation R1, numerical values are calculated for two parameters:

i) The volatilization factor for surficial soils (VF_{ss}) using Equations R3 and R4; and

ii) The volatilization factor for subsurface soils regarding particulates (VF_p) using Equation R5.

C) VF_{ss} uses Equations R3 and R4 to derive a numerical value. Equation R3 requires the use of Equation R6. Both equations must be used to calculate the VF_{ss}. The lowest calculated value from these equations must be substituted into Equation R1.

D) The remaining parameters in Equation R1 have either default values listed in Appendix C, Table D or toxicological-specific information (i.e., SF_o, SF_i), which can be obtained from IRIS or requested from the program under which the remediation is being performed.

E) For Equation R2, the parameters VF_{ss} and VF_p are calculated. The remaining parameters in Equation R2 have either default values listed in Appendix C, Table D or toxicological-specific information (i.e., RfD_o, RfD_i) , which can be obtained from IRIS or requested from the program under which the remediation is being performed.

F) For chemicals other than inorganics which do not have default values for the dermal absorption factor (RAF_d) in Appendix C, Table D, a dermal absorption factor of 0.5 shall be used for

Equations R1 and R2. For inorganics, dermal absorption may be disregarded (i.e., RAF_d=0).

3) Ambient Vapor Inhalation (outdoor) route from Subsurface Soils (soil below one meter)

A) Equations R7 and R8 form the basis for deriving Tier 2 remediation objectives for the ambient vapor inhalation (outdoor) route from subsurface soils using the RBCA approach. Equation R7 is used to calculate soil remediation objectives for carcinogenic contaminants. Equation R8 is used to calculate soil remediation objectives for noncarcinogenic contaminants.

B) For Equation R7, the carcinogenic risk-based screening level for air ($RBSL_{air}$) and the volatilization factor for soils below one meter to ambient air (VF_{samb}) have numerical values that are calculated using Equations R9 and R11, respectively. Both equations rely on input parameters from a variety of sources.

C) The noncarcinogenic risk-based screening level for air ($RBSL_{air}$) and the volatilization factor for soils below one meter to ambient air (VF_{samb}) in Equation R8 have numerical values that can be calculated using Equations R10 and R11, respectively.

c) ~~Migration to Groundwater~~Soil Component ~~Portion~~of the Groundwater Ingestion Exposure Route

1) Equation R12 forms the basis for deriving Tier 2 remediation objectives for the ~~migration to groundwater~~soil component ~~portion~~of the groundwater ingestion exposure route using the RBCA approach. The parameters, groundwater at the source (GW_{source}), and Leaching Factor (LF_{sw}), have numerical values that are calculated using Equations R13 and R14, respectively.

2) Equation R13 requires numerical values that are calculated using Equation R15.

3) Equation R14 requires numerical values that are calculated using Equations R21, R22, and R24. For non-ionizing organics, the Soil Water ~~Absorption~~ Sorption Coefficient (k_s) shall be calculated using Equation R20. For ionizing organics and inorganics, the values for k_s are listed in Appendix C, Tables I and J, respectively. The pH-dependent k_s values for ionizing organics can be calculated using Equation R20 and the pH-dependent K_{oc} values in Appendix C, Table I. The remaining parameters in Equation R14 are field measurements or default values listed in Appendix C, Table D.

d) The default value for GW_{comp} is the Tier 1 groundwater remediation objective. For chemicals for which there is no Tier 1 groundwater remediation objective, the value for GW_{comp} shall be the Health Advisory concentration determined according to the procedures specified in 35 Ill. Adm. Code 620, Subpart F. As an alternative to using the Tier 1 groundwater remediation objectives or Health Advisory~~ies~~ concentrations, ~~a target risk for carcinogens greater than 1 in 1,000,000 may be used to calculate GW_{comp} using Equation R25, and a Target Hazard Quotient greater than 1.0 may be used to calculate GW_{comp} using the procedures of Subpart I,~~ GW_{comp} may be developed using Equations R25 and R26, if approved institutional controls are in place as may be required in Subpart J.

Section 742.720 Chemicals with Cumulative Noncarcinogenic Effects

Appendix A, Table E lists the groups of chemicals from Appendix B, Tables A and B that have remediation objectives based on noncarcinogenic toxicity and that affect the same target organ. If more than one chemical detected at a site affects the same target organ (i.e., has the same critical effect as defined by the RfD), the initially calculated remediation value for each chemical in the group shall be corrected for cumulative effects by one of the following two methods:

a) Calculate the weighted average using the following equations:

$$W_{ave} = \frac{x_1}{CUO_{x_1}} + \frac{x_2}{CUO_{x_2}} + \frac{x_3}{CUO_{x_3}} + \ldots + \frac{x_a}{CUO_{x_a}}$$

where:

W_{ave}= Weighted Average

x_1 through x_a = Concentration of each individual contaminant at the location of concern. Note that, depending on the target organ/mode of action, the actual number of contaminants will range from 2 to 14.

$CUOx_a$ = A Tier 2 remediation objective must be developed for each x_a.

If the value of the weighted average calculated in accordance with the equations above is less than or equal to 1.0, then the remediation objectives are met for those chemicals.

If the value of the weighted average calculated in accordance with the equations above is greater than 1.0, then additional remediation must be carried out until the level of contaminants remaining in the remediated area have a weighted average calculated in accordance with the equation above less than or equal to one;

b) Divide each individual chemical's remediation objective by the number of chemicals in that specific target organ group that were detected at the site. Each of the contaminant concentrations at the site is then compared to the remediation objectives that have been adjusted to account for this potential additivity. For the noncarcinogenic contaminants listed in Appendix A, Table E, a respective soil remediation objective need be no lower than the respective value listed in Appendix B, Tables A or B.

SUBPART H: TIER 2 GROUNDWATER EVALUATION

Section 742.800 Tier 2 Groundwater Overview ~~General~~

If the contaminant concentrations in the groundwater exceed the applicable Tier 1 remediation objectives, a person has the following options:

a) Demonstrate that the groundwater ingestion exposure route is excluded from consideration pursuant to Subpart C;

b) Demonstrate that the groundwater contamination is at or below area background concentrations in accordance with Subpart D and, if necessary, an institutional control restricting usage of the groundwater is in place in accordance with Subpart J;

c) Remediate to Tier 1 remediation objectives;

d) ~~Develop~~ Propose and obtain approval of Tier 2 groundwater remediation objectives in accordance with Section 742.805 and remediate to that level, if necessary;

e) Conduct a Tier 3 evaluation in accordance with Subpart I; or

f) Obtain approval from the Board to:

1) Reclassify the groundwater pursuant to 35 Ill. Adm. Code 620.260; or

2) Use an adjusted standard pursuant to Section 28.1 of the Act. (415 ILCS 5/28.1)~~.~~

Section 742.805 Tier 2 Groundwater Remediation Objectives

a) To develop a groundwater remediation objective under this Section that exceeds the applicable Tier 1 groundwater remediation objective, a person may request approval from the Agency if the person has performed the following:

1) Identified the horizontal and vertical extent of groundwater for which the Tier 2 groundwater remediation objective is sought;

2) Taken corrective action, to the maximum extent practicable to remove any free product;

3) Using Equation R26 in accordance with Section 742.810, demonstrated that the concentration of any contaminant of concern in groundwater will meet:

   A) The applicable Tier 1 groundwater remediation objective at the point of human exposure; or

   B) For any contaminant of concern for which there is no Tier 1 groundwater remediation objective, the Health Advisory concentration determined according to the procedures specified in 35 Ill. Adm. Code 620, Subpart F at the point of human exposure. A person may request the Agency to provide these concentrations or may propose these concentrations under Subpart I;.

4) Using Equation R26 in accordance with Section 742.810, demonstrated that the concentration of any contaminant of concern in groundwater within the minimum or designated maximum setback zone of an existing potable water supply well will meet the applicable Tier 1 groundwater remediation objective or if there is no Tier 1 groundwater remediation objective, the Health Advisory concentration;

5) Using Equation R26 in accordance with Section 742.810, demonstrated that the concentration of any contaminant of concern in groundwater discharging into a surface water will meet the applicable ~~surface~~ water quality standard under 35 Ill. Adm. Code 302;

6) Demonstrated that the source of the release is not located within the minimum or designated maximum setback zone ~~of potable water supply well nor~~ or within a regulated recharge area of an existing potable water supply well; and

7) If the selected corrective action includes an engineered barrier as set forth in Subpart K to minimize migration of contaminant of concern from the soil to the groundwater, demonstrated that the engineered barrier will remain in place for post-remediation land use through an institutional control as set forth in Subpart J.

b) A groundwater remediation objective that exceeds the water solubility of that chemical (refer to Appendix C, Table E for solubility values) is not allowed.

c) Groundwater remediation objectives for chemicals which affect the same target organ, organ system or similar mode of action shall meet the requirements of Section 742.505(b)(3). Contaminants of concern for which a Tier 1 ~~or Tier 3~~ remediation objective has been developed shall be included in any mixture of similar-acting substances under consideration in Tier 2.

Section 742.810 Calculations to Predict Impacts from Remaining Groundwater Contamination

a) Equation R26 predicts the contaminant concentration along the centerline of a plume emanating from a vertical planar source in the aquifer (dimensions S_w wide and S_d deep). This model accounts for both three-dimensional dispersion (x is the direction of groundwater flow, y is the other horizontal direction, and z is the vertical direction) and biodegradation.

1) The parameters in this equation are:

~~A)~~ X = distance from the planar source to the location of concern, along the centerline of the plume (i.e., y=0, z=0)

~~B)~~ $C_{(x)}$ = the concentration of the contaminant at a distance X from the source, along the centerline of the plume

~~C)~~ $C_{(source)}$ = the greatest potential concentration of the contaminant of concern in the groundwater at the source of the contamination, based on the concentrations of contaminants in groundwater due to the release and the projected concentration of the contaminant migrating from the soil to the groundwater. As indicated above, the model assumes a planar source discharging groundwater at a concentration equal to $C_{(source)}$

~~D)~~ α_x = dispersivity in the x direction (i.e., Equation R16)

~~E)~~ α_y = dispersivity in the y direction (i.e., Equation R17)

~~F)~~ α_z = dispersivity in the z direction (i.e., Equation R18)

~~G)~~ U = specific discharge (i.e., actual groundwater flow velocity through a porous medium; takes into account the fact that the groundwater actually flows only through the pores of the subsurface materials), where the aquifer hydraulic conductivity (K~~k~~), ~~the infiltration rate (I),~~ the hydraulic gradient (i), and the total soil porosity (θ_T) must be known (i.e., Equation R19)~~.~~

~~H)~~ λ = first order degradation constant obtained from Appendix C, Table E or from measured groundwater data~~.~~

~~I)~~ S_w = width of planar source in the y direction

~~J)~~ S_d = depth of planar source in the z direction

2) The following parameters are determined through field measurements: U, K~~k~~, ~~I~~ i, θ_T, S_w, S_d.

A) The determination of values for U, K~~k~~, ~~I~~ i, and θ_T can be obtained through the appropriate laboratory and field techniques;

B) From the immediate down-gradient edge of the source of the groundwater contamination values for S_w and S_d shall be determined. S_w is defined as the width of groundwater at the source which exceeds the Tier 1 groundwater remediation objective. S_d is defined as the depth of groundwater at the source which exceeds the Tier 1 groundwater remediation objective; and ~~.~~

C) Total soil porosity can also be calculated using Equation R23.

~~3) The value of $C_{(source)}$ equals the greatest concentration of the contaminant in the groundwater at the source of the contamination.~~

b) Once values are obtained for all the input parameters identified in subsection (a) of this Section, the contaminant concentration along the centerline of the plume at a distance X from the source shall be calculated ~~such that that distance from the down-gradient edge of the source of the contamination at the site to the point where the contaminant concentration is equal to the Tier 1 groundwater remediation objective or Health Advisory concentration.~~

1) ~~To demonstrate that no existing potable water supply well is adversely impacted, X shall be the distance from the down-gradient edge of the source of the contamination at the site to the nearest water supply well. This calculation must show that the contaminant in the groundwater at this location ($C_{(x)}$), does not exceed the applicable Tier 1 groundwater remediation objective or Health Advisory concentration.~~ If there are any potable water supply wells located within the calculated distance X, then the Tier 1 groundwater remediation objective or Health Advisory concentration shall be met at the edge of the minimum or designated maximum setback zone of the nearest potable water supply well down-gradient of the source. If no potable water supply wells exist within the calculated distance X, then it can be determined that no existing potable water supply wells are adversely impacted.

2) To demonstrate that no surface water is adversely impacted, X shall be the distance from the down-gradient edge of the source of the contamination at the site to the nearest surface water body. This calculation must show that the contaminant in the groundwater at this location ($C_{(x)}$)~~,~~ does not exceed the applicable ~~surface~~ water quality standard.

SUBPART I: TIER 3 EVALUATION

Section 742.900 Tier 3 Overview ~~Introduction~~

a) Tier 3 sets forth a flexible framework to develop remediation objectives outside of the requirements of Tiers 1 and 2. Although Tier 1 evaluations and Tier 2 evaluations are not prerequisites to conduct Tier 3 evaluations, data from Tier 1 and Tier 2 can assist in developing remediation objectives under a Tier 3 evaluation.

b) The level of detail required to adequately characterize a site depends on the particular use of Tier 3. Tier 3 can require additional investigative efforts beyond those described in Tier 2 to characterize the physical setting of the site. However, in situations where remedial efforts have simply reached a physical obstruction ~~(e.g., a building),~~ additional investigation may not be necessary for a Tier 3 submittal.

c) Situations that can be considered for a Tier 3 evaluation include, but are not limited to:

1) Modification of parameters not allowed under Tier 2 ~~(e.g., a target hazard quotient greater than 1 is requested)~~ ;

2) Use of models different from those used in Tier 2;

3) Use of additional site data to improve or confirm predictions of exposed receptors to contaminants of concern;

4) Analysis of site-specific risks using formal risk assessment, probabilistic data analysis, and sophisticated fate and transport models (e.g., requesting a target hazard quotient greater than 1 or a target cancer risk greater than 1 in 1,000,000) ;

5) Requests for site-specific remediation objectives because an ~~"common sense"~~ assessment indicates further remediation is not practical ~~(e.g., the remaining contamination is under a structure such as a permanent building)~~;

6) Incomplete human exposure pathway(s) not excluded under Subpart C;

7) Use of toxicological-specific information not available from the sources listed in Tier 2; and

8) Land uses which are substantially different from the assumed residential or industrial/commercial property uses of a site (e.g., a s site will be used for recreation in the future and cannot be evaluated in Tiers 1 or 2).

9) Requests for site-specific remediation objectives which exceed Tier 1 groundwater remediation objectives so long as the following is demonstrated:

A) TO THE EXTENT PRACTICAL, THE EXCEEDANCE OF THE GROUNDWATER QUALITY STANDARD HAS BEEN MINIMIZED AND BENEFICIAL USE APPROPRIATE TO THE GROUNDWATER THAT WAS IMPACTED HAS BEEN RETURNED; AND

B) ANY THREAT TO HUMAN HEALTH OR THE ENVIRONMENT HAS BEEN MINIMIZED. (Section 58.5(D)(4)(A))

d) For requests of a target cancer risk ranging between 1 in 1,000,000 and 1 in 10,000 at the point of human exposure or a target hazard quotient greater than 1 at the point of human exposure, the requirements of Section 742.915 shall be followed. Requests for a target cancer risk exceeding 1 in 10,000 at the point of human exposure are not allowed.

~~d~~e) Requests for approval of a Tier 3 evaluation must be submitted to the Agency for review under the specific program under which remediation is performed. When reviewing a submittal under Tier 3, the Agency shall consider WHETHER THE INTERPRETATIONS AND CONCLUSIONS REACHED ARE SUPPORTED

BY THE INFORMATION GATHERED. (Section 58.7(e)(1) of the Act) The Agency shall approve a Tier 3 evaluation if the person submits the information required under this Part and establishes through such information that public health is protected and that specified risks to human health and the environment have been minimized.

Section 742.905 Modifications of Parameters

Any proposed changes to Tier 2 parameters which are not provided for in Tier 2 shall be submitted to the Agency for review and approval. A submittal under this Section shall include the following information:

a) The justification for the modification; and

b) The technical and mathematical basis for the modification.

Section 742.910 Alternative Models

Any proposals for the use of models other than those specified in Tier 2 shall be submitted to the Agency for review and approval. A submittal under this Section shall include the following information:

a) Physical and chemical properties of contaminants of concern;

b) Contaminant movement properties;

c) Contaminant availability to receptors;

d) Receptor exposure to the contaminants of concern;

e) Mathematical and technical justification for the model proposed;

f) A licensed copy of the model, if the Agency does not have a licensed copy of the model currently available for use; and

g) Demonstration that the models were correctly applied.

Section 742.915 Formal Risk Assessments

A comprehensive site-specific risk assessment shall demonstrate that contaminants of concern at a site do not pose a significant risk to any human receptor. All site-specific risk assessments shall be submitted to the Agency for review and approval. A submittal under this Section shall address the following factors:

a) Whether the risk assessment procedure used is nationally recognized and accepted including, but not limited to, those procedures incorporated by reference in Section 742.210;

b) Whether the site-specific data reflect actual site conditions;

c) The adequacy of the investigation of present and post-remediation exposure routes and risks to receptors identified at the site;

d) The appropriateness of the sampling and analysis;

e) The adequacy and appropriateness of toxicity information;

f) The extent of contamination; ~~and~~

g) Whether the calculations were accurately performed; and~~.~~

h) Proposals seeking to modify the target risk consistent with Section 742.900(d) shall address the following factors:

1) the presence of sensitive populations;

2) the number of receptors potentially impacted;

3) the duration of risk at the differing target levels; and

4) the characteristics of the chemical of concern.

Section 742.920 Impractical Remediation

Any request for site-specific remediation objectives due to impracticality of remediation shall be submitted to the Agency for review and approval. A submittal under this Section shall include the following information:

a) The reason(s) why the remediation is impractical;

b) The extent of contamination;

c) Geology, including soil types;

d) The potential impact to groundwater;

e) Results and locations of sampling events;

f) Map of the area, including all utilities and structures; and

g) Present and post-remediation uses of the area of contamination, including human receptors at risk.

Section 742.925 Exposure Routes

Technical information may demonstrate that there is no actual or potential impact of contaminants of concern to receptors from a particular exposure route. In these instances, a demonstration excluding an exposure route shall be submitted to the Agency for review and approval. A submittal under this Section shall include the following information:

a) A description of the route evaluated;

b) Technical support including a discussion of the natural or man-made barriers to exposure through that route, calculations, and modeling results;

c) Physical and chemical properties of contaminants of concern;

d) Contaminant migration properties;

e) Description of the site and physical site characteristics; and

f) Discussion of the result and possibility of the route becoming active in the future.

Section 742.930 Derivation of Toxicological Data

If toxicological-specific information is not available for one or more contaminants of concern from the sources incorporated by reference in Section 742.210, the derivations of toxicological-specific information shall be submitted for Agency review and approval.

~~Section 742.935 Agricultural Uses and Ecological Receptors (Reserved)~~

SUBPART J: INSTITUTIONAL CONTROLS

Section 742.1000 Institutional Controls~~General~~

a) ~~Any person who develops remediation objectives under this Part based on an industrial/commercial property use or based on engineered barriers under Subpart K shall meet the requirements of this Subpart relative to institutional controls.~~ Institutional controls in accordance with this Subpart must be ~~in place~~ placed on the property when remediation objectives are based on any of the following assumptions:

1) Industrial/Commercial property use;

2) Target cancer risk greater than 1 in 1,000,000;

3) Target hazard quotient greater than 1;

4) Engineered barrier(s); ~~or~~

5) ~~Any combination of the above.~~The point of human exposure is located at a place other than at the source;

6) Exclusion of exposure routes under Subpart C; or

~~5~~ 7) Any combination of the above.

b) The Agency shall not approve any remediation objective under this Part that is based on the use of institutional controls unless the person has proposed institutional controls meeting the requirements of this Subpart and the requirements of the specific program under which the institutional control is proposed. A proposal for approval of institutional controls shall provide identification of the selected institutional controls from among the types recognized in this Subpart.

c) The following instruments ~~types of~~ may be institutional controls, subject to the requirements of this Subpart J and the requirements of the specific program under which the institutional control is proposed ~~are recognized under this Subpart~~:

1) No Further Remediation Letters;

2) Restrictive covenants and deed restrictions;

3) Negative easements;

4) Ordinances adopted and administered by a unit of local government; and

5) Agreements between a property owner and a highway authority with respect to any contamination remaining under highways.

~~BOARD NOTE: Definition in the Illinois Highway Code for "highway authority", "highway", and "right of way" are applicable to this Part.~~

d) An institutional control is transferred with the property.

Section 742.1005 No Further Remediation Letters

a) A No Further Remediation Letter issued by the Agency under Part 732 or 742 may be used as an institutional control under this Part if the requirements of subsection (b) of this Section are met~~and the Agency has determined that no further remediation is required as to the property(ies) to which the letter is to apply~~.

b) A request for approval of a No Further Remediation Letter as an institutional control shall ~~follow~~ shall meet the requirements applicable to the ~~remediation~~ specific program under which the remediation is performed.

~~c) The recipient of the letter shall submit the letter to the Office of the Recorder or the Registrar of Titles of the county in which the site is located within 45 days of receipt of the letter in such a manner that it forms a permanent part of the chain of title for the site. Proper recording of the "No Further Remediation" letter shall consist of adding the letter and an Environmental Notice form to other public documents that would normally be examined during a title search.~~

~~d) A "No Further Remediation" letter shall not become effective until officially recorded in accordance with subsection (c) of this Section. The recipient of the letter shall obtain and submit to the Agency a copy of the letter demonstrating that it has been recorded.~~

~~e) At no time shall any site for which land use has been restricted under a "No Further Remediation" letter be used in a manner inconsistent with such land use limitation unless further investigation or remedial action has been conducted that documents the attainment of objectives appropriate for the new land use and a new letter is obtained and recorded in accordance with subsection (c) of this Section.~~

~~f) Violation of the terms of a No Further Remediation Letter shall be grounds for voidance of the Letter and the Agency's "No Further Remediation" determination in accordance with the procedures applicable to the remediation program under which the remediation is performed.~~

Section 742.1010 Restrictive Covenants, Deed Restrictions, and Negative Easements

a) A restrictive covenant, deed restriction, or negative easement may be used as an institutional control under this Part if the requirements of this Section are met and the Agency has determined that ~~"~~ no further remediation~~"~~ is required as to the property(ies) to which the institutional control is to apply.

b) A request for approval of a restrictive covenant, deed restriction, or negative easement as an acceptable institutional control~~,~~ shall provide the following:

1) A copy of the restrictive covenant, deed restriction, or negative easement in the form it will be recorded with the Office of the Recorder or Registrar of Titles in the county where the site is located~~. The restrictive covenant, deed restriction, or negative easement shall reference or incorporate the terms of the "No Further Remediation determination so as to require any current owners and all successors in interest to meet the requirements of the "No Further Remediation" determination as a condition of use of the property~~;

2) A scaled map showing the horizontal extent of contamination above the applicable remediation objectives;

3) Information showing the concentration of contaminants of concern in which the applicable remediation objectives are exceeded;

4) A scaled map showing the legal boundaries of all properties under which contamination is located that exceeds the applicable remediation objectives and which are subject to the restrictive covenant, deed restriction, or negative easement~~subject to the restrictive covenant, deed restriction, or negative easement under which contamination is located that exceeds the applicable remediation objectives~~;

5) Information identifying the current owner(s) of each property identified in subsection (b)(4) of this Section; and

6) Authorization by the current owner(s), or person authorized by law to act on behalf of the owner, of each property identified in subsection (b)(5) of this Section to record the restrictive covenant or deed restriction.

c) Any restrictive covenant, deed restriction, or negative easement approved by the Agency pursuant to this Section shall be recorded in the Office of the Recorder or Registrar of Titles of the county in which the site is located together with the instrument memorializing the Agency's no further remediation determination pursuant to the specific program within 45 days after receipt of the Agency's no further remediation determination.~~Any restrictive covenant, deed restriction, or negative easement approved by the Agency pursuant to this Part shall be recorded with the "No Further Remediation" determination in the Office of the Recorder or the Registrar of Titles of the county in which the site is located within 45 days of receipt of the Agency approval in accordance with Section 742.1005(c)~~

d) An institutional control approved under this Section shall not become effective until officially recorded in accordance with subsection (c) of this Section. The person receiving the approval shall obtain and submit to the Agency within 30 days after recording a copy of the institutional control demonstrating that ~~is~~ it has been recorded.

e) At no time shall any site for which land use has been restricted under an institutional control approved under this Section be used in a manner inconsistent with such land use limitation unless further investigation or remedial action has been conducted that documents the attainment of remediation objectives appropriate for such land use and a new institutional control, if necessary, is approved and recorded in accordance with subsection (c) of this Section.

f) Violation of the terms of an institutional control approved under this Section shall be grounds for voidance of the institutional control and the instrument memorializing the Agency's ~~"N~~no ~~F~~further ~~R~~remediation~~"~~ determination ~~pursuant to Section 58.10 of Act~~.

Section 742.1015 Ordinances

a) An ordinance adopted by a unit of local government that effectively prohibits the installation of potable water supply wells (and the use of such wells) ~~use of groundwater as a potable supply of water, except at points of withdrawal by the unit of local government,~~ may be used as an institutional control to meet the requirements of Sections 742.320(d) or 742.805(a)(3) if the requirements of this Section are met. Ordinances prohibiting the installation of potable water supply wells (and the use of such wells) that do not expressly prohibit the installation of potable water supply wells (and the use of such wells) by units of local government may be acceptable as institutional controls if the requirements of this Section are met and a Memorandum of Understanding (MOU) is entered into under subsection (i) of this Section.

b) A request for approval of a local ordinance as an institutional control shall provide the following:

1) A copy of the ordinance restricting groundwater use certified by an official of the unit of local government in which the site is located~~,~~ that it is the latest, most current copy of the ordinance, unless the Agency and the unit of local government have entered an agreement under subsection (i) of this Section, in which case the request may alternatively reference the ~~Memorandum of Understanding (~~MOU~~)~~. The ordinance must demonstrate that potable use of groundwater from potable water supply wells is prohibited;

2) A scaled map(s) delineating the areal extent of groundwater contamination (measured or modeled) above the applicable remediation objectives;

3) Information showing the concentration of contaminants of concern in which the applicable remediation objectives are exceeded;

4) A scaled map delineating the boundaries of all properties under which groundwater is located which exceeds the applicable groundwater remediation objectives;

5) Information identifying the current owner(s) of each property identified in subsection (b)(4) of this Section; and

6) A copy of the proposed submission of the information to the current owners identified in subsection (b)(5) of this Section of the information required in subsections (b)(1) through (b)(5) of this Section and proof that the notification required in subsection (c) of this Section has been submitted.

c) Each of the property owners identified in subsection (b)(5) of this Section and the unit of local government must receive written notification from the party desiring to use the institutional control that groundwater remediation objectives have been approved by the Agency. Written proof of this notification shall be submitted to the Agency within 45 days from the date of the instrument memorializing the Agency's ~~"N~~no ~~F~~further ~~R~~remediation~~"~~ ~~Letter or~~ determination. The notification shall include:

1) The name and address of the unit of local government;

2) The citation to the ordinance;

3) A description of the property being sent notice by adequate legal description or by reference to a plat showing the boundaries;

4) A statement that the ordinance restricting groundwater use has been used by the Agency in reviewing a request for a groundwater remediation objective;

5) A statement as to the nature of the release and response action with the site name, address, and Agency site number or Illinois inventory identification number; and

6) A statement as to where more information may be obtained regarding the ordinance.

d) Unless the Agency and the unit of local government have entered into a MOU~~an agreement~~ under subsection (i) of this Section, the current owner or successors in interest of a site who have received approval of use of an ordinance as an institutional control under this Section shall:

1) Monitor activities of the unit of local government relative to variance requests or changes in the ordinance relative to the use of potable groundwater at properties identified in subsection (b)(4) of this Section; and

2) Notify the Agency of any approved variance requests or ordinance changes within ~~thirty (~~30~~)~~ days after the date such action has been approved.

e) The information required in subsections (b)(1) through (b)(6) of this Section and the Agency letter approving the groundwater remediation objective shall be submitted to the unit of local government. Proof that the information has been filed with the unit of local government shall be provided to the Agency.

f) Any ordinance or MOU used as an institutional control pursuant to this Section shall be recorded in the Office of the Recorder or Registrar of Titles of the county in which the site is located together with the instrument memorializing the Agency's no further remediation determination pursuant to the specific program within 45 days after receipt of the Agency's no further remediation determination~~Unless the Agency and the unit of local government have entered an agreement under subsection (i) of this Section, a site owner who has received approval of use of an ordinance as an institutional control under this Section shall record as an institutional control under Section 742.1005 or Section 742.1010, as applicable, the site owner's duties under subsection (d) of this Section to monitor activities of the unit of local government~~.

g) An institutional control approved under this Section shall not become effective until ~~the site owner's duties under subsection (d) of this Section are~~ officially recorded in accordance with subsection (f) of this Section. The person receiving the approval shall obtain and submit to the Agency within 30 days after recording a copy of the institutional control demonstrating that it has been recorded.

h) The following shall be grounds for voidance of the ordinance as an institutional control and the instrument memorializing the Agency's ~~"N~~no ~~F~~further ~~R~~remediation~~"~~ determination:

1) Modification of the ordinance by the unit of local government to allow potable use of groundwater;

2) Approval of a site-specific request, such as a variance, to allow potable use of groundwater at a site identified in subsection (b)(4) of this Section; or ~~and~~

3) Violation of the terms of an institutional control recorded under Section 742.1005 or Section 742.1010.

i) The Agency and a unit of local government may enter into a ~~memorandum of understanding(~~MOU~~)~~ under this Section if the unit of local government has adopted an ordinance satisfying subsection (a) of this Section ~~that effectively prohibits the use of groundwater as a potable supply of water, except at points of withdrawal by the unit of local government,~~ and if the requirements of this subsection are met. The MOU shall include the following:

1) Identification of the authority of the unit of local government to enter the MOU;

2) Identification of the legal boundaries, or equivalent, under which the ordinance is applicable;

3) A certified copy of the ordinance;

4) A commitment by the unit of local government to notify the Agency of any variance requests or proposed ordinance changes at least ~~thirty (~~30~~)~~ days prior to the date the local government is scheduled to take action on the request or proposed change; ~~and~~

5) A commitment by the unit of local government to maintain a registry of all sites within the unit of local government that have received ~~"N~~no ~~F~~further ~~R~~remediation~~"~~ determinations pursuant to specific programs~~under this Part;~~ and~~.~~

6) If the ordinance does not expressly prohibit the installation of potable water supply wells (and the use of such wells) by units of local government, a commitment by the unit of local government:

A) To review the registry of sites established under subsection (i)(5) of this Section prior to siting potable water supply wells within the area covered by the ordinance;

B) To determine whether the potential source of potable water may be or has been affected by contamination left in place at those sites; and

C) To take whatever steps are necessary to ensure that the potential source of potable water is protected from the contamination or treated before it is used as a potable water supply.

Section 742.1020 Highway Authority Agreements

a) An agreement with a highway authority may be used as an institutional control where the requirements of this Section are met and the Agency has determined that

~~"~~no further remediation~~"~~ is required as to the property(ies) to which the agreement is to apply.

b) As part of the agreement the highway authority shall agree to:

1) Prohibit the use of groundwater under the highway right of way that is contaminated above residential Tier 1 remediation objectives from the release as a potable supply of water.

2) Limit access to soil contamination under the highway right of way that is contaminated above residential Tier 1 remediation objectives from the release. Access to soil contamination may be allowed if, during and after any access, public health and the environment are protected.

c) A request for approval of an agreement as an institutional control shall provide the following:

1) A copy of the agreement executed by the highway authority and the owner of the property from which the release occurred;

2) A scaled map delineating the areal extent of soil and groundwater contamination above the applicable Tier 1 remediation objectives;

3) Information showing the concentration of contaminants of concern within the zone in which the applicable Tier 1 remediation objectives are exceeded;

4) A stipulation of the information required by subsection (b) of this Section in the agreement if it is not practical to obtain the information by sampling the highway right-of-way; and

5) Information identifying the current fee owner of the highway right-of-way and highway authority having jurisdiction.

d) Violation of the terms of an Agreement approved by the Agency as an institutional control under this Section shall be grounds for voidance of the Agreement as an institutional control and the instrument memorializing the Agency's ~~"~~Nno ~~F~~further ~~R~~remediation~~"~~ determination.

SUBPART K: ENGINEERED BARRIERS

Section 742.1100 Engineered Barriers~~General~~

a) Any person who develops remediation objectives under this Part based on engineered barriers shall meet the requirements of this Subpart and the requirements of Subpart J relative to institutional controls.

b) The Agency shall not approve any remediation objective under this Part that is based on the use of engineered barriers unless the person has proposed engineered barriers meeting the requirements of this Subpart.

c) The use of engineered barriers can be recognized in calculating remediation objectives only if the engineered barriers are intended for use as part of the final corrective action.

d) Any ~~"N~~no ~~F~~further ~~R~~remediation~~"~~ determination based upon the use of engineered barriers shall require effective maintenance of the engineered barrier. The maintenance requirements shall be included in an institutional control under Subpart J. ~~and are to be maintained by the owner of the site. This responsibility shall be transferable with the property.~~ This institutional control shall address provisions for temporary breaches of the barrier by requiring the following if intrusive construction work is to be performed in which the engineered barrier is to be temporarily breached:

1) The construction workers shall be notified by the site owner/operator in advance of intrusive activities. Such notification shall enumerate the contaminant of concern known to be present; and

2) The site owner/operator shall require construction workers to implement protective measures consistent with good industrial hygiene practice.

e) Failure to maintain an engineered barrier in accordance with the ~~"N~~no ~~F~~further ~~R~~remediation~~"~~ determination shall be grounds for voidance of th~~e~~at determination and the instrument memorializing the Agency's no further remediation determination.

Section 742.1105 Engineered Barrier Requirements

a) Natural attenuation, access controls, and point of use treatment shall not be considered engineered barriers. Engineered barriers may not be used to prevent direct human exposure to groundwater without the use of institutional controls.

b) For purposes of determining remediation objectives under Tier 1, engineered barriers are not recognized.

c) The following engineered barriers are recognized for purposes of calculating remediation objectives that exceed residential remediation objectives:

1) For the ~~migration to groundwater~~soil component ~~portion~~of the groundwater ingestion exposure route, the following engineered barriers are recognized:

   A) Caps, covering the contaminated media, constructed of compacted clay, asphalt, concrete or other material approved by the Agency; and

   B) Permanent structures such as buildings and highways.

2) For the soil ingestion exposure route, the following engineered barriers are recognized:

   A) Caps, covering the contaminated media, constructed of compacted clay, asphalt, concrete, or other material approved by the Agency;

   B) Permanent structures such as buildings and highways; and

   C) Clean soil, covering the contaminated media, that is a minimum of ~~one (1) meter~~ 3 feet in depth.

3) For the inhalation exposure route, the following engineered barriers are recognized:

   A) Caps, covering the contaminated media, constructed of compacted clay, asphalt, concrete, or other material approved by the Agency; ~~and~~

   B) Permanent structures such as buildings and highways~~.~~ ; and

   C) Clean soil covering the contaminated media, that is a minimum of ~~ten (~~10~~)~~ feet in depth and not within ~~ten (~~10~~)~~ feet of any manmade pathway.

4) For the ingestion of groundwater exposure route, the following engineered barriers are recognized:

   A) Slurry walls; and

   B) Hydraulic control of groundwater.

d) Unless otherwise prohibited under Section 742.1100, any other type of engineered barrier may be proposed if it will be as effective as the options listed in subsection (c) of this Section.

Section 742.APPENDIX A: General

TABLE A: Soil Saturation Limits (C_{sat}) for Chemicals Whose Melting Point is Less than 30° C.

CAS No.	Chemical Name	C_{sat} (mg/kg)
67-64-1	Acetone	100,000
71-43-2	Benzene	870
111-44-4	Bis(2-chloroethyl)ether	3,300
117-81-7	Bis(2-ethylhexyl)phthalate	31,000
75-27-4	Bromodichloromethane (Dichlorobromomethane)	3,000
75-25-2	Bromoform	1,900
71-36-3	Butanol	10,000
85-68-7	Butyl benzyl phthalate	930
75-15-0	Carbon disulfide	720
56-23-5	Carbon tetrachloride	1,100
108-90-7	Chlorobenzene (Monochlorobenzene)	680
124-48-1	Chlorodibromomethane (Dibromochloromethane)	1,300
67-66-3	Chloroform	2,900
96-12-8	1,2-Dibromo-3-chloropropane	1,400
106-93-4	1,2-Dibromoethane (Ethylene dibromide)	2,800
84-74-2	Di-*n*-butyl phthalate	2,300
95-50-1	1,2-Dichlorobenzene (o-Dichlorobenzene)	560
75-34-3	1,1-Dichloroethane	1,700
107-06-2	1,2-Dichloroethane (Ethylene dichloride)	1,800
75-35-4	1,1-Dichloroethylene	1,500
156-59-2	*cis*-1,2-Dichloroethylene	1,200
156-60-5	*trans*-1,2-Dichloroethylene	3,100
78-87-5	1,2-Dichloropropane	1,100
542-75-6	1,3-Dichloropropene (1,3-Dichloropropylene, *cis* + *trans*)	1,400

CAS No.	Chemical Name	C_{sat} (mg/kg)
84-66-2	Diethyl phthalate	2,000
117-84-0	Di-*n*-octyl phthalate	10,000
100-41-4	Ethylbenzene	400
77-47-4	Hexachlorocyclopentadiene	2,200
78-59-1	Isophorone	4,600
74-83-9	Methyl bromide (Bromomethane)	3,200
75-09-2	Methylene chloride (Dichloromethane)	2,400
98-95-3	Nitrobenzene	1,000
100-42-5	Styrene	1,500
127-18-4	Tetrachloroethylene (Perchloroethylene)	240
108-88-3	Toluene	650
120-82-1	1,2,4-Trichlorobenzene	3,200
71-55-6	1,1,1-Trichloroethane	1,200
79-00-5	1,1,2-Trichloroethane	1,800
79-01-6	Trichloroethylene	1,300
108-05-4	Vinyl acetate	2,700
75-01-4	Vinyl chloride	1,200
108-38-3	m-Xylene	420
95-47-6	o-Xylene	410
106-42-3	p-Xylene	460
1330-20-7	Xylenes (total)	410
	Ionizable Organics	
95-57-8	2-Chlorophenol	53,000

Section 742.APPENDIX A: General

TABLE B: Tolerance Factor (K)

Tolerance factors (K) for one-sided normal tolerance intervals with probability level (confidence factor) Y = 0.95 and coverage P = 95%. n = number of samples collected.

n	K	n	K
3	7.655	350	1.787
4	5.145	375	1.782
5	4.202	400	1.777
6	3.707	425	1.773
7	3.399	450	1.769
8	3.188	475	1.766
9	3.031	500	1.763
10	2.911	525	1.760
11	2.815	550	1.757
12	2.736	575	1.754
13	2.670	600	1.752
14	2.614	625	1.750
15	2.566	650	1.748
16	2.523	675	1.746
17	2.486	700	1.744
18	2.543	725	1.742
19	2.423	750	1.740
20	2.396	775	1.739
21	2.371	800	1.737
22	2.350	825	1.736
23	2.329	850	1.734
24	2.309	875	1.733
25	2.292	900	1.732
30	2.220	925	1.731
35	2.166	950	1.729
40	2.126	975	1.728
45	2.092	1000	1.727
50	2.065		
55	2.036		
60	2.017		
65	2.000		
70	1.986		
75	1.972		
100	1.924		
125	1.891		
150	1.868		
175	1.850		
200	1.836		
225	1.824		
250	1.814		
275	1.806		
300	1.799		
325	1.792		

Section 742.APPENDIX A: General

TABLE C: Coefficients $\{A_{N-I+1}\}$ for W Test of Normality, for N=2(1)50

i/n	2	3	4	5	6	7	8	9	10	
1	0.7071	0.7071	0.6872	0.6646	0.6431	0.6233	0.6052	0.5888	0.5739	
2	---	.0000	.1677	.2413	.2806	.3031	.3164	.3244	.3291	
3	---	---	---	.0000	.0875	.1401	.1743	.1976	.2141	
4	---	---	---	---	---	.0000	.0561	.0947	.1224	
5	---	---	---	---	---	---	---	.0000	.0399	
i/n	11	12	13	14	15	16	17	18	19	20
1	0.5601	0.5475	0.5359	0.5251	0.5150	0.5056	0.4968	0.4886	0.4808	0.4734
2	.3315	.3325	.3325	.3318	.3306	.3290	.3273	.3253	.3232	.3211
3	.2260	.2347	.2412	.2460	.2495	.2521	.2540	.2553	.2561	.2565
4	.1429	.1586	.1707	.1802	.1878	.1939	.1988	.2027	.2059	.2085
5	.0695	.0922	.1099	.1240	.1353	.1447	.1524	.1587	.1641	.1686
6	0.0000	0.0303	0.0539	0.0727	0.0880	0.1005	0.1109	0.1197	0.1271	0.1334
7	---	---	.0000	.0240	.0433	.0593	.0725	.0837	.0932	.1013
8	---	---	---	---	.0000	.0196	.0359	.0496	.0612	.0711
9	---	---	---	---	---	---	.0000	.0163	.0303	.0422
10	---	---	---	---	---	---	---	---	.0000	.0140

i/n	21	22	23	24	25	26	27	28	29	30
1	0.4643	0.4590	0.4542	0.4493	0.4450	0.4407	0.4366	0.4328	0.4291	0.4254
2	.3185	.3156	.3126	.3098	.3069	.3043	.3018	.2992	.2968	.2944
3	.2578	.2571	.2563	.2554	.2543	.2533	.2522	.2510	.2499	.2487
4	.2119	.2131	.2139	.2145	.2148	.2151	.2152	.2151	.2150	.2148
5	.1736	.1764	.1787	.1807	.1822	.1836	.1848	.1857	.1864	.1870
6	0.1399	0.1443	0.1480	0.1512	0.1539	0.1563	0.1584	0.1601	0.1616	0.1630
7	.1092	.1150	.1201	.1245	.1283	.1316	.1346	.1372	.1395	.1415
8	.0804	.0878	.0941	.0997	.1046	.1089	.1128	.1162	.1192	.1219
9	.0530	.0618	.0696	.0764	.0823	.0876	.0923	.0965	.1002	.1036
10	.0263	.0368	.0459	.0539	.0610	.0672	.0728	.0778	.0822	.0862
11	0.0000	0.0122	0.0228	0.0321	0.0403	0.0476	0.0540	0.0598	0.0650	0.0697
12	---	---	.0000	.0107	.0200	.0284	.0358	.0424	.0483	.0537
13	---	---	---	---	.0000	.0094	.0178	.0253	.0320	.0381
14	---	---	---	---	---	---	.0000	.0084	.0159	.0227
15	---	---	---	---	---	---	---	---	.0000	.0076

i/n	31	32	33	34	35	36	37	38	39	40
1	0.4220	0.4188	0.4156	0.4127	0.4096	0.4068	0.4040	0.4015	0.3989	0.3964
2	.2921	.2898	.2876	.2854	.2834	.2813	.2794	.2774	.2755	.2737
3	.2475	.2463	.2451	.2439	.2427	.2415	.2403	.2391	.2380	.2368
4	.2145	.2141	.2137	.2132	.2127	.2121	.2116	.2110	.2104	.2098
5	.1874	.1878	.1880	.1882	.1883	.1883	.1883	.1881	.1880	.1878
i/n	31	32	33	34	35	36	37	38	39	40
6	0.1641	0.1651	0.1660	0.1667	0.1673	0.1678	0.1683	0.1686	0.1689	0.1691
7	.1433	.1449	.1463	.1475	.1487	.1496	.1503	.1513	.1520	.1526
8	.1243	.1265	.1284	.1301	.1317	.1331	.1344	.1356	.1366	.1376
9	.1066	.1093	.1118	.1140	.1160	.1179	.1196	.1211	.1225	.1237
10	.0899	.0931	.0961	.0988	.1013	.1036	.1056	.1075	.1092	.1108
11	0.0739	0.0777	0.0812	0.0844	0.0873	0.0900	0.0924	0.0947	0.0967	0.0986
12	.0585	.0629	.0669	.0706	.0739	.0770	.0798	.0824	.0848	.0870
13	.0435	.0485	.0530	.0572	.0610	.0645	.0677	.0706	.0733	.0759
14	.0289	.0344	.0395	.0441	.0484	.0523	.0559	.0592	.0622	.0651
15	.0144	.0206	.0262	.0314	.0361	.0404	.0444	.0481	.0515	.0546

16	0.0000	0.0068	0.0131	0.0187	0.0239	0.0287	0.0331	0.0372	0.0409	0.0444
17	---	---	.0000	.0062	.0119	.0172	.0220	.0264	.0305	.0343
18	---	---	---	---	.0000	.0057	.0110	.0158	.0203	.0244
19	---	---	---	---	---	---	.0000	.0053	.0101	.0146
20	---	---	---	---	---	---	---	---	.0000	.0049
i/n	41	42	43	44	45	46	47	48	49	50
1	0.3940	0.3917	0.3894	0.3872	0.3850	0.3830	0.3808	0.3789	0.3770	0.3751
2	.2719	.2701	.2684	.2667	.2651	.2635	.2620	.2604	.2589	.2574
3	.2357	.2345	.2334	.2323	.2313	.2302	.2291	.2281	.2271	.2260
4	.2091	.2085	.2078	.2072	.2065	.2058	.2052	.2045	.2038	.2032
5	.1876	.1874	.1871	.1868	.1865	.1862	.1859	.1855	.1851	.1847
i/n	41	42	43	44	45	46	47	48	49	50
6	0.1693	0.1694	0.1695	0.1695	0.1695	0.1695	0.1695	0.1693	0.1692	0.1691
7	.1531	.1535	.1539	.1542	.1545	.1548	.1550	.1551	.1553	.1554
8	.1384	.1392	.1398	.1405	.1410	.1415	.1420	.1423`	.1427	.1430
9	.1249	.1259	.1269	.1278	.1286	.1293	.1300	.1306	.1312	.1317
10	.1123	.1136	.1149	.1160	.1170	.1180	.1189	.1197	.1205	.1212

11	0.1004	0.1020	0.1035	0.1049	0.1062	0.1073	0.1085	0.1095	0.1105	0.1113
12	.0891	.0909	.0927	.0943	.0959	.0972	.0986	.0998	.1010	.1020
13	.0782	.0804	.0824	.0842	.0860	.0876	.0892	.0906	.0919	.0932
14	.0677	.0701	.0724	.0745	.0775	.0785	.0801	.0817	.0832	.0846
15	.0575	.0602	.0628	.0651	.0673	.0694	.0713	.0731	.0748	.0764
16	0.0476	0.0506	0.0534	0.0560	0.0584	0.0607	0.0628	0.0648	0.0667	0.0685
17	.0379	.0411	.0442	.0471	.0497	.0522	.0546	.0568	.0588	.0608
18	.0283	.0318	.0352	.0383	.0412	.0439	.0465	.0489	.0511	.0532
19	.0188	.0227	.0263	.0296	.0328	.0357	.0385	.0411	.0436	.0459
20	.0094	.0136	.0175	.0211	.0245	.0277	.0307	.0335	.0361	.0386
21	0.0000	0.0045	0.0087	0.0126	0.0163	0.0197	0.0229	0.0259	0.0288	0.0314
22	---	---	.0000	.0042	.0081	.0118	.0153	.0185	.0215	.0244
23	---	---	---	---	.0000	.0039	.0076	.0111	.0143	.0174
24	---	---	---	---	---	---	.0000	.0037	.0071	.0104
25	---	---	---	---	---	---	---	---	.0000	.0035

Section 742.APPENDIX A: General

TABLE D: Percentage Points of the W Test for N=3(1)50

n	0.01	0.05
3	0.753	0.767
4	0.687	0.748
5	0.686	0.762
6	0.713	0.788
7	0.730	0.803
8	0.749	0.818
9	0.764	0.829
10	0.781	0.842
11	0.792	0.850
12	0.805	0.859
13	0.814	0.866
14	0.825	0.874
15	0.835	0.881
16	0.844	0.887
17	0.851	0.892
18	0.858	0.897
19	0.863	0.901
20	0.868	0.905
21	0.873	0.908
22	0.878	0.911
23	0.881	0.914
24	0.884	0.916
25	0.888	0.918
26	0.891	0.920
27	0.894	0.923
28	0.896	0.924
29	0.898	0.926
30	0.900	0.927
31	0.902	0.929
32	0.904	0.930
33	0.906	0.931
34	0.908	0.933
35	0.910	0.934

Section 742.APPENDIX A: General

TABLE E: Chemicals with Noncarcinogenic Toxic Effects on Specific Target Organs/Organ Systems or Similar Modes of Action

Kidney
Acetone
Cadmium (Ingestion only)
Chlorobenzene
Dalapon
1,1-Dichloroethane
Di-n-octyl phthalate
Endosulfan
Ethylbenzene
Fluoranthene
Nitrobenzene
Pyrene
Toluene
2,4,5-Trichlorophenol
Vinyl acetate

Liver
Acenaphthene
Acetone
Butylbenzyl phthalate
1,1-Dichloroethylene
Chlorobenzene
Di-n-octyl phthalate
Endrin
Ethylbenzene
Fluoranthene
Nitrobenzene
Picloram
Styrene
2,4,5-TP (Silvex)
Toluene
2,4,5-Trichlorophenol

Central Nervous System
Butanol
Cyanide ~~(amendable)~~ (amenable)
2,4-Dimethylphenol
Endrin
Manganese
2-Methylphenol
Mercury
Styrzene
Xylenes

Circulatory System
Antimony
Barium
2,4-D
cis-1,2-Dichloroethylene
Nitrobenzene
trans 1,2-Dichloroethylene
2,4-Dimethylphenol
Fluoranthene
Fluorene
Styrene
Zinc

Gastrointestinal System
Endothall
Hexachlorocyclopentadiene
Methyl bromide

Reproductive System
Barium
Boron
Carbon disulfide
2-Chlorophenol
1,2 Dibromo-3-Chloropropane (Inhalation only)
Dinoseb
Methoxychlor
Phenol

Cholinesterase Inhibition
Aldicarb
Carbofuran

Decreased Body Weight Gains and Circulatory System Effects
Atrazine
Simazine

Adrenal Gland
Nitrobenzene
1,2,4-Trichlorobenzene

Respiratory System
1,2-Dichloropropane

Hexachlorocyclopentadiene
Methyl bromide
Vinyl acetate

Immune System
2,4-Dichlorophenol
p-Chloroaniline

Section 742.APPENDIX A: General

TABLE F: Chemicals With Carcinogenic Toxic Effects on Specific Target Organs/Organ Systems or Similar Modes of Action

Kidney
Bromodichloromethane
Chloroform
1,2-Dibromo-3-chloropropane
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Hexachlorobenzene

Liver
Aldrin
Bix(2-chloroethyl)ether
Bis(2-ethylhexyl)phthalate
Carbazole
Carbon tetrachloride
Chlordane
Chloroform
DDD
DDE
DDT
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
3,3□-Dichlorobenzidine
1,2-Dichloroethane
1,3-Dichloropropane (Ingestion only)
1,3-Dichloropropylene
Dieldrin
2,4-Dinitrotoluene
2,6-Dinitortoluene
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
alpha-HCH
gamma-HCH (Lindane)
Methylene chloride
N-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine
Pentachlorophenol
Tetrachloroethylene
Trichloroethylene
2,4,6-Trichlorophenol
Toxaphene
Vinyl chloride

Circulatory System
Benzene
2,4,6-Trichlorophenol

Gastrointestinal System
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Chrysene
Dibenzo(a,h)anthracene
Indeno(1,2,3-c,d)pyrene
Bromodichloromethane
Bromoform
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
1,3-Dichloropropylene

Lung
Arsenic
Beryllium (Inhalation only)
Cadmium (Inhalation only)
Chromium, hexavalent (Inhalation only)
1,3-Dichloropropylene
Methylene chroride
N-Nitrosodi-n-propylamine
Vinyl chloride

Nasal Cavity
1,2-Dibromo-3-chloropropane (Inhalation only)
1,2-Dibromoethane (Inhalation only)
N-Nitrosodi-n-propylamine

Bladder
3,3□-Dichlorobenzidine
1,3-Dichloropropylene
N-Nitrosodiphenylamine

Section 742.APPENDIX A: General

TABLE G: Concentrations of Inorganic Chemicals in Background Soils

Chemical Name	Counties Within Metropolitan Statistical Areas[a] (mg/kg)	Counties Outside Metropolitan Statistical Areas (mg/kg)
Aluminum	9,500	9,200
Antimony	4.0	3.3
Arsenic	7.2	5.2
Barium	110`	122
Beryllium	0.59	0.56
Cadmium	0.6	0.50
Calcium	9,300	5,525
Chromium	16.2	13.0
Cobalt	8.9	8.9
Copper	19.6	12.0
Cyanide	0.51	0.50
Iron	15,900	15,000
Lead	36.0	20.9
Magnesium	4,820	2,700
Manganese	636	630
Mercury	0.06	0.05

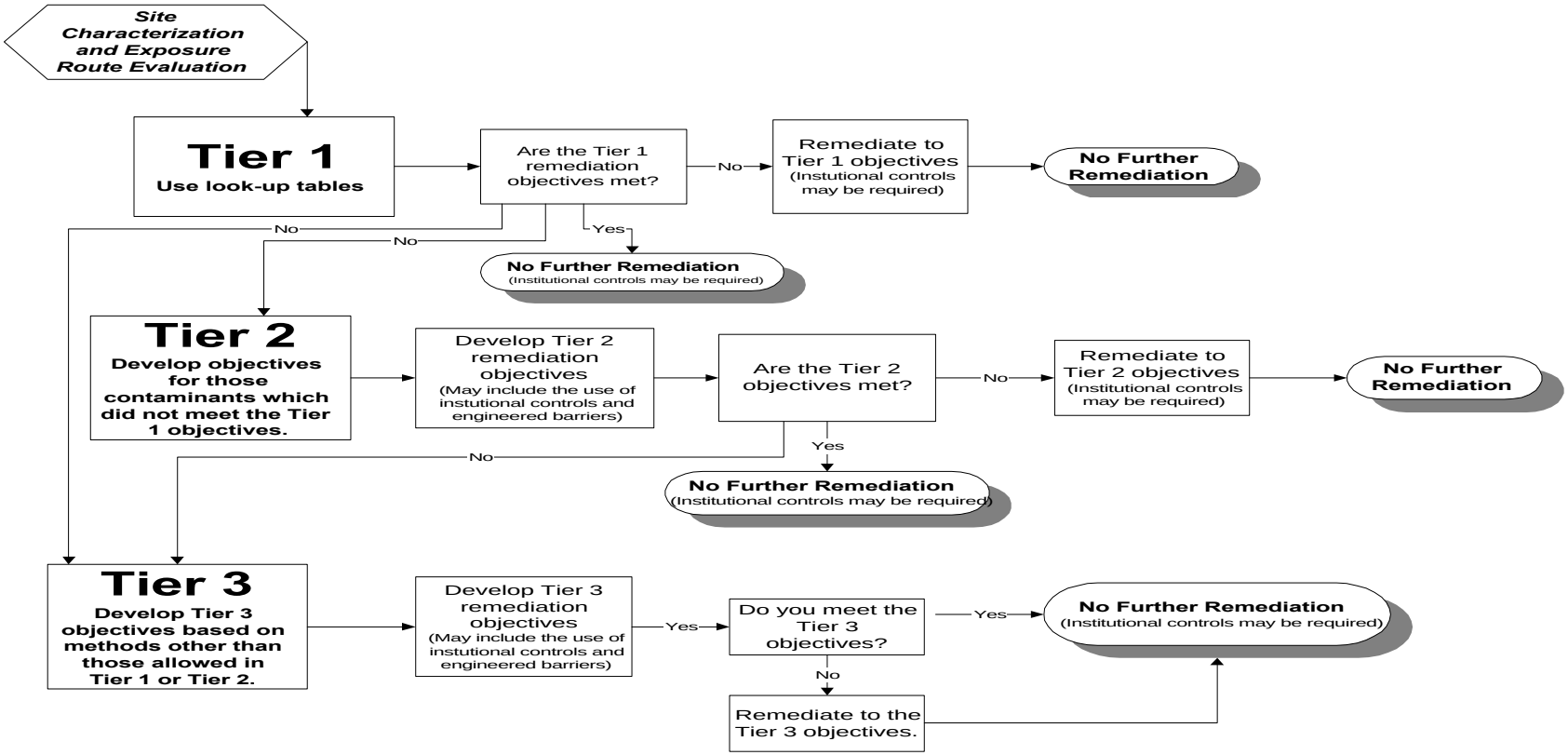
[a]Counties within Metropolitan Statistical Areas: Boone, Champaign, Clinton, Cook, DuPage, Grundy, Henry, Jersey, Kane, Kankakee, Kendall, Lake, Macon, Madison, McHenry, McLean, Menard, Monroe, Peoria, Rock Island, Sangamon, St. Clair, Tazewell, Will, Winnebago, and Woodford.

~~[b]ND=Below the Detection Limit~~

Chemical Name	Counties Within Metropolitan Statistical Areas[a] (mg/kg)	Counties Outside Metropolitan Statistical Areas (mg/kg)
Nickel	18.0	13.0
Potassium	1,268	1,100
Selenium	0.48	0.37
Silver	0.55	0.50
Sodium	130	130.0
Sulfate	85.5	110
Sulfide	3.1	2.9
Thallium	0.32	0.42
Vanadium	25.2	25.0
Zinc	95.0	60.2

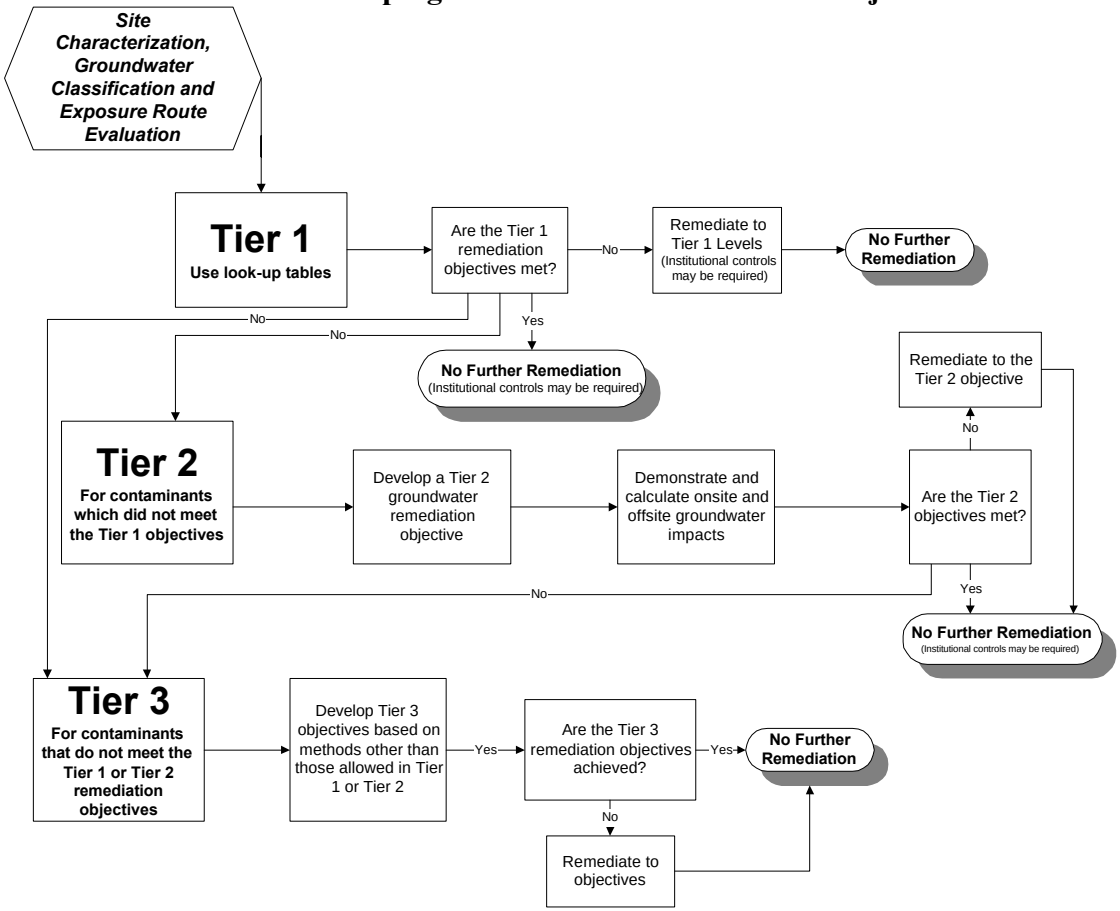
Section 742.APPENDIX A: General

Illustration A: Developing Soil Remediation Objectives Under the Tiered Approach



Section 742.APPENDIX A: General

Illustration B: Developing Groundwater Remediation Objectives Under the Tiered Approach



Section 742.APPENDIX B: Tier 1 Tables and Illustrations

TABLE A: Tier 1 Soil Remediation Objectives[a] for Residential Properties

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
83-32-9	Acenaphthene	4,700[b]	---[c]	570[b]	2,900	*
67-64-1	Acetone	7,800[b]	100,000[d]	16[b]	16	*
15972-60-8	Alachlor[o]	8[e]	---[c]	0.04	0.2	NA
116-06-3	Aldicarb[o]	78[b]	---[c]	0.013	0.07	NA
309-00-2	Aldrin	0.04[e]	3[e]	0.5[e]	2.5	*
120-12-7	Anthracene	23,000[b]	---[c]	12,000[b]	59,000	*
1912-24-9	Atrazine[o]	2700[b]	---[c]	0.066	0.33	NA
71-43-2	Benzene	22[e]	0.8[e]	0.03	0.17	*
56-55-3	Benzo(*a*)anthracene	0.9[e]	---[c]	2	8	*
205-99-2	Benzo(*b*)fluoranthene	0.9[e]	---[c]	5	25	*

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
207-08-9	Benzo(*k*)fluroanthene	9[e]	---[c]	49	250	*
50-32-8	Benzo(*a*)pyrene	0.09[e,f]	---[c]	8	82	*
111-44-4	Bis(2-chloroethyl)ether	0.6[e]	0.2[e,f]	0.0004[e,f]	0.0004	0.66
117-81-7	Bis(2-ethylhexyl)phthalate	46[e]	31,000[d]	3,600	31,000[d]	*
75-27-4	Bromodichloromethane (Dichlorobromomethane)	10[e]	3,000[d]	0.6	0.6	*
75-25-2	Bromoform	81[e]	53[e]	0.8	0.8	*
71-36-3	Butanol	7,800[b]	10,000[d]	17[b]	17	NA
85-68-7	Butyl benzyl phthalate	16,000[b]	930[d]	930[d]	930[d]	*
86-74-8	Carbazole	32[e]	---[c]	0.6[e]	2.8	NA
1563-66-2	Carbofuran[o]	390[b]	---[c]	0.22	1.1	NA
75-15-0	Carbon disulfide	7,800[b]	720[d]	32[b]	160	*

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
56-23-5	Carbon tetrachloride	5[e]	0.3[e]	0.07	0.33	*
57-74-9	Chlordane	0.5[e]	20[e]	10	48	*
106-47-8	4-Chloroaniline (*p*-Chloroaniline)	310[b]	---[c]	0.7[b]	0.7	1.3
108-90-7	Chlorobenzene (Monochlorobenzene)	1,600[b]	130[b]	1	6.5	*
124-48-1	Chlorodibromomethane (Dibromochloromethane)	1,600[b]	1,300[d]	0.4	0.4	*
67-66-3	Chloroform	100[e]	0.3[e]	0.6	2.9	*
218-01-9	Chrysene	88[e]	---[c]	160	800	*
94-75-7	2,4-D	780[b]	---[c]	1.5	7.7	*
75-99-0	Dalapon	2,300[b]	---[c]	0.85	8.5	1.2
72-54-8	DDD	3[e]	---[c]	16[e]	80	*
72-55-9	DDE	2[e]	---[c]	54[e]	270	*

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
50-29-3	DDT	2[e]	---[g]	32[e]	160	*
53-70-3	Dibenzo(*a,h*)anthracene	0.09[e,f]	---[c]	2	7.6	*
96-12-8	1,2-Dibromo-3-chloropropane	0.46[e]	11[b]	0.002	0.002	*
106-93-4	1,2-Dibromoethane (Ethylene dibromide)	0.0075[e]	0.17[e]	0.0004	0.004	0.005
84-74-2	Di-*n*-butyl phthalate	7,800[b]	2,300[d]	2,300[d]	2,300[d]	*
95-50-1	1,2-Dichlorobenzene (*o* - Dichlorobenzene)	7,000[b]	560[d]	17	43	*
106-46-7	1,4-Dichlorobenzene (*p* - Dichlorobenzene)	---[c]	---[g]	2	11	*
91-94-1	3,3'-Dichlorobenzidine	1[e]	---[c]	0.007[e,f]	0.033	1.3
75-34-3	1,1-Dichloroethane	7,800[b]	1,300[b]	23[b]	110	*

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
107-06-2	1,2-Dichloroethane (Ethylene dichloride)	7[e]	0.4[e]	0.02	0.1	*
75-35-4	1,1-Dichloroethylene	700[b]	1,500[d]	0.06	0.3	*
156-59-2	*cis*-1,2-Dichloroethylene	780[b]	1,200[d]	0.4	1.1	*
156-60-5	*trans*-1,2-Dichloroethylene	1,600[b]	3,100[d]	0.7	3.4	*
78-87-5	1,2-Dichloropropane	9[e]	15[b]	0.03	0.15	*
542-75-6	1,3-Dichloropropene (1,3-Dichloropropylene, *cis* + *trans*)	4[e]	0.1[e]	0.004[e]	0.02	0.005
60-57-1	Dieldrin[n]	0.04[e]	1[e]	0.004[e]	0.02	*
84-66-2	Diethyl phthalate	63,000[b]	2,000[d]	470[b]	470	*
105-67-9	2,4-Dimethylphenol	1,600[b]	---[c]	9[b]	9	*
121-14-2	2,4-Dinitrotoluene	0.9[e]	---[c]	0.0008[e,f]	0.0008	0.013

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
606-20-2	2,6-Dinitrotoluene	0.9[e]	---[c]	0.0007[e,f]	0.0007	0.0067
117-84-0	Di-*n*-octyl phthalate	1,600[b]	10,000[d]	10,000[d]	10,000[d]	*
115-29-7	Endosulfan	470[b]	---[c]	18[b]	90	*
145-73-3	Endothall[o]	1,600[b]	---[c]	0.4	0.4	NA
72-20-8	Endrin	23[b]	---[c]	1	5	*
100-41-4	Ethylbenzene	7,800[b]	400[d]	13	19	*
206-44-0	Fluoranthene	3,100[b]	---[c]	4,300[b]	21,000	*
86-73-7	Fluorene	3,100[b]	---[c]	560[b]	2,800	*
76-44-8	Heptachlor	0.1[e]	0.1[e]	23	110	*
1024-57-3	Heptachlor epoxide	0.07[e]	5[e]	0.7	3.3	*
118-74-1	Hexachlorobenzene	0.4[e]	1[e]	2	11	*
319-84-6	*alpha*-HCH (*alpha*-BHC)	0.1[e]	0.8[e]	0.0005[e,f]	0.003	0.002

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
58-89-9	*gamma*-HCH (Lindane)[n]	0.5[e]	---[c]	0.009	0.047	*
77-47-4	Hexachlorocyclopentadiene	550[b]	10[b]	400	2,200[d]	*
67-72-1	Hexachloroethane	78[b]	---[c]	0.5[b]	2.6	*
193-39-5	Indeno(1,2,3-*c,d*)pyrene	0.9[e]	---[c]	14	69	*
78-59-1	Isophorone	15,600[b]	4,600[d]	8[b]	8	*
72-43-5	Methoxychlor	390[b]	---[c]	160	780	*
74-83-9	Methyl bromide (Bromomethane)	110[b]	10[b]	0.2[b]	1.2	*
75-09-2	Methylene chloride (Dichloromethane)	85[e]	13[e]	0.02[e]	0.2	*
95-48-7	2-Methylphenol (*o* - Cresol)	3,900[b]	---[c]	15[b]	15	*
91-20-3	Naphthalene	3,100[b]	---[c]	84[b]	420	*
98-95-3	Nitrobenzene	39[b]	92[b]	0.1[b,f]	0.1	0.26

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
86-30-6	*N*-Nitrosodiphenylamine	130[e]	---[c]	1[e]	5.6	*
621-64-7	*N*-Nitrosodi-*n*-propylamine	0.09[e,f]	---[c]	0.00005[e,f]	0.00005	0.66
108-95-2	Phenol	47,000[b]	---[c]	100[b]	100	*
1918-02-1	Picloram[o]	5,500[b]	---[c]	2	20	NA
1336-36-3	Polychlorinated biphenyls (PCBs)[n]	1; 10[h]	---[c,h]	---[h]	---[h]	*
129-00-0	Pyrene	2,300[b]	---[c]	4,200[b]	21,000	*
122-34-9	Simazine[o]	390[b]	---[c]	0.04	0.37	NA
100-42-5	Styrene	16,000[b]	1,500[d]	4	18	*
127-18-4	Tetrachloroethylene (Perchloroethylene)	12[e]	11[e]	0.06	0.3	*
108-88-3	Toluene	16,000[b]	650[d]	12	29	*

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
8001-35-2	Toxaphene[n]	0.6[e]	89[e]	31	150	*
120-82-1	1,2,4-Trichlorobenzene	780[b]	3,200[b]	5	53	*
71-55-6	1,1,1-Trichloroethane	---[c]	1,200[d]	2	9.6	*
79-00-5	1,1,2-Trichloroethane	310[b]	1,800[d]	0.02	0.3	*
79-01-6	Trichloroethylene	58[e]	5[e]	0.06	0.3	*
108-05-4	Vinyl acetate	78,000[b]	1,000[b]	170[b]	170	*
75-01-4	Vinyl chloride	0.3[e]	0.03[e]	0.01[f]	0.07	*
108-38-3	m-Xylene	160,000[b]	420[d]	210	210	*
95-47-6	o-Xylene	160,000[b]	410[d]	190	190	*
106-42-3	p-Xylene	160,000[b]	460[d]	200	200	*

		Exposure Route-Specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
1330-20-7	Xylenes (total)	160,000[b]	410[d]	150	150	*
	Ionizable Organics					
65-85-0	Benzoic Acid	310,000[b]	---[c]	400[b,i]	400[i]	*
95-57-8	2-Chlorophenol	390[b]	53,000[d]	4[b,i]	~~420~~[i]	*
120-83-2	2,4-Dichlorophenol	230[b]	---[c]	1[b,i]	1[i]	*
51-28-5	2,4-Dinitrophenol	160[b]	---[c]	0.2[b,f]	0.2	3.3
88-85-7	Dinoseb[o]	78[b]	---[c]	0.34[b,i]	3.4[i]	*
87-86-5	Pentachlorophenol	3[e,j]	---[c]	0.03[f,i]	0.14[i]	2.4
93-72-1	2,4,5-TP (Silvex)	630[b]	---[c]	11[i]	55[i]	*
95-95-4	2,4,5-Trichlorophenol	7,800[b]	---[c]	270[b,i]	1,400[i]	*
88-06-2	2,4,6 Trichlorophenol	58[e]	200[e]	0.2[e,f,i]	0.77[i]	0.43

		Exposure Route-specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/L) ~~TCLP~~	Class II (mg/L) ~~TCLP~~	ADL (mg/kg)
	Inorganics					
7440-36-0	Antimony	31[b]	---[c]	0.006[m]	0.024[m]	*
7440-38-2	Arsenic[l,n]	0.4[e,t]	750[e]	0.05[m]	0.2[m]	*
7440-39-3	Barium	5,500[b]	690,000[b]	2.0[m]	2.0[m]	*
7440-41-7	Beryllium	0.1[e,t]	1,300[e]	0.004[m]	0.5[m]	*
7440-42-8	Boron	7,000[b]	---[g]	2.0[m]	2.0[m]	*
7440-43-9	Cadmium[l,n]	78[b, r]	1,800[e]	0.005[m]	0.05[m]	*
16887-00-6	Chloride	---[c]	---[c]	200[m]	200[m]	*
7440-47-3	Chromium, total	390[b]	270[e]	0.1[m]	1.0[m]	*
16065-83-1	Chromium, ion, trivalent	78,000[b]	---[c]	---[g]	---[g]	*
18540-29-9	Chromium, ion, hexavalent	390[b]	270[e]	---	---	*
7440-48-4	Cobalt	4,700[b]	---[c]	1.0[m]	1.0[m]	*

		Exposure Route-specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/L) ~~TCLP~~	Class II (mg/L) ~~TCLP~~	ADL (mg/kg)
7440-50-8	Copper[n]	2,900[b]	---[c]	0.65[m]	0.65[m]	*
57-12-5	Cyanide (amenable)	1,600[b]	---[c]	0.2[q]	0.6[q]	*
7782-41-4	Fluoride	4,700[b]	---[c]	4.0[m]	4.0[m]	*
15438-31-0	Iron	---[c]	---[c]	5.0[m]	5.0[m]	*
7439-92-1	Lead	400[k]	---[c]	0.0075[m]	0.1[m]	*
7439-96-5	Manganese	3,700[b]	69,000[b]	0.15[m]	10.0[m]	*
7439-97-6	Mercury[l,n]	23[b,s]	10[b,i]	0.002[m]	0.01[m]	*
7440-02-0	Nickel[l]	1,600[b]	13,000[e]	0.1[m]	2.0[m]	*
14797-55-8	Nitrate as N[p]	130,000[b]	---[c]	10.0[q]	100[q]	*
7782-49-2	Selenium[l,n]	390[b]	---[c]	0.05[m]	0.05[m]	*

		Exposure Route-specific Values for Soils		Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/L) ~~TCLP~~	Class II (mg/L) ~~TCLP~~	ADL (mg/kg)
7440-22-4	Silver	390[b]	---[c]	0.05[m]	---	*
14808-79-8	Sulfate	---[c]	---[c]	400[m]	400[m]	*
7440-28-0	Thallium	6.3[b,u]	---[c]	0.002[m]	0.02[m]	*
7440-62-2	Vanadium	550[b]	---[c]	0.049[m]	---	*
7440-66-6	Zinc[l]	23,000[b]	---[c]	5.0[m]	10[m]	*

"*" indicates that the ADL is less than or equal to the specified cleanup objective.
NA means not available; no PQL or EQL available in USEPA analytical methods.

Chemical Name and Soil Remediation~~Cleanup~~ Objective Notations

a Soil remediation~~cleanup~~ objectives based on human health criteria only.

b Calculated values correspond to a target hazard quotient of 1.

c No toxicity criteria available for the route of exposure.

d Soil saturation concentration (C_{sat}) = the concentration at which the absorptive limits of the soil particles, the solubility limits of the available soil moisture, and saturation of soil pore air have been reached. Above the soil saturation concentration, the assumptions regarding vapor transport to air and/or dissolved phase transport to groundwater (for chemicals which are liquid at ambient soil temperatures) have been violated, and alternative modeling approaches are required.

e Calculated values correspond to a cancer risk level of 1 in 1,000,000.

f Level is at or below Contract Laboratory Program required quantitation limit for Regular Analytical Services (RAS).

g Chemical-specific properties are such that this route is not of concern at any soil contaminant concentration.

h A preliminary goal of 1 ppm has been set for PCBs based on *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*, EPA/540G-90/007, and on USEPA efforts to manage PCB contamination. See 40 CFR 761.120 - USEPA "PCB Spill Cleanup Policy." This regulation goes on to say that the cleanup goal for an unrestricted area is 10 ppm and 25 ppm for a restricted area, provided both have at least 10 inches of clean cover.

i Soil remediation~~cleanup~~ objective for pH of 6.8. If soil pH is other than 6.8, refer to Appendix B, Tables C and D of this Part.

j Ingestion soil remediation~~cleanup~~ objective adjusted by a factor of 0.5 to account for dermal route.

k A preliminary remediation goal of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, OSWER Directive #9355.4-12.

l Potential for soil-plant-human exposure.

m ~~Concentration in mg/L determined by the Toxicity Characteristic Leaching Procedure (TCLP).~~ The person conducting the remediation has the option to use: 1) TCLP or SPLP test results to compare with the remediation objectives ~~cleanup objectives~~ listed in this Table; or 2) the total amount of contaminant in the soil sample results to compare with pH specific remediation objectives~~the applicable pH specific soil cleanup objectives~~ listed in Appendix B, Tables C or D of this Part. (See Section 742.510) If the person conducting the remediation wishes to calculate soil remediation~~cleanup~~ objectives based on background concentrations, this should be done in accordance with Subpart D of this Part.

n The Agency reserves the right to evaluate the potential for remaining contaminant concentrations to pose significant threats to crops, livestock, or wildlife.

o For agrichemical facilities, remediation~~cleanup~~ objectives for surficial soils which are based on field application rates may be more appropriate for currently registered pesticides. Consult the Agency for further information.

p For agrichemical facilities, soil remediation~~cleanup~~ objectives based on site-specific background concentrations of Nitrate as N may be more appropriate. Such determinations shall be conducted in accordance with the procedures set forth in Subparts D and I of this Part.

q ~~For Cyanide~~ the TCLP extraction must be done using water at a pH of 7.0.

r Value based on dietary Reference Dose.

s Value based on Reference Dose for Mercuric chloride (CAS No. 7487-94-7).

t Note that Table value is likely to be less than background concentration for this chemical; screening or remediation concentrations using the procedures of Subpart D of this Part may be more appropriate.

u Value based on Reference Dose for thallium sulfate (CAS No. 7446-18-6)

Section 742.APPENDIX B: Tier 1 Tables and Illustrations

Table B: Tier 1 Soil Remediation Objectives[a] for Industrial/Commercial Properties

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	ClassII (mg/kg)	ADL (mg/kg)
83-32-9	Acenaphthene	120,000[b]	-----[c]	120,000[b]	-----[c]	570[b]	2,900	*
67-64-1	Acetone	200,000[b]	100,000[d]	200,000[b]	100,000[d]	16[b]	16	*
15972-60-8	Alachlor[o]	72[e]	-----[c]	1,600[e]	-----[c]	0.04	0.2	NA
116-06-3	Aldicarb[o]	2,000[b]	-----[c]	200[b]	-----[c]	0.013	0.07	NA
309-00-2	Aldrin	0.3[e]	6.6[e]	6.1[b]	9.3[e]	0.5[e]	2.5	*
120-12-7	Anthracene	610,000[b]	-----[c]	610,000[b]	-----[c]	12,000[b]	59,000	*
1912-24-9	Atrazine[o]	72,000[b]	-----[c]	7,100[b]	-----[c]	0.066	0.33	NA
71-43-2	Benzene	200[e]	1.5[e]	4,300[e]	2.1[e]	0.03	0.17	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
56-55-3	Benzo(*a*)anthracene	8[e]	-----[c]	170[e]	-----[c]	2	8	*
205-99-2	Benzo(*b*)fluoranthene	8[e]	-----[c]	170[e]	-----[c]	5	25	*
207-08-9	Benzo(*k*)fluroanthene	78[e]	-----[c]	1,700[e]	-----[c]	49	250	*
50-32-8	Benzo(*a*)pyrene	0.8[e]	-----[c]	17[e]	-----[c]	8	82	*
111-44-4	Bis(2-chloroethyl)ether	5[e]	0.47[e]	75[e]	0.66[e]	0.0004[e,f]	0.0004	0.66
117-81-7	Bis(2-ethylhexyl)phthalate	410[e]	31,000[d]	4,100[b]	31,000[d]	3,600	31,000[d]	*
75-27-4	Bromodichloromethane (Dichlorobromomethane)	92[e]	3,000[d]	2,000[e]	3,000[d]	0.6	0.6	*
75-25-2	Bromoform	720[e]	100[e]	16,000[e]	140[e]	0.8	0.8	*
71-36-3	Butanol	200,000[b]	10,000[d]	200,000[b]	10,000[d]	17[b]	17	NA
85-68-7	Butyl benzyl phthalate	410,000[b]	930[d]	410,000[b]	930[d]	930[d]	930[d]	*
86-74-8	Carbazole	290[e]	-----[c]	6,200[e]	-----[c]	0.6[e]	2.8	NA

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
1563-66-2	Carbofuran[o]	10,000[b]	-----[c]	1,000[b]	-----[c]	0.22	1.1	NA
75-15-0	Carbon disulfide	200,000[b]	720[d]	20,000[b]	9.0[b]	32[b]	160	*
56-23-5	Carbon tetrachloride	44[e]	0.64[e]	410[b]	0.90[e]	0.07	0.33	*
57-74-9	Chlordane	4[e]	38[e]	12[b]	53[e]	10	48	*
106-47-8	4 - Chloroaniline (*p*-Chloroaniline)	8,200[b]	-----[c]	820[b]	-----[c]	0.7[b]	0.7	1.3
108-90-7	Chlorobenzene (Monochlorobenzene)	41,000[b]	210[b]	4,100[b]	1.3[b]	1	6.5	*
124-48-1	Chlorodibromomethane (Dibromochloromethane)	41,000[b]	1,300[d]	41,000[b]	1,300[d]	0.4	0.4	*
67-66-3	Chloroform	940[e]	0.54[e]	2,000[b]	0.76[e]	0.6	2.9	*
218-01-9	Chrysene	780[e]	-----[c]	17,000[e]	-----[e]	160	800	*
94-75-7	2,4-D	20,000[b]	-----[c]	2,000[b]	-----[c]	1.5	7.7	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
75-99-0	Dalapon	61,000[b]	-----[c]	6,100[b]	-----[c]	0.85	8.5	1.2
72-54-8	DDD	24[e]	-----[c]	520[e]	-----[c]	16[e]	80	*
72-55-9	DDE	17[e]	-----[c]	370[e]	-----[c]	54[e]	270	*
50-29-3	DDT	17[e]	1,500[e]	100[b]	2,100[e]	32[e]	160	*
53-70-3	Dibenzo(*a,h*)anthracene	0.8[e]	-----[c]	17[e]	-----[c]	2	7.6	*
96-12-8	1,2-Dibromo-3-chloropropane	4[e]	17[b]	89[e]	0.11[b]	0.002	0.002	*
106-93-4	1,2-Dibromoethane (Ethylene dibromide)	0.07[e]	0.32[e]	1.5[e]	0.45[e]	0.0004	0.004	0.005
84-74-2	Di-*n*-butyl phthalate	200,000[b]	2,300[d]	200,000[b]	2,300[d]	2,300[d]	2,300[d]	*
95-50-1	1,2-Dichlorobenzene (*o* - Dichlorobenzene)	180,000[b]	560[d]	18,000[b]	310[b]	17	43	*
106-46-7	1,4-Dichlorobenzene (*p* - Dichlorobenzene)	-----[c]	17,000[b]	-----[c]	340[b]	2	11	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
91-94-1	3,3'-Dichlorobenzidine	13[e]	-----[c]	280[e]	-----[c]	0.007[e,f]	0.033	1.3
75-34-3	1,1-Dichloroethane	200,000[b]	1,700[d]	200,000[b]	130[b]	23[b]	110	*
107-06-2	1,2-Dichloroethane (Ethylene dichloride)	63[e]	0.70[e]	1,400[e]	0.99[e]	0.02	0.1	*
75-35-4	1,1-Dichloroethylene	18,000[b]	1,500[d]	1,800[b]	1,500[d]	0.06	0.3	*
156-59-2	*cis*-1,2-Dichloroethylene	20,000[b]	1,200[d]	20,000[b]	1,200[d]	0.4	1.1	*
156-60-5	*trans*-1,2-Dichloroethylene	41,000[b]	3,100[d]	41,000[b]	3,100[d]	0.7	3.4	*
78-87-5	1,2-Dichloropropane	84[e]	23[b]	1,800[e]	0.50[b]	0.03	0.15	*
542-75-6	1,3-Dichloropropene (1,3-Dichloropropylene, *cis* + *trans*)	33[e]	0.23[e]	610[b]	0.33[e]	0.004[e]	0.02	0.005
60-57-1	Dieldrin[n]	0.4[e]	2.2[e]	7.8[e]	3.1[e]	0.004[e]	0.02	0.0013
84-66-2	Diethyl phthalate	1,000,000[b]	2,000[d]	1,000,000[b]	2,000[d]	470[b]	470	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
105-67-9	2,4-Dimethylphenol	41,000[b]	-----[c]	41,000[b]	-----[c]	9[b]	9	*
121-14-2	2,4-Dinitrotoluene	8.4[e]	-----[c]	180[e]	-----[c]	0.0008[e,f]	0.0008	0.013
606-20-2	2,6-Dinitrotoluene	8.4[e]	-----[c]	180[e]	-----[c]	0.0007[e,f]	0.0007	0.0067
117-84-0	Di-*n*-octyl phthalate	41,000[e]	10,000[d]	4,100[b]	10,000[d]	10,000[d]	10,000[d]	*
115-29-7	Endosulfan	12,000[b]	-----[c]	1,200[b]	-----[c]	18[b]	90	*
145-73-3	Endothall[o]	41,000[c]	-----[c]	4,100[b]	-----[c]	0.4	0.4	NA
72-20-8	Endrin	610[b]	-----[c]	61[b]	-----[c]	1	5	*
100-41-4	Ethylbenzene	200,000[b]	400[d]	20,000[b]	58[b]	13	19	*
206-44-0	Fluoranthene	82,000[b]	-----[c]	82,000[b]	-----[c]	4,300[b]	21,000	*
86-73-7	Fluorene	82,000[b]	-----[c]	82,000[b]	-----[c]	560[b]	2,800	*
76-44-8	Heptachlor	1[e]	11[e]	28[e]	16[e]	23	110	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
1024-57-3	Heptachlor epoxide	0.6[e]	9.2[e]	2.7[b]	13[e]	0.7	3.3	*
118-74-1	Hexachlorobenzene	4[e]	1.8[e]	78[e]	2.6[e]	2	11	*
319-84-6	*alpha*-HCH (*alpha*-BHC)	0.9[e]	1.5[e]	20[e]	2.1[e]	0.0005[e,f]	0.003	0.002
58-89-9	*gamma*-HCH (Lindane)[n]	4[e]	-----[c]	96[e]	-----[c]	0.009	0.047	*
77-47-4	Hexachlorocyclopentadiene	14,000[b]	16[b]	14,000[b]	1.1[b]	400	2,200[d]	*
67-72-1	Hexachloroethane	2,000[b]	-----[c]	2,000[b]	-----[c]	0.5[b]	2.6	*
193-39-5	Indeno(1,2,3-*c,d*)pyrene	8[e]	-----[c]	170[e]	-----[c]	14	69	*
78-59-1	Isophorone	410,000[b]	4,600[d]	410,000[b]	4,600[d]	8[b]	8	*
72-43-5	Methoxychlor	10,000[b]	-----[c]	1,000[b]	-----[c]	160	780	*
74-83-9	Methyl bromide (Bromomethane)	2,900[b]	15[b]	1,000[b]	3.9[b]	0.2[b]	1.2	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
75-09-2	Methylene chloride (Dichloromethane)	760[e]	24[e]	12,000[b]	34[e]	0.02[e]	0.2	*
95-48-7	2-Methylphenol (*o* - Cresol)	100,000[b]	-----[c]	100,000[b]	-----[c]	15[b]	15	*
86-30-6	*N*-Nitrosodiphenylamine	1,200[e]	-----[c]	25,000[e]	-----[c]	1[e]	5.6	0.66
621-64-7	*N*-Nitrosodi-*n*-propylamine	0.8[e]	-----[c]	18[e]	-----[c]	0.00005[e,f]	0.00005	0.66
91-20-3	Naphthalene	82,000[b]	-----[c]	8,200[b]	-----[c]	84[b]	420	*
98-95-3	Nitrobenzene	1,000[b]	140[b]	1,000[b]	9.4[b]	0.1[b,f]	0.1	0.26
108-95-2	Phenol	1,000,000[b]	-----[c]	120,000[b]	-----[c]	100[b]	100	*
1918-02-1	Picloram[o]	140,000[b]	-----[c]	14,000[b]	-----[c]	2	20	NA
1336-36-3	Polychlorinated biphenyls (PCBs)[n]	1; 10; 25[h]	-----[c,h]	1[h]	-----[c,h]	-----[h]	-----[h]	*
129-00-0	Pyrene	61,000[b]	-----[c]	61,000[b]	-----[c]	4,200[b]	21,000	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
122-34-9	Simazine[o]	10,000[b]	-----[c]	1,000[b]	-----[c]	0.04	0.37	NA
100-42-5	Styrene	410,000[b]	1,500[d]	41,000[b]	430[b]	4	18	*
127-18-4	Tetrachloroethylene (Perchloroethylene)	110[e]	20[e]	2,400[e]	28[e]	0.06	0.3	*
108-88-3	Toluene	410,000[b]	650[d]	410,000[b]	42[b]	12	29	*
8001-35-2	Toxaphene[n]	5.2[e]	170[e]	110[e]	240[e]	31	150	*
120-82-1	1,2,4-Trichlorobenzene	20,000[b]	3,200[d]	2,000[b]	920[b]	5	53	*
71-55-6	1,1,1-Trichloroethane	-----[c]	1,200[d]	-----[c]	1,200[d]	2	9.6	*
79-00-5	1,1,2-Trichloroethane	8,200[b]	1,800[d]	8,200[b]	1,800[d]	0.02	0.3	*
79-01-6	Trichloroethylene	520[e]	8.9[e]	1,200[b]	12[e]	0.06	0.3	*
108-05-4	Vinyl acetate	1,000,000[b]	1,600[b]	200,000[b]	10[b]	170[b]	170	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
75-01-4	Vinyl chloride	3[e]	0.06[e]	65[e]	0.08[e]	0.01[f]	0.07	*
108-38-3	m-Xylene	1,000,000	420[d]	410,000[b]	420[d]	210	210	*
95-47-6	o-Xylene	1,000,000	410[d]	410,000[b]	410[d]	190	190	*
106-42-3	p-Xylene	1,000,000	460[d]	410,000[b]	460[d]	200	200	*
1330-20-7	Xylenes (total)	1,000,000[b]	410[d]	410,000[b]	410[d]	150	150	*
	Ionizable Organics							
65-85-0	Benzoic Acid	1,000,000[b]	-----[c]	820,000[b]	-----[c]	400[b,i]	400[i]	*
95-57-8	2-Chlorophenol	10,000[b]	53,000[d]	10,000[b]	53,000[d]	4[b,i]	20[i]	*
120-83-2	2,4-Dichlorophenol	6,100[b]	-----[c]	610[b]	-----[c]	1[b,i]	1[i]	*
51-28-5	2,4-Dinitrophenol	4,100[b]	-----[c]	410[b]	-----[c]	0.2[b,f,i]	0.2[i]	3.3
88-85-7	Dinoseb[o]	2,000[b]	-----[c]	200[b]	-----[c]	0.34[b,i]	3.4[i]	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/kg)	Class II (mg/kg)	ADL (mg/kg)
87-86-5	Pentachlorophenol	24[e,j]	-----[c]	520[e,j]	-----[c]	0.03[f,i]	0.14[i]	2.4
93-72-1	2,4,5-TP (Silvex)	16,000[b]	-----[c]	1,600[b]	-----[c]	11[i]	55[i]	*
95-95-4	2,4,5-Trichlorophenol	200,000[b]	-----[c]	200,000[b]	-----[c]	270[b,i]	1,400[i]	*
88-06-2	2,4,6- Trichlorophenol	520[e]	390[e]	11,000[e]	540[e]	0.2[e,f,i]	0.77[i]	0.43

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/L)	Class II (mg/L)	
	Inorganics							
7440-36-0	Antimony	820[b]	-----[c]	82[b]	-----[c]	0.006[m]	0.024[m]	*
7440-38-2	Arsenic[l,n]	3[e,t]	1,200[e]	61[b]	25,000[e]	0.05[m]	0.2[m]	
7440-39-3	Barium	140,000[b]	910,000[b]	14,000[b]	870,000[b]	2.0[m]	2.0[m]	*
7440-41-7	Beryllium	1[e,t]	2,100[e]	29[e]	44,000[e]	0.004[m]	0.5[m]	*
7440-42-8	Boron	180,000[b]	1,000,000	18,000[b]	1,000,000	2.0[m]	2.0[m]	*
7440-43-9	Cadmium[l,n]	2,000[b,r]	2,800[e]	200[b,r]	59,000[e]	0.005[m]	0.05[m]	*
16887-00-6	Chloride	--------[c]	-----[c]	-----[c]	-----[c]	200[m]	200[m]	*
7440-47-3	Chromium, total	10,000[b]	420[e]	4,100[b]	8,800[e]	0.1[m]	1.0[m]	*
16065-83-1	Chromium, ion, trivalent	1,000,000[b]	-----[c]	330,000[b]	-----[c]	-----[g]	-----[g]	*
18540-29-9	Chromium, ion, hexavalent	10,000[b]	420[e]	4,100[b]	8,800[e]	-----	-----	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/L)	Class II (mg/L)	
7440-48-4	Cobalt	120,000[b]	-----[c]	12,000[b]	-----[c]	1.0[m]	1.0[m]	*
7440-50-8	Copper[n]	82,000[b]	-----[c]	8,200[b]	-----[c]	0.65[m]	0.65[m]	*
57-12-5	Cyanide (amenable)	41,000[b]	-----[c]	4,100[b]	-----[c]	0.2[q]	0.6[q]	*
7782-41-4	Fluoride	120,000[b]	-----[c]	12,000[b]	-----[c]	4.0[m]	4.0[m]	*
15438-31-0	Iron	-----[c]	-----[c]	-----[c]	-----[c]	5.0[m]	5.0[m]	*
7439-92-1	Lead	400[k]	-----[c]	400[k]	-----[c]	0.0075[m]	0.1[m]	*
7439-96-5	Manganese	96,000[b]	91,000[b]	9,600[b]	8,700[b]	0.15[m]	10.0[m]	*
7439-97-6	Mercury[l,n]	610[b]	540,000[b]	61[b,s]	52,000[b]	0.002[m]	0.01[m]	*
7440-02-0	Nickel[l]	41,000[b]	21,000[e]	4,100[b]	440,000[e]	0.1[m]	2.0[m]	*
14797-55-8	Nitrate as N[p]	1,000,000[b]	-----[c]	330,000[b]	-----[c]	10.0[q]	100[q]	*
7782-49-2	Selenium[l,n]	10,000[b]	-----[c]	1,000[b]	-----[c]	0.05[m]	0.05[m]	*

		Exposure Route-Specific Values for Soils				Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route Values		
		Industrial-Commercial		Construction Worker				
CAS No.	Chemical Name	Ingestion (mg/kg)	Inhalation (mg/kg)	Ingestion (mg/kg)	Inhalation (mg/kg)	Class I (mg/L)	Class II (mg/L)	
7440-22-4	Silver	10,000[b]	-----[c]	1,000[b]	-----[c]	0.05[m]	-----	*
14808-79-8	Sulfate	-----[c]	-----[c]	-----[c]	-----[c]	400[m]	400[m]	*
7440-28-0	Thallium	160[b,u]	-----[c]	160[b,u]	-----[c]	0.002[m]	0.02[m]	*
7440-62-2	Vanadium	14,000[b]	-----[c]	1,400[b]	-----[c]	0.049[m]	-----	*
7440-66-6	Zinc[l]	610,000[b]	-----[c]	61,000[b]	-----[c]	5.0[m]	10[m]	*

"*" indicates that the ADL is less than or equal to the specified cleanup objective.

NA means Not Available; no PQL or EQL available in USEPA analytical methods.

Chemical Name and Soil Remediation~~Cleanup~~ Objective Notations (2nd, 5th thru 8th Columns)

a Soil remediation~~cleanup~~ objectives based on human health criteria only.
b Calculated values correspond to a target hazard quotient of 1.
c No toxicity criteria available for this route of exposure.
d Soil saturation concentration (C_{sat}) = the concentration at which the absorptive limits of the soil particles, the solubility limits of the available soil moisture, and saturation of soil pore air have been reached. Above the soil saturation concentration, the assumptions regarding vapor transport to air and/or dissolved phase transport to groundwater (for chemicals which are liquid at ambient soil temperatures) have been violated, and alternative modeling approaches are required.
e Calculated values correspond to a cancer risk level of 1 in 1,000,000. ~~Site-specific conditions may warrant use of a greater risk level but not to exceed 1 in 10,000.~~
f Level is at or below Contract Laboratory Program required quantitation limit for Regular Analytical Services (RAS).
g Chemical-specific properties are such that this route is not of concern at any soil contaminant concentration.
h A preliminary goal of 1 ppm has been set for PCBs based on *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*, EPA/540G-90/007, and on USEPA efforts to manage PCB contamination. See 40 CFR 761.120 for USEPA "PCB Spill Cleanup Policy." This regulation goes on to say that the cleanup goal for an unrestricted area is 10 ppm and 25 ppm for a restricted area, provided both have at least 10 inches of clean cover.
~~i~~ Soil remediation~~cleanup~~ objective for pH of 6.8. If soil pH is other than 6.8, refer to Appendix B, Tables C and D in this Part.
j Ingestion soil remediation~~cleanup~~ objective adjusted by a factor of 0.5 to account for dermal route.
k A preliminary remediation goal of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*, OSWER Directive #9355.4-12.
l Potential for soil-plant-human exposure.
m ~~Concentration in mg/L determined by the Toxicity Characteristic Leaching Procedure (TCLP).~~ The person conducting the remediation has the option to use: 1) TCLP or SPLP test results to compare with the remediation objectives ~~cleanup objectives~~ listed in this Table; or 2) the total amount of contaminant in the soil sample results to compare with pH specific remediation objectives ~~of the applicable pH specific soil cleanup objectives~~ listed in Appendix B, Tables C or D of this Part. (See Section 742.510). If the person conducting the remediation wishes to calculate soil remediation ~~cleanup~~ objectives based on background concentrations, this should be done in accordance with Subpart D of this Part.
n The Agency reserves the right to evaluate the potential for remaining contaminant concentrations to pose significant threats to crops, livestock, or wildlife.
o For agrichemical facilities, ~~cleanup~~ remediation objectives for surficial soils which are based on field application rates may be more appropriate for currently registered pesticides. Consult the Agency for further information.
p For agrichemical facilities, soil remediation ~~cleanup~~ objectives based on site-specific background concentrations of Nitrate as N may be more appropriate. Such determinations shall be conducted in accordance with the located in Subparts D and I of this Part.
q ~~For Cyanide~~ the TCLP extraction must be done using water at a pH of 7.0.
r Value based on dietary Reference Dose.
s Value based on Reference Dose for Mercuric chloride (CAS No. 7487-94-7).
t Note that Table value is likely to be less than background concentration for this chemical; screening or remediation concentrations using the procedures of Subpart D of this Part.

u Value based on Reference Dose for thallium sulfate (CAS No. 7446-18-6)

Section 742.APPENDIX B: Tier 1 Tables and Illustrations

Table C: pH Specific Soil Remediation Objectives for Inorganics and Ionizing Organics for the Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Route (Class I Groundwater)

Chemical (totals) (mg/kg)	pH 4.5 to 4.74	pH 4.75 to 5.24	pH 5.25 to 5.74	pH 5.75 to 6.24	pH 6.25 to 6.64	pH 6.65 to 6.89	pH 6.9 to 7.24	pH 7.25 to 7.74	pH 7.75 to 8.0
Inorganics									
Antimony	5	5	5	5	5	5	5	5	5
Arsenic	25	26	27	28	29	29	29	30	31
Barium	260	490	850	1,200	1,500	1,600	1,700	1,800	2,100
Beryllium	1.1	2.1	3.4	6.6	22	63	140	1,000	8,000
Cadmium	1.0	1.7	2.7	3.7	5.2	7.5	11	59	430
Chromium (+6)	70	62	54	46	40	38	36	32	28
Copper	330	580	2,100	11,000	59,000	130,000	200,000	330,000	330,000
Cyanide	40	40	40	40	40	40	40	40	40
Mercury	0.01	0.01`	0.03	0.15	0.89	2.1	3.3	6.4	8.0
Nickel	20	36	56	76	100	130	180	700	3,800
Selenium	24	17	12	8.8	6.3	5.2	4.5	3.3	2.4
Silver	0.24	0.33	0.62	1.5	4.4	8.5	13	39	110

Chemical (totals) (mg/kg)	pH 4.5 to 4.74	pH 4.75 to 5.24	pH 5.25 to 5.74	pH 5.75 to 6.24	pH 6.25 to 6.64	pH 6.65 to 6.89	pH 6.9 to 7.24	pH 7.25 to 7.74	pH 7.75 to 8.0
Thallium	1.6	1.8	2.0	2.4	2.6	2.8	3.0	3.4	3.8
Vanadium	980	980	980	980	980	980	980	980	980
Zinc	1,000	1,800	2,600	3,600	5,100	6,200	7,500	16,000	53,000
Organics									
Benzoic Acid	440	420	410	400	400	400	400	400	400
2-Chlorophenol	4.0	4.0	4.0	4.0	3.9	3.9	3.9	3.6	3.1
2,4-Dichlorophenol	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.86	0.69
Dinoseb	8.4	4.5	1.9	0.82	0.43	0.34	0.31	0.27	0.25
Pentachlorophenol	0.54	0.32	0.15	0.07	0.04	0.03	0.02	0.02	0.02
2,4,5-TP (Silvex)	26	16	12	11	11	11	11	11	11
2,4,5-Trichlorophenol	400	390	390	370	320	270	230	130	64
2,4,6-Trichlorophenol	0.37	0.36	0.34	0.26	0.20	0.15	0.13	0.09	0.07

Section 742.APPENDIX B

Table D: pH Specific Soil Remediation Objectives for Inorganics and Ionizing Organics for the Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Route (Class II Groundwater)

Chemical (totals) (mg/kg)	pH 4.5 to 4.74	pH 4.75 to 5.24	pH 5.25 to 5.74	pH 5.75 to 6.24	pH 6.25 to 6.64	pH 6.65 to 6.89	pH 6.9 to 7.24	pH 7.25 to 7.74	pH 7.75 to 8.0
Inorganics									
Antimony	20	20	20	20	20	20	20	20	20
Arsenic	100	100	100	110	110	120	120	120	120
Barium	260	490	850	1,200	1,500	1,600	1,700	1,800	2,100
Beryllium	140	260	420	820	2,800	7,900	17,000	130,000	1,000,000
Cadmium	10	17	27	37	52	75	110	590	4,300
Chromium (+6)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Copper	330	580	2,100	11,000	59,000	130,000	200,000	330,000	330,000
Cyanide	120	120	120	120	120	120	120	120	120
Mercury	0.05	0.06	0.14	0.75	4.4	10	16	32	40
Nickel	400	730	1,100	1,500	2,000	2,600	3,500	14,000	76,000
Selenium	24	17	12	8.8	6.3	5.2	4.5	3.3	2.4
Thallium	16	18	20	24	26	28	30	34	38
Zinc	2,000	3,600	5,200	7,200	10,000	12,000	15,000	32,000	110,000

Chemical (totals) (mg/kg)	pH 4.5 to 4.74	pH 4.75 to 5.24	pH 5.25 to 5.74	pH 5.75 to 6.24	pH 6.25 to 6.64	pH 6.65 to 6.89	pH 6.9 to 7.24	pH 7.25 to 7.74	pH 7.75 to 8.0
Organics									
Benzoic Acid	440	420	410	400	400	400	400	400	400
2-Chlorophenol	20	20	20	20	20	20	19	3.6	3.1
2,4-Dichlorophenol	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.86	0.69
Dinoseb	84	45	19	8.2	4.3	3.4	3.1	2.7	2.5
Pentachlorophenol	2.7	1.6	0.75	0.33	0.18	0.15	0.12	0.11	0.10
2,4,5-TP (Silvex)	130	79	62	57	55	55	55	55	55
2,4,5-Trichlorophenol	2,000	2,000	1,900	1,800	1,600	1,400	1,200	640	64
2,4,6-Trichlorophenol	0.37	0.36	0.34	0.26	0.20	0.15	0.13	0.09	0.07

Section 742.APPENDIX B: Tier 1 Tables and Illustrations

TABLE E: Tier 1 Groundwater Remediation Objectives for the ~~Direct Ingestion of~~ Groundwater Component~~Groundwater Portion~~ of the Groundwater Ingestion Route

		Groundwater Remediation~~Cleanup~~ Objective	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
83-32-9	Acenaphthene	0.42	2.1
67-64-1	Acetone	0.7	0.7
15972-60-8	Alachlor	0.002[c]	0.01[c]
116-06-3	Aldicarb	0.003[c]	0.015[c]
309-00-2	Aldrin	0.00004[a]	0.0002
120-12-7	Anthracene	2.1	10.5
1912-24-9	Atrazine	0.003[c]	0.015[c]
71-43-2	Benzene	0.005[c]	0.025[c]
56-55-3	Benzo(*a*)anthracene	0.00013[a]	0.00065
205-99-2	Benzo(*b*)fluoranthene	0.00018[a]	0.0009
207-08-9	Benzo(*k*)fluroanthene	0.00017[a]	0.00085
50-32-8	Benzo(*a*)pyrene	0.0002[a,c]	0.002[c]
111-44-4	Bis(2-chloroethyl)ether	0.01[a]	0.01
117-81-7	Bis(2-ethylhexyl)phthalate	0.006[a,c]	0.06[c]
75-27-4	Bromodichloromethane (Dichlorobromomethane)	0.00002[a]	0.00002
75-25-2	Bromoform	0.0002[a]	0.0002
71-36-3	Butanol	0.7	0.7
85-68-7	Butyl benzyl phthalate	1.4	7.0
86-74-8	Carbazole	---	---
1563-66-2	Carbofuran	0.04[c]	0.2[c]
75-15-0	Carbon disulfide	0.7	3.5
56-23-5	Carbon tetrachloride	0.005[c]	0.025[c]
57-74-9	Chlordane	0.002[c]	0.01[c]

		Groundwater Remediation ~~Cleanup~~ Objective	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
108-90-7	Chlorobenzene (Monochlorobenzene)	0.1[c]	0.5[c]
124-48-1	Chlorodibromomethane (Dibromochloromethane)	0.14	0.14
67-66-3	Chloroform	0.00002[a]	0.0001
218-01-9	Chrysene	0.0015[a]	0.0075
94-75-7	2,4-D	0.07[c]	0.35[c]
75-99-0	Dalapon	0.2[c]	2.0[c]
72-54-8	DDD	0.00011[a]	0.00055
72-55-9	DDE	0.00004[a]	0.0002
50-29-3	DDT	0.00012[a]	0.0006
53-70-3	Dibenzo(*a,h*)anthracene	0.0003[a]	0.0015
96-12-8	1,2-Dibromo-3-chloropropane	0.0002[c]	0.0002[c]
106-93-4	1,2-Dibromoethane (Ethylene dibromide)	0.00005[a,c]	0.0005[c]
84-74-2	Di-*n*-butyl phthalate	0.7	3.5
95-50-1	1,2-Dichlorobenzene (*o* - Dichlorobenzene)	0.6[c]	1.5[c]
106-46-7	1,4-Dichlorobenzene (*p* - Dichlorobenzene)	0.075[c]	0.375[c]
91-94-1	3,3'-Dichlorobenzidine	0.02[a]	0.1
75-34-3	1,1-Dichloroethane	0.7	3.5
107-06-2	1,2-Dichloroethane (Ethylene dichloride)	0.005[c]	0.025[c]
75-35-4	1,1-Dichloroethylene[b]	0.007[c]	0.035[c]
156-59-2	*cis*-1,2-Dichloroethylene	0.07[c]	0.2[c]
156-60-5	*trans*-1,2-Dichloroethylene	0.1[c]	0.5[c]
78-87-5	1,2-Dichloropropane	0.005[c]	0.025[c]
542-75-6	1,3-Dichloropropene (1,3-Dichloropropylene,*cis* + *trans*)	0.001[a]	0.005

		Groundwater Remediation ~~Cleanup~~ Objective	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
60-57-1	Dieldrin	0.00002[a]	0.0001
84-66-2	Diethyl phthalate	5.6	5.6
121-14-2	2,4-Dinitrotoluene[3]	0.00002	0.00002
606-20-2	2,6-Dinitrotoluene[3]	0.0001	0.0001
88-85-7	Dinoseb	0.007[c]	0.07[c]
117-84-0	Di-*n*-octyl phthalate	0.14	0.7
115-29-7	Endosulfan	0.042	0.21
145-73-3	Endothall	0.1[c]	0.1[c]
72-20-8	Endrin	0.002[c]	0.01[c]
100-41-4	Ethylbenzene	0.7[c]	1.0[c]
206-44-0	Fluoranthene	0.28	1.4
86-73-7	Fluorene	0.28	1.4
76-44-8	Heptachlor	0.0004[c]	0.002[c]
1024-57-3	Heptachlor epoxide	0.0002[c]	0.001[c]
118-74-1	Hexachlorobenzene	0.00006[a]	0.0003
319-84-6	*alpha*-HCH (*alpha*-BHC)	0.00003[a]	0.00015
58-89-9	*gamma*-HCH (Lindane)	0.0002[c]	0.001[c]
77-47-4	Hexachlorocyclopentadiene	0.05[c]	0.5[c]
67-72-1	Hexachloroethane	0.007	0.035
193-39-5	Indeno(1,2,3-*c,d*)pyrene	0.00043[a]	0.00215
78-59-1	Isophorone	1.4	1.4
72-43-5	Methoxychlor	0.04[c]	0.2[c]
74-83-9	Methyl bromide (Bromomethane)	0.0098	0.049
75-09-2	Methylene chloride (Dichloromethane)	0.005[c]	0.05[c]
91-20-3	Naphthalene[2]	0.025	0.039
98-95-3	Nitrobenzene[2]	0.0035	0.0035

		Groundwater Remediation ~~Cleanup~~ Objective	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
1918-02-1	Picloram	0.5[c]	5.0[c]
1336-36-3	Polychlorinatedbiphenyls (PCBs)[n]	0.0005[c]	0.0025[c]
129-00-0	Pyrene	0.21	1.05
122-34-9	Simazine	0.004[c]	0.04[c]
100-42-5	Styrene	0.1[c]	0.5[c]
93-72-1	2,4,5-TP (Silvex)	0.05[c]	0.25[c]
127-18-4	Tetrachloroethylene (Perchloroethylene)	0.005[c]	0.025[c]
108-88-3	Toluene	1.0[c]	2.5[c]
8001-35-2	Toxaphene	0.003[c]	0.015[c]
120-82-1	1,2,4-Trichlorobenzene	0.07[c]	0.7[c]
71-55-6	1,1,1-Trichloroethane[2]	0.2[c]	1.0[c]
79-00-5	1,1,2-Trichloroethane	0.005[c]	0.05[c]
79-01-6	Trichloroethylene	0.005[c]	0.025[c]
108-05-4	Vinyl acetate	7.0	7.0
75-01-4	Vinyl chloride	0.002[c]	0.01[c]
1330-20-7	Xylenes (total)	10.0[c]	10.0[c]
	Ionizable Organics		
65-85-0	Benzoic Acid	28	28
106-47-8	4-Chloroaniline (*p*-Chloroaniline)	0.028	0.028
95-57-8	2-Chlorophenol	0.035	0.175
120-83-2	2,4-Dichlorophenol	0.021	0.021
105-67-9	2,4-Dimethylphenol	0.14	0.14
51-28-5	2,4-Dinitrophenol	0.014	0.014
95-48-7	2-Methylphenol (*o* - Cresol)	0.35	0.35
86-30-6	*N*-Nitrosodiphenylamine	0.01[a]	0.05

		Groundwater Remediation ~~Cleanup~~ Objective	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
621-64-7	*N*-Nitrosodi-*n*-propylamine	0.01[a]	0.01
87-86-5	Pentachlorophenol	0.001[a,c]	0.005[c]
108-95-2	Phenol	0.1[c]	0.1[c]
95-95-4	2,4,5-Trichlorophenol	0.7	3.5
88-06-2	2,4,6 Trichlorophenol	0.0064[a]	0.032
	Inorganics		
7440-36-0	Antimony	0.006[c]	0.024[c]
7440-38-2	Arsenic	0.05[c]	0.2[c]
7440-39-3	Barium	2.0[c]	2.0[c]
7440-41-7	Beryllium	0.004[c]	0.5[c]
7440-42-8	Boron	2.0[c]	2.0[c]
7440-43-9	Cadmium	0.005[c]	0.05[c]
16887-00-6	Chloride	200[c]	200[c]
7440-47-3	Chromium, total	0.1[c]	1.0[c]
18540-29-9	Chromium, ion,hexavalent	---	---
7440-48-4	Cobalt	1.0[c]	1.0[c]
7440-50-8	Copper	0.65[c]	0.65[c]
57-12-5	Cyanide	0.2[c]	0.6[c]
7782-41-4	Fluoride	4.0[c]	4.0[c]
15438-31-0	Iron	5.0[c]	5.0[c]
7439-92-1	Lead	0.0075[c]	0.1[c]
7439-96-5	Manganese	0.15[c]	10.0[c]
7439-97-6	Mercury	0.002[c]	0.01[c]
7440-02-0	Nickel	0.1[c]	2.0[c]
14797-55-8	Nitrate as N	10.0[c]	100[c]
7782-49-2	Selenium	0.05[c]	0.05[c]
7440-22-4	Silver	0.05[c]	---
14808-79-8	Sulfate	400[c]	400[c]

		Groundwater Remediation ~~Cleanup~~ Objective	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
7440-28-0	Thallium	0.002[c]	0.02[c]
7440-62-2	Vanadium[2]	0.049	---
7440-66-6	Zinc	5.0[c]	10[c]

Chemical Name and Groundwater Remediation ~~Cleanup~~ Objective Notations

[a] The groundwater Health Advisory concentration is equal to ADL for carcinogens.

[b] Oral Reference Dose and/or Reference Concentration under review by USEPA. Listed values subject to change.

[c] Value listed is also the Groundwater Quality Standard for this chemical pursuant to 35 Ill. Adm. Code 620.410 for Class I Groundwater or 35 Ill. Adm. Code 620.420 for Class II Groundwater.

Section 742.APPENDIX B: Tier 1 Tables and Illustrations

TABLE F: Values Used to Calculate the Tier 1 Soil Remediation Objectives for the Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Route

		GW_{obj} Concentration used to Calculate Tier 1 SoilRememdiationObjectives[a]	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
83-32-9	Acenaphthene	2.0[b]	10
67-64-1	Acetone	4.0[b]	4.0
15972-60-8	Alachlor	0.002[c]	0.01[c]
116-06-3	Aldicarb	0.003[c]	0.015[c]
309-00-2	Aldrin	5.0E-6[b]	2.5E-5
120-12-7	Anthracene	10[b]	50
1912-24-9	Atrazine	0.003[c]	0.015[c]
71-43-2	Benzene	0.005[c]	0.025[c]
56-55-3	Benzo(*a*)anthracene	0.0001[b]	0.0005
205-99-2	Benzo(*b*)fluoranthene	0.0001[b]	0.0005
207-08-9	Benzo(*k*)fluroanthene	0.001[b]	0.005
50-32-8	Benzo(*a*)pyrene	0.0002[a,c]	0.002[c]
111-44-4	Bis(2-chloroethyl)ether	8.0E-5[b]	8.0E-5
117-81-7	Bis(2-ethylhexyl)phthalate	0.006[a,c]	0.06[c]
75-27-4	Bromodichloromethane (Dichlorobromomethane)	0.1[b]	0.1
75-25-2	Bromoform	0.1[b]	0.01
71-36-3	Butanol	4.0[b]	4.0
85-68-7	Butyl benzyl phthalate	7.0[b]	35
86-74-8	Carbazole	0.004[b]	0.02
1563-66-2	Carbofuran	0.04[c]	0.2[c]
75-15-0	Carbon disulfide	4.0[b]	20
56-23-5	Carbon tetrachloride	0.005[c]	0.025[c]
57-74-9	Chlordane	0.002[c]	0.01[c]

CAS No.	Chemical Name	GW_{obj} Concentration used to Calculate Tier 1 SoilRememdiationObjectives[a]	
		Class I (mg/L)	Class II (mg/L)
108-90-7	Chlorobenzene (Monochlorobenzene)	0.1[c]	0.5[c]
124-48-1	Chlorodibromomethane (Dibromochloromethane)	0.06[b]	0.06
67-66-3	Chloroform	0.1[b]	0.5
218-01-9	Chrysene	0.1[b]	0.05
94-75-7	2,4-D	0.07[c]	0.35[c]
75-99-0	Dalapon	0.2[c]	2.0[c]
72-54-8	DDD	0.0004[b]	0.002
72-55-9	DDE	0.0003[b]	0.0015
50-29-3	DDT	0.0003[b]	0.0015
53-70-3	Dibenzo(*a,h*)anthracene	1.0E-5[b]	5.0E-5
96-12-8	1,2-Dibromo-3-chloropropane	0.0002[c]	0.0002[c]
106-93-4	1,2-Dibromoethane (Ethylene dibromide)	0.00005[a,c]	0.0005[c]
84-74-2	Di-*n*-butyl phthalate	4.0[b]	20
95-50-1	1,2-Dichlorobenzene (*o* - Dichlorobenzene)	0.6[c]	1.5[c]
106-46-7	1,4-Dichlorobenzene (*p* - Dichlorobenzene)	0.075[c]	0.375[c]
91-94-1	3,3'-Dichlorobenzidine	0.0002[b]	0.001
75-34-3	1,1-Dichloroethane	4.0[b]	20
107-06-2	1,2-Dichloroethane (Ethylene dichloride)	0.005[c]	0.025[c]
75-35-4	1,1-Dichloroethylene	0.007[c]	0.035[c]
156-59-2	*cis*-1,2-Dichloroethylene	0.07[c]	0.2[c]
156-60-5	*trans*-1,2-Dichloroethylene	0.1[c]	0.5[c]
78-97-5	1,2-Dichloropropane	0.005[c]	0.025[c]
542-75-6	1,3-Dichloropropene (1,3-Dichloropropylene,*cis* + *trans*)	0.0005[b]	0.0025

		GW_{obj} Concentration used to Calculate Tier 1 SoilRememdiationObjectives[a]	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
60-57-1	Dieldrin	5.0E-6[b]	2.5E-5
84-66-2	Diethyl phthalate	30[b]	30
121-14-2	2,4-Dinitrotoluene	0.0001[b]	0.0001
606-20-2	2,6-Dinitrotoluene	0.0001	0.0001
88-85-7	Dinoseb	0.007[c]	0.07[c]
117-84-0	Di-*n*-octyl phthalate	0.7[b]	3.5
115-29-7	Endosulfan	0.2[b]	1.0
145-73-3	Endothall	0.1[c]	0.1[c]
72-20-8	Endrin	0.002[c]	0.01[c]
100-41-4	Ethylbenzene	0.7[c]	1.0[c]
206-44-0	Fluoranthene	1.0[b]	5.0
86-73-7	Fluorene	1.0[b]	5.0
76-44-8	Heptachlor	0.0004[c]	0.002[c]
1024-57-3	Heptachlor epoxide	0.0002[c]	0.001[c]
118-74-1	Hexachlorobenzene	0.001[b]	0.005
319-84-6	*alpha*-HCH (*alpha*-BHC)	1.0E-5[b]	5.0E-5
58-89-9	*gamma*-HCH (Lindane)	0.0002[c]	0.001[c]
77-47-4	Hexachlorocyclopentadiene	0.05[c]	0.5[c]
67-72-1	Hexachloroethane	0.007	0.035
193-39-5	Indeno(1,2,3-*c,d*)pyrene	0.0001[b]	0.0005
78-59-1	Isophorone	1.4	1.4
72-43-5	Methoxychlor	0.04[c]	0.2[c]
74-83-9	Methyl bromide (Bromomethane)	0.05[b]	0.25
75-09-2	Methylene chloride (Dichloromethane)	0.005[c]	0.05[c]
91-20-3	Naphthalene	1.0[b]	5.0
98-95-3	Nitrobenzene	0.02[b]	0.02

		GW_{obj} Concentration used to Calculate Tier 1 SoilRememdiationObjectives[a]	
CAS No.	Chemical Name	Class I (mg/L)	Class II (mg/L)
1918-02-1	Picloram	0.5[c]	5.0[c]
1336-36-3	Polychlorinatedbiphenyls (PCBs)	---	---
129-00-0	Pyrene	1.0[b]	5.0
122-34-9	Simazine	0.004[c]	0.04[c]
100-42-5	Styrene	0.1[c]	0.5[c]
93-72-1	2,4,5-TP (Silvex)	0.05[c]	0.25[c]
127-18-4	Tetrachloroethylene (Perchloroethylene)	0.005[c]	0.025[c]
108-88-3	Toluene	1.0[c]	2.5[c]
8001-35-2	Toxaphene	0.003[c]	0.015[c]
120-82-1	1,2,4-Trichlorobenzene	0.07[c]	0.7[c]
71-55-6	1,1,1-Trichloroethane[2]	0.2[c]	1.0[c]
79-00-5	1,1,2-Trichloroethane	0.005[c]	0.05[c]
79-01-6	Trichloroethylene	0.005[c]	0.025[c]
108-05-4	Vinyl acetate	40[b]	40
75-01-4	Vinyl chloride	0.002[c]	0.01[c]
1330-20-7	Xylenes (total)	10.0[c]	10.0[c]
	Ionizable Organics		
65-85-0	Benzoic Acid	100[b]	100
106-47-8	4-Chloroaniline (*p*-Chloroaniline)	0.1[b]	0.1
95-57-8	2-Chlorophenol	0.2[b]	1.0
120-83-2	2,4-Dichlorophenol	0.1[b]	0.1
105-67-9	2,4-Dimethylphenol	0.7[b]	0.7
51-28-5	2,4-Dinitrophenol	0.04[b]	0.04
95-48-7	2-Methylphenol (*o* - Cresol)	2.0[b]	2.0
86-30-6	*N*-Nitrosodiphenylamine	0.02[b]	0.1

CAS No.	Chemical Name	GW_{obj} Concentration used to Calculate Tier 1 SoilRememdiationObjectives[a]	
		Class I (mg/L)	Class II (mg/L)
621-64-7	*N*-Nitrosodi-*n*-propylamine	1.0E-5[b]	1.0E-5
87-86-5	Pentachlorophenol	0.001[a,c]	0.005[c]
108-95-2	Phenol	0.1[c]	0.1[c]
95-95-4	2,4,5-Trichlorophenol	4.0[b]	20
88-06-2	2,4,6 Trichlorophenol	0.008[b]	0.04
	Inorganics		
7440-36-0	Antimony	0.006[c]	0.024[c]
7440-38-2	Arsenic	0.05[c]	0.2[c]
7440-39-3	Barium	2.0[c]	2.0[c]
7440-41-7	Beryllium	0.004[c]	0.5[c]
7440-42-8	Boron	2.0[c]	2.0[c]
7440-43-9	Cadmium	0.005[c]	0.05[c]
16887-00-6	Chloride	200[c]	200[c]
7440-47-3	Chromium, total	0.1[c]	1.0[c]
18540-29-9	Chromium, ion,hexavalent	---	---
7440-48-4	Cobalt	1.0[c]	1.0[c]
7440-50-8	Copper	0.65[c]	0.65[c]
57-12-5	Cyanide	0.2[c]	0.6[c]
7782-41-4	Fluoride	4.0[c]	4.0[c]
15438-31-0	Iron	5.0[c]	5.0[c]
7439-92-1	Lead	0.0075[c]	0.1[c]
7439-96-5	Manganese	0.15[c]	10.0[c]
7439-97-6	Mercury	0.002[c]	0.01[c]
7440-02-0	Nickel	0.1[c]	2.0[c]
14797-55-8	Nitrate as N	10.0[c]	100[c]
7782-49-2	Selenium	0.05[c]	0.05[c]
7440-22-4	Silver	0.05[c]	---
14808-79-8	Sulfate	400[c]	400[c]

CAS No.	Chemical Name	GW_{obj} Concentration used to Calculate Tier 1 SoilRememdiationObjectives[a]	
		Class I (mg/L)	Class II (mg/L)
7440-28-0	Thallium	0.002[c]	0.02[c]
7440-62-2	Vanadium	0.049	---
7440-66-6	Zinc	5.0[c]	10[c]

Chemical Name and Groundwater Remediation ~~Cleanup~~ Objective Notations

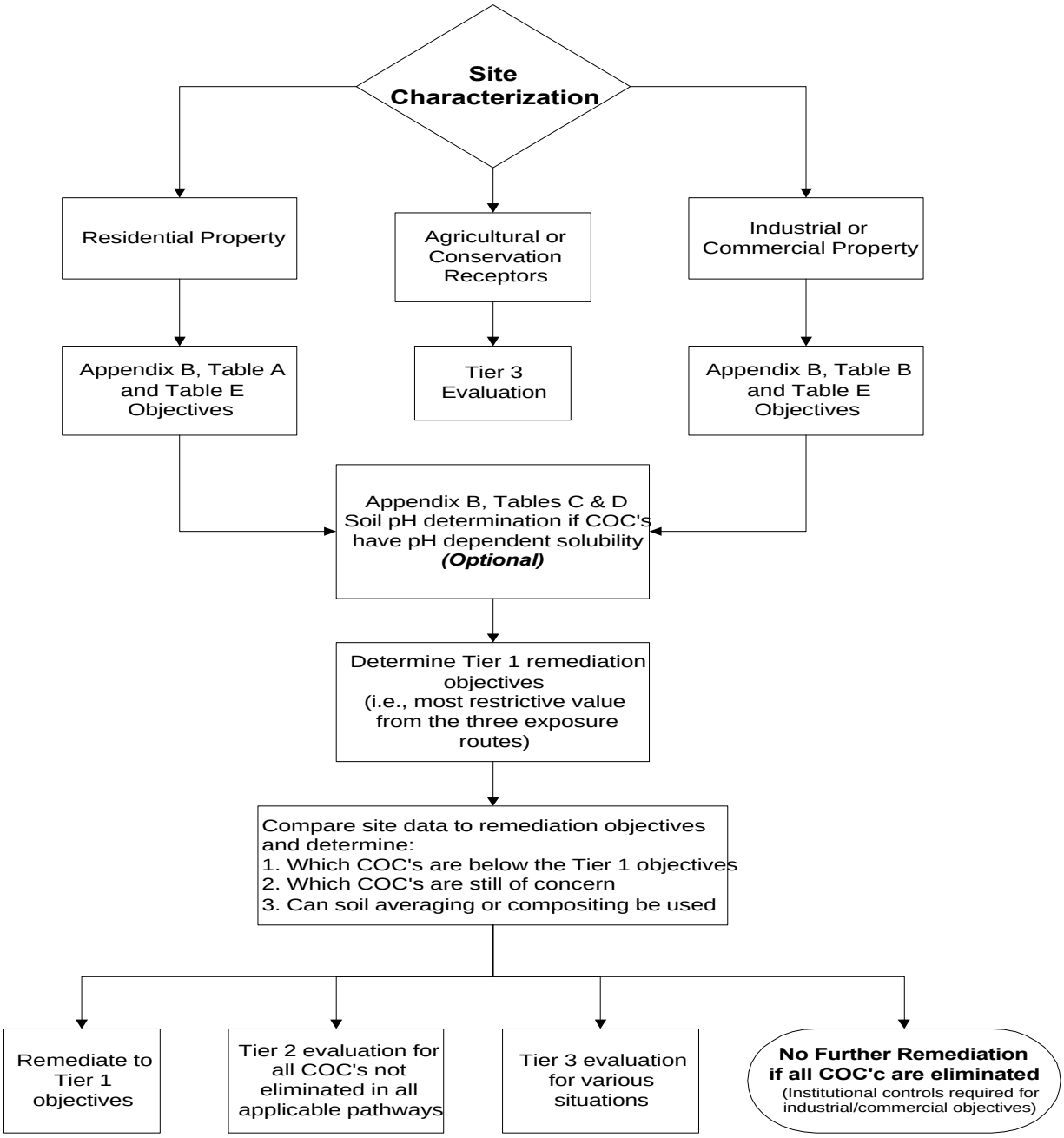
[a] The Equation S17 is used to calculate the Soil Remediation Objective for the Soil ~~Migration to~~ Component ~~Groundwater portion~~ of the Groundwater Ingestion Route; this equation requires calculation of the Target Soil Leachate Concentration (C_w) from Equation S18: $C_w = DF \times GW_{obj}$.

[b] Value listed is the Water Health Based Limit (HBL) for this chemical from Soil Screening Guidance: User's Guide, incorporated by reference at Section 742.210; for carcinogens, the HBL is equal to a cancer risk of 1.0E-6, and for noncarcinogens is equal to a Hazard Quotient of 1.0. NOTE: These GW_{obj} concentrations are not equal to the Tier 1 Groundwater Remediation Objectives for the Direct Ingestion of Groundwater Component ~~Groundwater portion~~ of the Groundwater Ingestion Route, listed in Section 742.Appendix B, Table E.

[c] Value listed is also the Groundwater Quality Standard for this chemical pursuant to 35 Ill. Adm. Code 620.410 for Class I Groundwater or 35 Ill. Adm. Code 620.420 for Class II Groundwater.

Section 742.APPENDIX B: Tier 1 Tables and Illustrations

Illustration A: Tier 1 Evaluation



Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Table A: SSL Equations

Equations for Soil Ingestion Exposure Route	Remediation Objectives for Noncarcinogenic Contaminants (mg/kg)	$\frac{THQ \bullet BW \bullet AT \bullet 365\frac{d}{yr}}{\frac{1}{RfD_O} \bullet 10^{-6}\frac{kg}{mg} \bullet EF \bullet ED \bullet IR_{soil}}$	**S1**
	Remediation Objectives for Carcinogenic Contaminants - Residential (mg/kg)	$\frac{TR \bullet AT_c \bullet 365\frac{d}{yr}}{SF_o \bullet 10^{-6}\frac{kg}{mg} \bullet EF \bullet IF_{soil-adj}}$	**S2**
	Remediation Objectives for Carcinogenic Contaminants - Industrial/ Commercial, Construction Worker (mg/kg)	$\frac{TR \bullet BW \bullet AT_c \bullet 365\frac{d}{yr}}{SF_o \bullet 10^{-6}\frac{kg}{mg} \bullet EF \bullet ED \bullet IR_{soil}}$	**S3**
Equations for Inhalation Exposure Route (Volatiles)	Remediation Objectives for Noncarcinogenic Contaminants - Residential, Industrial/Commercial (mg/kg)	$\frac{THQ \bullet AT \bullet 365\frac{d}{yr}}{EF \bullet ED \bullet \left(\frac{1}{RfC} \bullet \frac{1}{VF}\right)}$	**S4**

Remediation Objectives for Noncarcinogenic Contaminants - Construction Worker (mg/kg)	$$\frac{THQ \bullet AT \bullet 365\frac{d}{yr}}{EF \bullet ED \bullet \left(\frac{1}{RfC} \bullet \frac{1}{VF'}\right)}$$	**S5**
Remediation Objectives for Carcinogenic Contaminants - Residential, Industrial/ Commercial (mg/kg)	$$\frac{TR \bullet AT_c \bullet 365\frac{d}{yr}}{URF \bullet 1{,}000\frac{ug}{mg} \bullet EF \bullet ED \bullet \frac{1}{VF}}$$	**S6**
Remediation Objectives for Carcinogenic Contaminants - Construction Worker (mg/kg)	$$\frac{TR \bullet AT_c \bullet 365\frac{d}{yr}}{URF \bullet 1{,}000\frac{ug}{mg} \bullet EF \bullet ED \bullet \frac{1}{VF'}}$$	**S7**
Equation for Derivation of the Volatilization Factor - Residential, Industrial/ Commercial, VF (m^3/kg)	$$VF = \frac{Q}{C} \bullet \frac{\left(3.14 \bullet D_A \bullet T\right)^{1/2}}{\left(2 \bullet \rho_b \bullet D_A\right)} \bullet 10^{-4}\ \frac{m^2}{cm^2}$$	**S8**
Equation for Derivation of the Volatilization Factor - Construction Worker, VF′ (m^3/kg)	$$VF' = \frac{VF}{10}$$	**S9**
Equation for Derivation of Apparent Diffusivity, D_A (cm^2/s)	$$D_A = \frac{\left(\theta_a^{3.33} \bullet D_i \bullet H'\right) + \left(\theta_w^{3.33} \bullet D_w\right)}{\eta^2} \bullet \frac{1}{\left(\rho_b \bullet K_d\right) + \theta_w + \left(\theta_a \bullet H'\right)}$$	**S10**

Equations for Inhalation Exposure Route (Fugitive Dusts)	Remediation Objectives for Noncarcinogenic Contaminants - Residential, Industrial/Commercial (mg/kg)	$\frac{THQ \bullet AT \bullet 365\frac{d}{yr}}{EF \bullet ED \bullet \left(\frac{1}{RfC} \bullet \frac{1}{PEF}\right)}$	**S11**
	Remediation Objectives for Noncarcinogenic Contaminants - Construction Worker (mg/kg)	$\frac{THQ \bullet AT \bullet 365\frac{d}{yr}}{EF \bullet ED \bullet \left(\frac{1}{RfC} \bullet \frac{1}{PEF'}\right)}$	**S12**
	Remediation Objectives for Carcinogenic Contaminants - Residential, Industrial/ Commercial (mg/kg)	$\frac{TR \bullet AT_c \bullet 365\frac{d}{yr}}{URF \bullet 1{,}000\frac{ug}{mg} \bullet EF \bullet ED \bullet \frac{1}{PEF}}$	**S13**
	Remediation Objectives for Carcinogenic Contaminants - Construction Worker (mg/kg)	$\frac{TR \bullet AT_c \bullet 365\frac{d}{yr}}{URF \bullet 1{,}000\frac{ug}{mg} \bullet EF \bullet ED \bullet \frac{1}{PEF'}}$	**S14**
	Equation for Derivation of Particulate Emission Factor, PEF (m^3/kg)	$PEF = \frac{Q}{C} \bullet \frac{3{,}600\frac{s}{hr}}{0.036 \bullet (1-V) \bullet \left(\frac{U_m}{U_t}\right)^3 \bullet F(x)}$	**S15**

	Equation for Derivation of Particulate Emission Factor, PEF′ - Construction Worker (m^3/kg)	$$PEF' = \frac{PEF}{10}$$ NOTE: PEF must be the industrial/commercial value	**S16**
Equations for the Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route	Remediation Objective (mg/kg)	$$C_w \bullet \left[K_d + \frac{\left(\theta_w + \theta_a \bullet H'\right)}{\rho_b} \right]$$ NOTE: This equation can only be used to model contaminant migration not in the water bearing unit.	**S17**
	Target Soil Leachate Concentration, C_w (mg/L)	$$C_w = DF \bullet GW_{obj}$$	**S18**
	Soil-Water Partition Coefficient, K_d (cm^3/g)	$$K_d = K_{oc} \bullet f_{oc}$$	**S19**
	Water-Filled Soil Porosity, θ_w (L_{water}/L_{soil})	$$\theta_w = \eta \bullet \left(\frac{I}{K_s} \right)^{1/(2b+3)}$$	**S20**
	Air-Filled Soil Porosity, θ_a (L_{air}/L_{soil})	$$\theta_a = \eta - \theta_w$$	**S21**
	Dilution Factor, DF (unitless)	$$DF = 1 + \frac{K \bullet i \bullet d}{I \bullet L}$$	**S22**

	Groundwater Remediation Objective for Carcinogenic Contaminants, GW_{obj} (mg/L)	$$\frac{TR \bullet BW \bullet AT_c \bullet 365\frac{d}{yr}}{SF_o \bullet IR_w \bullet EF \bullet ED}$$	**S23**
	Total Soil Porosity, η (L_{pore}/L_{soil})	$$\eta = 1 - \frac{\rho_b}{\rho_s}$$	**S24**
	Equation for Estimation of Mixing Zone Depth, d (m)	$$d = \left(0.0112 \bullet L^2\right)^{0.5} + d_a\left[1 - \exp\frac{(-L \bullet I)}{\left(K \bullet i \bullet d_a\right)}\right]$$	**S25**
Mass-Limit Equations for Inhalation Exposure Route and Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route	Mass-Limit Volatilization Factor for the Inhalation Exposure Route - Residential, Industrial/ Commercial, VF (m^3/kg)	$$VF_{M-L} = \frac{Q}{C} \bullet \frac{\left[T_{M-L} \bullet \left(3.15 \bullet 10^7 \frac{s}{yr}\right)\right]}{\rho_b \bullet d_s \bullet 10^6 \frac{g}{mg}}$$ NOTE: This equation may be used when area and depth of contaminant source are known or can be estimated reliably.	**S26**
	Mass-Limit Volatilization Factor for Inhalation Exposure Route - Construction Worker, VF′ - (m^3/kg)	$$VF'_{M-L} = \frac{VF_{M-L}}{10}$$	**S27**

	Mass-Limit Remediation Objective for Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route (mg/kg)	$\frac{\left(C_w \bullet I_{M-L} \bullet ED_{M-L}\right)}{\rho_b \bullet d_s}$ NOTE: This equation may be used when area and depth of contaminant source are known or can be estimated reliably.	**S28**
Equation for Derivation of the Soil Saturation Limit, C_{sat}		$C_{sat} = \frac{S}{\rho_b} \bullet \left[\left(K_d \bullet \rho_b\right) + \theta_w + \left(H' \bullet \theta_a\right)\right]$	**S29**

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Table B: SSL Parameters

Symbol	Parameter	Units	Source	Parameter Value(s)
AT	Averaging Time for Noncarcinogens in Ingestion Equation	yr		Residential = 6 Industrial/Commercial = 25 Construction Worker = 0.115
AT	Averaging Time for Noncarcinogens in Inhalation Equation	yr		Residential = 30 Industrial/Commercial = 25 Construction Worker = 0.115
AT_c	Averaging Time for Carcinogens	yr	SSL	70
BW	Body Weight	kg		Residential = 15, noncarcinogens 70, carcinogens Industrial/Commercial = 70 Construction Worker = 70
C_{sat}	Soil Saturation Concentration	mg/kg	Appendix A, Table A or Equation S29 in Appendix C, Table A	Chemical-Specific or Calculated Value
C_w	Target Soil Leachate Concentration	mg/L	Equation S18 in Appendix C, Table A	Groundwater Standard, Health Advisory concentration, or Calculated Value
d	Mixing Zone Depth	m	SSL or Equation S25 in Appendix C, Table A	2 m or Calculated Value
d_a	Aquifer Thickness	m	Field Measurement	Site-Specific

Symbol	Parameter	Units	Source	Parameter Value(s)
d_s	Depth of Source	m	Field Measurement or Estimation	Site-Specific
D_A	Apparent Diffusivity	cm^2/s	Equation S10 in Appendix C, Table A	Calculated Value
D_i	Diffusivity in Air	cm^2/s	Appendix C, Table E	Chemical-Specific
D_w	Diffusivity in Water	cm^2/s	Appendix C, Table E	Chemical-Specific
DF	Dilution Factor	unitless	Equation S22 in Appendix C, Table A	20 or Calculated Value
ED	Exposure Duration for Ingestion of Carcinogens	yr		Industrial/Commercial = 25 Construction Worker = 1
ED	Exposure Duration for Inhalation of Carcinogens	yr		Residential = 30 Industrial/Commercial = 25 Construction Worker = 1
ED	Exposure Duration for Ingestion of Noncarcinogens	yr		Residential = 6 Industrial/Commercial = 25 Construction Worker = 1
ED	Exposure Duration for Inhalation of Noncarcinogens	yr		Residential = 30 Industrial/Commercial = 25 Construction Worker = 1
ED	Exposure Duration for the Direct Ingestion of Groundwater	yr		Residential = 30 Industrial/Commercial = 25 Construction Worker = 1

Symbol	Parameter	Units	Source	Parameter Value(s)
ED_{M-L}	Exposure Duration for Migration to Groundwater Mass-Limit Equation S28	yr	SSL	70
EF	Exposure Frequency	d/yr		Residential = 350 Industrial/Commercial = 250 Construction Worker = 30
F(x)	Function dependent on U_m/U_t	unitless	SSL	0.194
f_{oc}	Organic Carbon Content of Soil	g/g	SSL or Field Measurement (See Appendix C, Table F)	Surface Soil = 0.006 Subsurface soil = 0.002, or Site-Specific
GW_{obj}	Groundwater Cleanup Objective	mg/L	Appendix B, Table E, 35 IAC 620.Subpart F, or Equation S23 in Appendix C, Table A	Chemical-Specific or Calculated
H'	Henry's Law Constant	unitless	Appendix C, Table E	Chemical-Specific
i	Hydraulic Gradient	m/m	Field Measurement (See Appendix C, Table F)	Site-Specific
I	Infiltration Rate	m/yr	SSL	0.3
I_{M-L}	Infiltration Rate for Migration to Groundwater Mass-Limit Equation S28	m/yr	SSL	0.18

Symbol	Parameter	Units	Source	Parameter Value(s)
$IF_{soil-adj}$ (residential)	Age Adjusted Soil Ingestion Factor for Carcinogens	(mg-yr)/(kg-d)	SSL	~~Residential =~~ 114
IR_{soil}	Soil Ingestion Rate	mg/d		Residential = 200 Industrial/Commercial = 50 Construction Worker = 480
IR_W	Daily Water Ingestion Rate	L/d		Residential = 2 Industrial/Commercial = 1
K	Aquifer Hydraulic Conductivity	m/yr	Field Measurement (See Appendix C, Table F)	Site-Specific
K_d	Soil-Water Partition Coefficient	cm^3/g or L/kg	Equation S19 in Appendix C, Table A	Calculated Value
K_{oc}	Organic Carbon Partition Coefficient	cm^3/g or L/kg	Appendix C, Table E or Appendix C, Table I	Chemical-Specific
K_s	Saturated Hydraulic Conductivity	m/yr	Appendix C, Table K Appendix C, Illustration C	Site-Specific
L	Source Length Parallel to Groundwater Flow	m	Field Measurement	Site-Specific
PEF	Particulate Emission Factor	m^3/kg	SSL or Equation S15 in Appendix C, Table A	Residential = $1.32 \bullet 10^9$ or Site-Specific Industrial/Commercial = $1.24 \bullet 10^9$ or Site-Specific
PEF′	Particulate Emission Factor adjusted for Agitation (construction worker)	m^3/kg	Equation S16 in Appendix C, Table A using PEF (industrial/commercial)	$1.24 \bullet 10^8$ or Site-Specific

Symbol	Parameter	Units	Source	Parameter Value(s)
Q/C (used in VF equations)	Inverse of the mean concentration at the center of a square source	$(g/m^2\text{-}s)/(kg/m^3)$	Appendix C, Table H	Residential = 68.81 Industrial/Commercial = 85.81 Construction Worker = 85.81
Q/C (used in PEF equations)	Inverse of the mean concentration at the center of a square source	$(g/m^2\text{-}s)/(kg/m^3)$	SSL or Appendix C, Table H	Residential = 90.80 Industrial/Commercial = 85.81 Construction Worker = 85.81
RfC	Inhalation Reference Concentration	mg/m^3	IEPA (IRIS/HEAST[a])	Toxicological-Specific (Note: for Construction Workers use subchronic reference concentrations)
RfD_o	Oral Reference Dose	mg/(kg-d)	IEPA (IRIS/HEAST[a])	Toxicological-Specific (Note: for Construction Worker use subchronic reference doses)
S	Solubility in Water	mg/L	Appendix C, Table E	Chemical-Specific
SF_o	Oral Slope Factor	$(mg/kg\text{-}d)^{-1}$	IEPA (IRIS/HEAST[a])	Toxicological-Specific
T	Exposure Interval	s		Residential = $9.5 \bullet 10^8$ Industrial/Commercial = $7.9 \bullet 10^8$ Construction Worker = $3.6 \bullet 10^6$
$T_{M\text{-}L}$	Exposure Interval for Mass-Limit Volatilization Factor Equation S26	yr	SSL	30
THQ	Target Hazard Quotient	unitless	SSL	1

Symbol	Parameter	Units	Source	Parameter Value(s)
TR	Target Cancer Risk	unitless		Residential = 10^{-6} at the point of human exposure Industrial/Commercial = 10^{-6} at the point of human exposure Construction Worker = 10^{-6} at the point of human exposure
U_m	Mean Annual Windspeed	m/s	SSL	4.69
URF	Inhalation Unit Risk Factor	$(ug/m^3)^{-1}$	IEPA (IRIS/HEAST[a])	Toxicological-Specific
U_t	Equivalent Threshold Value of Windspeed at 7 m	m/s	SSL	11.32
V	Fraction of Vegetative Cover	unitless	SSL or Field Measurement	0.5 or Site-Specific
VF	Volatilization Factor	m^3/kg	Equation S8 in Appendix C, Table A	Calculated Value
VF′	Volatilization Factor adjusted for Agitation	m^3/kg	Equation S9 in Appendix C, Table A	Calculated Value
VF_{M-L}	Mass-Limit Volatilization Factor	m^3/kg	Equation S26 in Appendix C, Table A	Calculated Value
VF'_{M-L}	Mass-Limit Volatilization Factor adjusted for Agitation	m^3/kg	Equation S27 in Appendix C, Table A	Calculated Value

Symbol	Parameter	Units	Source	Parameter Value(s)
η	Total Soil Porosity	L_{pore}/L_{soil}	SSL or Equation S24 in Appendix C, Table A	0.43, or Gravel = 0.25 Sand = 0.32 Silt = 0.40 Clay = 0.36, or Calculated Value
θ_a	Air-Filled Soil Porosity	L_{air}/L_{soil}	SSL or Equation S21 in Appendix C, Table A	Surface Soil (top 1 meter) = 0.28 Subsurface Soil (below 1 meter) = 0.13, or Gravel = 0.05 Sand = 0.14 Silt - 0.24 Clay = 0.19, or Calculated Value
θ_w	Water-Filled Soil Porosity	L_{water}/L_{soil}	SSL or Equation S20 in Appendix C, Table A	Surface Soil (top 1 meter) = 0.15 Subsurface Soil (below 1 meter) = 0.30, or Gravel = 0.20 Sand = 0.18 Silt = 0.16 Clay = 0.17, or Calculated Value

Symbol	Parameter	Units	Source	Parameter Value(s)
ρ_b	Dry Soil Bulk Density	kg/L or g/cm^3	SSL or Field Measurement (See Appendix C, Table F)	1.5, or Gravel = 2.0 Sand = 1.8 Silt = 1.6 Clay = 1.7, or Site-Specific
ρ_s	Soil Particle Density	g/cm^3	SSL or Field Measurement (See Appendix C, Table F)	2.65, or Site-Specific
ρ_w	Water Density	g/cm^3	SSL	1
1/(2b+3)	Exponential in Equation S20	unitless	Appendix C, Table K Appendix C, Illustration C	Site-Specific

a HEAST = Health Effects Assessment Summary Tables. USEPA, Office of Solid Waste and Emergency Response. EPA/SQO/R-95/036. Updated Quarterly.

Section 742.Appendix C: Tier 2 Tables and Illustrations

Table C: RBCA Equations

Equations for the combined exposures routes of soil ingestion inhalation of vapors and particulates, and dermal contact with soil	Remediation Objectives for Carcinogenic Contaminants (mg/kg)	$$\frac{TR \bullet BW \bullet AT_C \bullet 365\frac{d}{yr}}{EF \bullet ED \bullet \left\{\left[SF_o \bullet 10^{-6}\frac{kg}{mg} \bullet \left(\left(IR_{soil} \bullet RAF_o\right) + \left(SA \bullet M \bullet RAF_d\right)\right)\right] + \left[SF_i \bullet IR_{air} \bullet \left(VF_{ss} + VF_p\right)\right]\right\}}$$	**R1**
	Remediation Objectives for Non-carcinogenic Contaminants (mg/kg)	$$\frac{THQ \bullet BW \bullet AT_n \bullet 365\frac{d}{yr}}{EF \bullet ED \bullet \left[\frac{10^{-6}\frac{kg}{mg}\left[\left(IR_{soil} \bullet RAF_o\right) + \left(SA \bullet M \bullet RAF_d\right)\right]}{RfD_o} + \frac{IR_{air} \bullet \left(VF_{ss} + VF_p\right)}{RfD_i}\right]}$$	**R2**
	Volatilization Factor for Surficial Soils, VF_{ss} (kg/m^3) Whichever is less between R3 and R4	$$\frac{\bullet W \bullet \mathrm{r}_s \quad 10^3\frac{cm^3 \cdot}{m^3 \cdot g}}{{}_{air}\,\mathrm{d}} \bullet \sqrt{\frac{D_s^{eff} \bullet H}{\mathrm{p} \bullet \left[\mathrm{q} + \left({}_s\ \mathrm{r}_s\right) + \left(H'\ \mathrm{q}\right)\right] \bullet \mathrm{t}}}$$	**R3**
		$$VF_{ss} = \frac{W \bullet \mathrm{r}_s \bullet d \bullet 10^3\frac{cm^3 \cdot kg}{m^3 \cdot g}}{U_{air} \bullet \mathrm{d}_{air} \bullet \mathrm{t}}$$	**R4**

	Volatilization Factor for Surficial Soils Regarding Particulates, VF_p (kg/m^3)	$$VF_p = \frac{P_e \bullet W \bullet 10^3 \frac{cm^3 \cdot kg}{m^3 \cdot g}}{U_{air} \bullet \delta_{air}}$$	**R5**
	Effective Diffusion Coefficient in Soil Based on Vapor-Phase Concentration D_s^{eff} (cm^2/s)	$$D_s^{eff} = \frac{D^{air} \bullet \theta_{as}^{3.33}}{\theta_T^2} + \frac{D^{water} \bullet \theta_{ws}^{3.33}}{H' \bullet \theta_T^2}$$	**R6**
Equations for the ambient vapor inhalation (outdoor) route from subsurface soils	Remediation Objectives for Carcinogenic Contaminants (mg/kg)	$$\frac{RBSL_{air} \bullet 10^{-3}}{VF_{samb}}$$	**R7**
	Remediation Objectives for Non-carcinogenic Contaminants (mg/kg)	$$\frac{RBSL_{air} \bullet 10^{-3}}{VF_{samb}}$$	**R8**

	Carcinogenic Risk-Based Screening Level for Air, $RBSL_{air}$ (ug/m^3)	$$RBSL_{air} = \frac{TR \bullet BW \bullet AT_c \bullet 365 \frac{d}{yr} \bullet 10^3 \frac{ug}{mg}}{SF_i \bullet IR_{air} \bullet EF \bullet ED}$$	**R9**
	Noncarcinogenic Risk-Based Screening Level for Air, $RBSL_{air}$ (ug/m^3)	$$RBSL_{air} = \frac{THQ \bullet RfD_i \bullet BW \bullet AT_n \bullet 365 \frac{d}{yr} \bullet 10^3 \frac{ug}{mg}}{IR_{air} \bullet EF \bullet ED}$$	**R10**
	Volatilization Factor - Subsurface Soil to Ambient Air, VF_{samb} $(mg/m^3)/(mg/kg_{soil})$	$$VF_{samb} = \frac{H' \bullet \rho_s \bullet 10^3 \frac{cm^3 \cdot kg}{m^3 \cdot g}}{\left[\theta_{ws} + \left(k_s \bullet \rho_s\right) + \left(H' \bullet \theta_{as}\right)\right] \bullet \left[1 + \frac{\left(U_{air} \bullet \delta_{air} \bullet L_s\right)}{\left(D_s^{eff} \bullet W\right)}\right]}$$	**R11**

Equations for the Soil~~Migration to~~ Component~~Groundwater Portion~~ of the Groundwater Ingestion Exposure Route	Remediation Objective (mg/kg)	$\frac{GW_{source}}{LF_{sw}}$ NOTE: This equation can only be used to model contaminant migration not in the water bearing unit.	**R12**
	Groundwater at the source, GW_{source} (mg/L)	$GW_{source} = \frac{GW_{comp}}{C_{(x)} / C_{source}}$	**R13**
	Leaching Factor, LF_{sw} $(mg/L_{water})/(mg/kg_{soil})$	$LF_{sw} = \frac{r_s \bullet \frac{cm^3 \cdot kg}{L \cdot g}}{\left[q_{ws} + \left(k_s \bullet r_s\right) + \left(H' \bullet q_{as}\right)\right] \bullet \left[1 + \frac{\left(U_{gw} \bullet d_{gw}\right)}{\left(I \bullet W\right)}\right]}$	**R14**
	Steady-State Attenuation Along the Centerline of a Dissolved Plume, $C_{(x)}/C_{source}$	$C_{(x)} / C_{source} = \exp\left[\left(\frac{X}{2a_x}\right) \bullet \left(1 - \sqrt{1 + \frac{4l \bullet a_x}{U}}\right)\right] \bullet erf\left[\frac{S_w}{4 \bullet \sqrt{a_y \bullet X}}\right] \bullet erf\left[\frac{S_d}{2 \bullet \sqrt{a_z \bullet X}}\right]$ NOTE: 1. This equation does not predict the contaminant flow within bedrock. 2. If the value of the First Order Degradation Constant (λ) is not readily available, then set $\lambda = 0$.	**R15**
	Longitudinal Dispersivity, α_x (cm)	$a_x = 0.10 \bullet X$	**R16**

Transverse Dispersivity, α_y (cm)	$a_y = \frac{a_x}{3}$	**R17**
Vertical Dispersivity, α_z (cm)	$a_z = \frac{a_x}{20}$	**R18**
Specific Discharge, U (cm/d)	$U = \frac{K \bullet i}{q_T}$	**R19**
Soil-Water Sorption Coefficient, k_s	$k_s = K_{oc} \bullet f_{oc}$	**R20**
Volumetric Air Content in Vadose Zone Soils, θ_{as} (cm^3_{air}/cm^3_{soil})	$q_{as} = q_T - \frac{(w \bullet r_s)}{r_w}$	**R21**
Volumetric Water Content in Vadose Zone Soils, θ_{ws} (cm^3_{water}/cm^3_{soil})	$q_{ws} = \frac{w \bullet r_s}{r_w}$	**R22**
Total Soil Porosity, θ_T (cm^3/cm^3_{soil})	$q_T = q_{as} + q_{ws}$	**R23**

	Groundwater Darcy Velocity, U_{gw} (cm/yr)	$$U_{gw} = K \bullet i$$	**R24**
Equations for the Groundwater Ingestion Exposure Route	Remediation Objective for Carcinogenic Contaminants (mg/L)	$$\frac{TR \bullet BW \bullet AT_c \bullet 365 \frac{d}{yr}}{SF_o \bullet IR_w \bullet EF \bullet ED}$$	**R25**
	Dissolved Hydrocarbon Concentration along Centerline, $C_{(x)}$ (g/cm^3_{water})	$$C_{(x)} = C_{source} \bullet \exp\left[\left(\frac{X}{2a_x}\right) \bullet \left(1 - \sqrt{1 + \frac{4\lambda \bullet a_x}{U}}\right)\right] \bullet erf\left[\frac{S_w}{4 \bullet \sqrt{a_y \bullet X}}\right] \bullet erf\left[\frac{S_d}{2 \bullet \sqrt{a_z \bullet X}}\right]$$ NOTE: 1. This equation does not predict the contaminant flow within bedrock. 2. If the value of the First Order Degradation Constant (λ) is not readily available, then set λ = 0.	**R26**

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Table D: RBCA Parameters

Symbol	Parameter	Units	Source	Parameter Value(s)
AT_c	Averaging Time for Carcinogens	yr	RBCA	70
AT_n	Averaging Time for Noncarcinogens	yr	RBCA	Residential = 30 Industrial/Commercial = 25 Construction Worker = 0.115
BW	Adult Body Weight	kg	RBCA	70
C_{source}	The greatest potential concentration of the contaminant of concern in the groundwater at the source of the contamination, based on the concentrations of contaminants in groundwater due to the release and the projected concentration of the contaminant migrating from the soil to the groundwater.	mg/L	Field Measurement	Site-Specific
$C_{(x)}$	Concentration of Contaminant in Groundwater at Distance X from the source	mg/L	Equation R26 in Appendix C, Table C	Calculated Value

Symbol	Parameter	Units	Source	Parameter Value(s)
$C_{(x)}/C_{source}$	Steady-State Attenuation Along the Centerline of a Dissolved Plume	unitless	Equation R15 in Appendix C, Table C	Calculated Value
d	Lower Depth of Surficial Soil Zone	cm	Field Measurement	100 or Site-Specific (not to exceed 100)
D^{air}	Diffusion Coefficient in Air	cm^2/s	Appendix C, Table E	Chemical-Specific
D^{water}	Diffusion Coefficient in Water	cm^2/s	Appendix C, Table E	Chemical-Specific
D_s^{eff}	Effective Diffusion Coefficient in Soil Based on Vapor-Phase Concentration	cm^2/s	Equation R6 in Appendix C, Table C	Calculated Value
ED	Exposure Duration	yr	RBCA	Residential = 30 Industrial/Commercial = 25 Construction Worker = 1
EF	Exposure Frequency	d/yr	RBCA	Residential = 350 Industrial/Commercial = 250 Construction Worker = 30
erf	Error Function	unitless	Appendix C, Table G	Mathematical Function

Symbol	Parameter	Units	Source	Parameter Value(s)
f_{oc}	Organic Carbon Content of Soil	g/g	RBCA or Field Measurement (See Appendix C, Table F)	Surface Soil = 0.006 Subsurface Soil = 0.002 or Site-Specific
GW_{comp}	Groundwater Objective at the Compliance Point	mg/L	Appendix B, Table E, 35 IAC 620.Subpart F, or Equation R25 in Appendix C, Table C	Site-Specific
GW_{source}	Groundwater Concentration at the Source	mg/L	Equation R13 in Appendix C, Table C	Calculated Value
H’	Henry’s Law Constant	cm^3_{water}/cm^3_{air}	Appendix C, Table E	Chemical-Specific
i	Hydraulic Gradient	cm/cm (unitless)	Field Measurement (See Appendix C, Table F)	Site-Specific
I	Infiltration Rate	cm/yr	RBCA	30
IR_{air}	Daily Outdoor Inhalation Rate	m^3/d	RBCA	20
IR_{soil}	Soil Ingestion Rate	mg/d	RBCA	Residential = 100 Industrial/Commercial = 50 Construction Worker = 480
IR_w	Daily Water Ingestion Rate	L/d	RBCA	Residential = 2 Industrial/Commercial = 1

Symbol	Parameter	Units	Source	Parameter Value(s)
K	Aquifer Hydraulic Conductivity	cm/d for Equations R15, R19 and R26 cm/yr for Equation R24	Field Measurement (See Appendix C, Table F)	Site-Specific
K_{oc}	Organic Carbon Partition Coefficient	cm^3/g or L/kg	Appendix C, Table E or Appendix C, Table I	Chemical-Specific
k_s (non-ionizing organics)	Soil Water Sorption Coefficient	cm^3_{water}/g_{soil}	Equation R20 in Appendix C,Table C	Calculated Value
k_s (ionizing organics)	Soil Water Sorption Coefficient	cm^3_{water}/g_{soil}	Equation R20 in Appendix C, Table C	Chemical-Specific
k_s (inorganics)	Soil Water Sorption Coefficient	cm^3_{water}/g_{soil}	Appendix C,Table J	Chemical-Specific
L_s	Depth to Subsurface Soil Sources	cm	RBCA	100
LF_{sw}	Leaching Factor	$(mg/L_{water})/(mg/kg_{soil})$	Equation R14 in Appendix C, Table C	Calculated Value
M	Soil to Skin Adherence Factor	mg/cm^2	RBCA	0.5

Symbol	Parameter	Units	Source	Parameter Value(s)
Pe	Particulate Emission Rate	g/cm^2-s	RBCA	$6.9 \bullet 10^{-14}$
RAF_d	Dermal Relative Absorption Factor	unitless	RBCA	0.5
RAF_d (PNAs)	Dermal Relative Absorption Factor	unitless	RBCA	0.05
RAF_d (inorganics)	Dermal Relative Absorption Factor	unitless	RBCA	0
RAF_o	Oral Relative Absorption Factor	unitless	RBCA	1.0
$RBSL_{air}$	Carcinogenic Risk-Based Screening Level for Air	ug/m^3	Equation R9 in Appendix C, Table C	Chemical-, Media-, and Exposure Route-Specific
$RBSL_{air}$	Noncarcinogenic Risk-Based Screening Level for Air	ug/m^3	Equations R10 in Appendix C, Table C	Chemical-, Media-, and Exposure Route-Specific
RfD_i	Inhalation Reference Dose	mg/kg-d	IEPA (IRIS/HEAST[a])	Toxicological-Specific
RfD_o	Oral Reference Dose	mg/(kg-d)	IEPA (IRIS/HEAST[a])	Toxicological-Specific (Note: for Construction Worker use subchronic reference doses)
SA	Skin Surface Area	cm^2/d	RBCA	3,160

Symbol	Parameter	Units	Source	Parameter Value(s)
S_d	Source Width Perpendicular to Groundwater Flow Direction in Vertical Plane	cm	Field Measurement	For Migration to Groundwater Route: Use 200 or Site-Specific For Groundwater cleanup objective: Use Site-Specific
S_w	Source Width Perpendicular to Groundwater Flow Direction in Horizontal Plane	cm	Field Measurement	Site-Specific
SF_i	Inhalation Cancer Slope Factor	$(mg/kg\text{-}d)^{-1}$	IEPA (IRIS/HEAST[a])	Toxicological-Specific
SF_o	Oral Slope Factor	$(mg/kg\text{-}d)^{-1}$	IEPA (IRIS/HEAST[a])	Toxicological-Specific
THQ	Target Hazard Quotient	unitless	RBCA	1
TR	Target Cancer Risk	unitless	RBCA	Residential = 10^{-6} at the point of human exposure Industrial/Commercial = 10^{-6} at the point of human exposure Construction Worker = 10^{-6} at the point of human exposure
U	Specific Discharge	cm/d	Equation R19 in Appendix C, Table C	Calculated Value

Symbol	Parameter	Units	Source	Parameter Value(s)
U_{air}	Average Wind Speed Above Ground Surface in Ambient Mixing Zone	cm/s	RBCA	225
U_{gw}	Groundwater Darcy Velocity	cm/yr	Equation R24 in Appendix C, Table C	Calculated Value
VF_{p}	Volatilization Factor for Surficial Soils Regarding Particulates	kg/m^3	Equation R5 in Appendix C, Table C	Calculated Value
VF_{samb}	Volatilization Factor (Subsurface Soils to Ambient Air)	$(mg/m^3_{air})/(mg/kg_{soil})$ or kg/m^3	Equation R11 in Appendix C, Table C	Calculated Value
VF_{ss}	Volatilization Factor for Surficial Soils	kg/m^3	Use Equations R3 and R4 in Appendix C, Table C	Calculated Value from Equation R3 or R4 (whichever is less)
W	Width of Source Area Parallel to Direction to Wind or Groundwater Movement	cm	Field Measurement	Site-Specific

Symbol	Parameter	Units	Source	Parameter Value(s)
w	Average Soil Moisture Content	g_{water}/g_{soil}	RBCA or Field Measurement (See Appendix C, Table F)	0.1, or Surface Soil (top 1 meter) = 0.1 Subsurface Soil (below 1 meter) = 0.2, or Site-Specific
X	Distance along the Centerline of the Groundwater Plume Emanating from a Source. The x direction is the direction of groundwater flow	cm	Field Measurement	Site-Specific
α_x	Longitudinal Dispersitivity	cm	Equation R16 in Appendix C, Table C	Calculated Value
α_y	Transverse Dispersitivity	cm	Equation R17 in Appendix C, Table C	Calculated Value
α_z	Vertical Dispersitivity	cm	Equation R18 in Appendix C, Table C	Calculated Value
δ_{air}	Ambient Air Mixing Zone Height	cm	RBCA	200

Symbol	Parameter	Units	Source	Parameter Value(s)
δ_{gw}	Groundwater Mixing Zone Thickness	cm	RBCA	200
θ_{as}	Volumetric Air Content in Vadose Zone Soils	cm^3_{air}/cm^3_{soil}	RBCA or Equation R21 in Appendix C, Table C	Surface Soil (top 1 meter) = 0.28 Subsurface Soil (below 1 meter)= 0.13, or Gravel = 0.05 Sand = 0.14 Silt = 0.16 Clay = 0.17, or Calculated Value
θ_{ws}	Volumetric Water Content in Vadose Zone Soils	cm^3_{water}/cm^3_{soil}	RBCA or Equation R22 in Appendix C, Table C	Surface Soil (top 1 meter) = 0.15 Subsurface Soil (below 1 meter) = 0.30, or Gravel = 0.20 Sand = 0.18 Silt = 0.16 Clay = 0.17, or Calculated Value

Symbol	Parameter	Units	Source	Parameter Value(s)
θ_T	Total Soil Porosity	cm^3/cm^3_{soil}	RBCA or Equation R23 in Appendix C, Table C	0.43, or Gravel = 0.25 Sand = 0.32 Silt = 0.40 Clay = 0.36, or Calculated Value
λ	First Order Degradation Constant	d^{-1}	Appendix C, Table E	Chemical-Specific
π	pi			3.1416
ρ_s	Soil Bulk Density	g/cm^3	RBCA or Field Measurement (See Appendix C, Table F)	1.5, or Gravel = 2.0 Sand = 1.8 Silt = 1.6 Clay = 1.7, or Site-Specific
ρ_w	Water Density	g/cm^3	RBCA	1
τ	Averaging Time for Vapor Flux	s	RBCA	$9.46 \bullet 10^8$

[a] HEAST = Health Effects Assessment Summary Tables. USEPA, Office of Solid Waste and Emergency Response. EPA/540/R-95/036. Updated Quarterly.

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Table E: Default Physical and Chemical Parameters

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
Neutral Organics							
83-32-9	Acenaphthene	4.24	0.0421	7.69E-6	0.00636	7,080	0.0034
67-64-1	Acetone	1,000,000	0.124	1.14E-5	0.00159	0.575	0.0495
15972-60-8	Alachlor	242	0.0198	5.69E-6	0.00000132	394	No Data
116-06-3	Aldicarb	6,000	0.0305	7.19E-6	0.0000000574	12	0.00109
309-00-2	Aldrin	0.18	0.0132	4.86E-6	0.00697	2,450,000	0.00059
120-12-7	Anthracene	0.0434	0.0324	7.74E-6	0.00267	29,500	0.00075
1912-24-9	Atrazine	70	0.0258	6.69E-6	0.00000005	451	No Data
71-43-2	Benzene	1,750	0.088	9.80E-6	0.228	58.9	0.0009

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
56-55-3	Benzo(a)anthracene	0.0094	0.0510	9.00E-6	0.000137	398,000	0.00051
205-99-2	Benzo(b)fluoranthene	0.0015	0.0226	5.56E-6	0.00455	1,230,000	0.00057
207-08-9	Benzo(k)fluoranthene	0.0008	0.0226	5.56E-6	0.000034	1,230,000	0.00016
65-85-0	Benzoic Acid	3,500	0.0536	7.97E-6	0.0000631	0.600	No Data
50-32-8	Benzo(a)pyrene	0.00162	0.043	9.00E-6	0.0000463	1,020,000	0.00065
111-44-4	Bis(2-chloroethyl)ether	17,200	0.0692	7.53E-6	0.000738	15.5	0.0019
117-81-7	Bis(2-ethylhexyl)phthalate	0.34	0.0351	3.66E-6	0.00000418	15,100,000	0.0018
75-27-4	Bromodichloromethane	6,740	0.0298	1.06E-5	0.0656	55.0	No Data
75-25-2	Bromoform	3,100	0.0149	1.03E-5	0.0219	87.1	0.0019
71-36-3	Butanol	74,000	0.0800	9.30E-6	0.000361	6.92	0.01283
85-68-7	Butyl Benzyl Phthalate	2.69	0.0174	4.83E-6	0.0000517	57,500	0.00385
86-74-8	Carbazole	7.48	0.0390	7.03E-6	0.000000626	3,390	No Data

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
1563-66-2	Carbofuran	320	0.0249	6.63E-6	.00377	37	No Data
75-15-0	Carbon Disulfide	1,190	0.104	1.00E-5	1.24	45.7	No Data
56-23-5	Carbon Tetrachloride	793	0.0780	8.80E-6	1.25	174	0.0019
57-74-9	Chlordane	0.056	0.0118	4.37E-6	0.00199	120,000	0.00025
106-47-8	p-Chloroaniline	5,300	0.0483	1.01E-5	0.0000136	66.1	No Data
108-09-7	Chlorobenzene	472	0.0730	8.70E-6	0.152	219	0.0023
124-48-1	Chlorodibromomethane	2,600	0.0196	1.05E-5	0.0321	63.1	0.00385
67-66-3	Chloroform	7,920	0.104	1.00E-5	0.15	39.8	0.00039
95-57-8	2-Chlorophenol	22,000	0.0501	9.46E-6	0.016	388	No Data
218-01-9	Chrysene	0.0016	0.0248	6.21E-6	0.00388	398,000	0.00035
94-75-7	2,4-D	680	0.0231	7.31E-6	0.00000041	451	0.00385
72-54-8	4,4'-DDD	0.09	0.0169	4.76E-6	0.000164	1,000,000	0.000062

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
72-55-9	4,4'-DDE	0.12	0.0144	5.87E-6	0.000861	4,470,000	0.000062
50-29-3	4,4'-DDT	0.025	0.0137	4.95E-6	0.000332	2,630,000	0.000062
75-99-0	Dalapon	900,000	0.0414	9.46E-6	0.00000264	5.8	0.005775
53-70-3	Dibenzo(a,h)anthracene	0.00249	0.0202	5.18E-6	0.000000603	3,800,000	0.00037
96-12-8	1,2-Dibromo-3-chloropropane	1,200	0.0212	7.02E-6	0.00615	182	0.001925
106-93-4	1,2-Dibromoethane	4,200	0.0287	8.06E-6	0.0303	93	0.005775
84-74-2	Di-n-butyl Phthalate	11.2	0.0438	7.86E-6	0.0000000385	33,900	0.03013
95-50-1	1,2-Dichlorobenzene	156	0.0690	7.90E-6	0.0779	617	0.0019
106-46-7	1,4-Dichlorobenzene	73.8	0.0690	7.90E-6	0.0996	617	0.0019
91-94-1	3,3-Dichlorobenzidine	3.11	0.0194	6.74E-6	0.000000164	724	0.0019

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
75-34-3	1,1-Dichloroethane	5,060	0.0742	1.05E-5	0.23	31.6	0.0019
107-06-2	1,2-Dichloroethane	8,520	0.104	9.90E-6	0.0401	17.4	0.0019
75-35-4	1,1-Dichloroethylene	2,250	0.0900	1.04E-5	1.07	58.9	0.0053
156-59-2	cis-1,2-Dichloroethylene	3,500	0.0736	1.13E-5	0.167	35.5	0.00024
156-60-5	trans-1,2-Dichloroethylene	6,300	0.0707	1.19E-5	0.385	52.5	0.00024
120-83-2	2,4-Dichlorophenol	4,500	0.0346	8.77E-6	0.00013	147	0.00027
78-87-5	1,2-Dichloropropane	2,800	0.0782	8.73E-6	0.115	43.7	0.00027
542-75-6	1,3-Dichloropropylene (cis + trans)	2,800	0.0626	1.00E-5	0.726	45.7	0.061
60-57-1	Dieldrin	0.195	0.0125	4.74E-6	0.000619	21,400	0.00032
84-66-2	Diethyl Phthalate	1,080	0.0256	6.35E-6	0.0000185	288	0.00619
105-67-9	2,4-Dimethylphenol	7,870	0.0584	8.69E-6	0.000082	209	0.0495
51-28-5	2,4-Dinitrophenol	2,790	0.0273	9.06E-6	0.0000182	0.01	0.00132

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
121-14-2	2,4-Dinitrotoluene	270	0.203	7.06E-6	0.0000038	95.5	0.00192
606-20-2	2,6-Dinitrotoluene	182	0.0327	7.26E-6	0.0000306	69.2	0.00192
88-85-7	Dinoseb	52	0.0215	6.62E-6	0.0000189	1,120	0.002817
117-84-0	Di-n-octyl Phthalate	0.02	0.0151	3.58E-6	0.00274	83,200,000	0.0019
115-29-7	Endosulfan	0.51	0.0115	4.55E-6	0.000459	2,140	0.07629
145-73-3	Endothall	21,000	0.0291	8.07E-6	0.0000000107	0.29	No Data
72-20-8	Endrin	0.25	0.0125	4.74E-6	0.000308	12,300	0.00032
100-41-4	Ethylbenzene	169	0.0750	7.80E-6	0.323	363	0.003
206-44-0	Fluoranthene	0.206	0.0302	6.35E-6	0.00066	107,000	0.00019
86-73-7	Fluorene	1.98	0.0363	7.88E-6	0.00261	13,800	0.000691
76-44-8	Heptachlor	0.18	0.0112	5.69E-6	60.7	1,410,000	0.13
1024-57-3	Heptachlor epoxide	0.2	0.0132	4.23E-6	0.00039	83,200	0.00063

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
118-74-1	Hexachlorobenzene	6.2	0.0542	5.91E-6	0.0541	55,000	0.00017
319-84-6	alpha-HCH (alpha-BHC)	2.0	0.0142	7.34E-6	0.000435	1,230	0.0025
58-89-9	gamma-HCH (Lindane)	6.8	0.0142	7.34E-6	0.000574	1,070	0.0029
77-47-4	Hexachlorocyclo-pentadiene	1.8	0.0161	7.21E-6	1.11	200,000	0.012
67-72-1	Hexachloroethane	50	0.0025	6.80E-6	0.159	1,780	0.00192
193-39-5	Indeno(1,2,3-c,d)pyrene	0.000022	0.0190	5.66E-6	0.0000656	3,470,000	0.00047
78-59-1	Isophorone	12,000	0.0623	6.76E-6	0.000272	46.8	0.01238
7439-97-6	Mercury	---	0.0307	6.30E-6	0.467	---	No Data
72-43-5	Methoxychlor	0.045	0.0156	4.46E-6	0.000648	97,700	0.0019
74-83-9	Methyl Bromide	15,200	0.0728	1.21E-5	0.256	10.5	0.01824
75-09-2	Methylene Chloride	13,000	0.101	1.17E-5	0.0898	11.7	0.012
95-48-7	2-Methylphenol	26,000	0.0740	8.30E-6	0.0000492	91.2	0.0495

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
91-20-3	Naphthalene	31.0	0.0590	7.50E-6	0.0198	2,000	0.0027
98-95-3	Nitrobenzene	2,090	0.0760	8.60E-6	0.000984	64.6	0.00176
86-30-6	N-Nitrosodiphenylamine	35.1	0.0312	6.35E-6	0.000205	1,290	0.01
621-64-7	N-Nitrosodi-n-propylamine	9,890	0.0545	8.17E-6	0.0000923	24.0	0.0019
87-86-5	Pentachlorophenol	1,950	0.0560	6.10E-6	0.000001	592	0.00045
108-95-2	Phenol	82,800	0.0820	9.10E-6	0.0000163	28.8	0.099
1918-02-1	Picloram	430	0.0255	5.28E-6	0.00000000166	1.98	No Data
1336-36-3	Polychlorinated biphenyls (PCBs)	0.7	-------[a]	-------[a]	-------[a]	309,000	No Data
129-00-0	Pyrene	0.135	0.0272	7.24E-6	0.000451	105,000	0.00018
122-34-9	Simazine	5	0.027	7.36E-6	0.0000000133	133	No Data
100-42-5	Styrene	310	0.0710	8.00E-6	0.113	776	0.0033
93-72-1	2,4,5-TP (Silvex)	31	0.0194	5.83E-6	0.0000000032	5,440	No Data

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
127-18-4	Tetrachloroethylene	200	0.0720	8.20E-6	0.754	155	0.00096
108-88-3	Toluene	526	0.0870	8.60E-6	0.272	182	0.011
8001-35-2	Toxaphene	0.74	0.0116	4.34E-6	0.000246	257,000	No Data
120-82-1	1,2,4-Trichlorobenzene	300	0.0300	8.23E-6	0.0582	1,780	0.0019
71-55-6	1,1,1-Trichloroethane	1,330	0.0780	8.80E-6	0.705	110	0.0013
79-00-5	1,1,2-Trichloroethane	4,420	0.0780	8.80E-6	0.0374	50.1	0.00095
79-01-6	Trichloroethylene	1,100	0.0790	9.10E-6	0.422	166	0.00042
95-95-4	2,4,5-Trichlorophenol	1,200	0.0291	7.03E-6	0.000178	1,600	0.00038
88-06-2	2,4,6-Trichlorophenol	800	0.0318	6.25E-6	0.000319	381	0.00038
108-05-4	Vinyl Acetate	20,000	0.0850	9.20E-6	0.021	5.25	No Data
57-01-4	Vinyl Chloride	2,760	0.106	1.23E-6	1.11	18.6	0.00024
108-38-3	m-Xylene	161	0.070	7.80E-6	0.301	407	0.0019

CAS No.	Chemical	Solubility in Water (S) (mg/L)	Diffusivity in Air (Di) (cm^2/s)	Diffusivity in Water (D_w) (cm^2/s)	Dimensionless Henry's Law Constant (H') (25^oC)	Organic Carbon Partition Coefficient (K_{oc}) (L/kg)	First Order Degradation Constant (λ) (d^{-1})
95-47-6	o-Xylene	178	0.087	1.00E-5	0.213	363	0.0019
106-42-3	p-Xylene	185	0.0769	8.44E-6	0.314	389	0.0019
1330-20-7	Xylenes (total)	186	0.0720	9.34E-6	0.25	260	0.0019

Chemical Abstracts Service (CAS) registry number. This number in the format xxx-xx-x, is unique for each chemical and allows efficient searching on computerized data bases.

[a]Soil Remediation objectives are determined pursuant to 40 CFR 761.120, as incorporated by reference at Section 732.104 (the USEPA "PCB Spill Cleanup Policy"), for most sites; persons remediating sites should consult with BOL if calculation of Tier 2 soil remediation objectives is desired.

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Table F: Methods for Determining Physical Soil Parameters

Methods for Determining Physical Soil Parameters		
Parameter	Sampling Location[a]	Method
ρ_b (soil bulk density)	Surface	ASTM - D 1556-90 Sand Cone Method[b]
		ASTM - D 2167-94 Rubber Balloon Method[b]
		ASTM - D 2922-91 Nuclear Method[b]
	Subsurface	ASTM - D 2937-94 Drive Cylinder Method[b]
ρ_s (soil particle density)	Surface or Subsurface	ASTM - D 854-92 Specific Gravity of Soil[b]
w (moisture content)	Surface or Subsurface	ASTM - D 4959-89 (Reapproved 1994) Standard[b]
		ASTM - D 4643-93 Microwave Oven[b]
		ASTM - D2216-92 Laboratory Determination[b]
		ASTM - D3017-88 (Reapproved 1993) Nuclear Method[b]
		Equivalent USEPA Method (e.g., sample preparation procedures described in methods 3541 or 3550)
f_{oc} (organic carbon content)	Surface or Subsurface	Nelson and Sommers (1982)
		ASTM - D 2974-87 (Reapproved 1995) Moisture, Ash, and Organic Matter[b]
		USEPA Method 9060A Total Organic Content

Methods for Determining Physical Soil Parameters		
Parameter	Sampling Location[a]	Method
η or θ_T (total soil porosity)	Surface or Subsurface (calculated)	Equation S24 in Appendix C, Table A for SSL Model, or Equation R23 in Appendix C, Table C for RBCA Model
θ_a or θ_{as} (air-filled soil porosity)	Surface or Subsurface (calculated)	Equation S21 in Appendix C, Table A for SSL Model, or Equation R21 in Appendix C, Table C for RBCA Model
θ_w or θ_{ws} (water-filled soil porosity)	Surface or Subsurface (calculated)	Equation S20 in Appendix C, Table A for SSL Model, or Equation R22 in Appendix C, Table C for RBCA Model
K (hydraulic conductivity)	Surface or Subsurface	ASTM - D 5084-90 Flexible Wall Permeameter
		Pump Test - ~~Appendix D~~
		Slug Test - ~~Appendix D~~
i (hydraulic gradient)	Surface or Subsurface	Field Measurement

[a] This is the location where the sample is collected
[b] As incorporated by reference in Section 742.120.

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Table G: Error Function (erf)

$$erf(\beta) = \frac{2}{\sqrt{\pi}} \int_0^{\beta} e^{-\varepsilon^2} d\varepsilon$$

β	*erf* (β)
0	0
0.05	0.056372
0.1	0.112463
0.15	0.167996
0.2	0.222703
0.25	0.276326
0.3	0.328627
0.35	0.379382
0.4	0.428392
0.45	0.475482
0.5	0.520500
0.55	0.563323
0.6	0.603856
0.65	0.642029
0.7	0.677801
0.75	0.711156
0.8	0.742101
0.85	0.770668
0.9	0.796908
0.95	0.820891
1.0	0.842701
1.1	0.880205
1.2	0.910314
1.3	0.934008
1.4	0.952285
1.5	0.966105
1.6	0.976348
1.7	0.983790
1.8	0.989091
1.9	0.992790
2.0	0.995322
2.1	0.997021
2.2	0.998137
2.3	0.998857
2.4	0.999311
2.5	0.999593
2.6	0.999764
2.7	0.999866
2.8	0.999925
2.9	0.999959
3.0	0.999978

742.APPENDIX C: Tier 2 Tables and Illustrations

Table H: Q/C Values by Source Area

Source (Acres)	Area Q/C Value (g/m^2-s per kg/m^3)
0.5	97.78
1	85.81
2	76.08
5	65.75
10	59.16
30	50.60

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

TABLE I: Koc Values for Ionizing Organics as a Function of pH (cm^3/g or L/kg)

pH	Benzoic Acid	2-Chloro-phenol	2,4-Dichloro-phenol	Pentachloro-phenol	2,4,5-Trichloro-phenol	2,4,6-Trichloro-phenol	Dinoseb	2,3,5-TP (Silvex)
4.5	1.07E+01	3.98E+02	1.59E+02	1.34E+04	2.37E+03	1.06E+03	3.00E+03	1.28E+04
4.6	9.16E+00	3.98E+02	1.59E+02	1.24E+04	2.37E+03	1.05E+03	2.71E+03	1.13E+04
4.7	7.79E+00	3.98E+02	1.59E+02	1.13E+04	2.37E+03	1.05E+03	2.41E+03	1.01E+04
4.8	6.58E+00	3.98E+02	1.59E+02	1.02E+04	2.37E+03	1.05E+03	2.12E+03	9.16E+03
4.9	5.54E+00	3.98E+02	1.59E+02	9.05E+03	2.37E+03	1.04E+03	1.85E+04	8.40E+03
5.0	4.64E+00	3.98E+02	1.59E+02	7.96E+03	2.36E+03	1.03E+03	1.59E+04	7.76E+03
5.1	3.88E+00	3.98E+02	1.59E+02	6.93E+03	2.36E+03	1.02E+03	1.36E+04	7.30E+03
5.2	3.25E+00	3.98E+02	1.59E+02	5.97E+03	2.35E+03	1.01E+03	1.15E+04	6.91E+03
5.3	2.72E+00	3.98E+02	1.59E+02	5.10E+03	2.34E+03	9.99E+02	9.66E+03	6.60E+03
5.4	2.29E+00	3.98E+02	1.58E+02	4.32E+03	2.33E+03	9.82E+02	8.10E+03	6.36E+03
5.5	1.94E+00	3.97E+02	1.58E+02	3.65E+03	2.32E+03	9.62E+02	6.77E+03	6.16E+03
5.6	1.65E+00	3.97E+02	1.58E+02	3.07E+03	2.31E+03	9.38E+02	5.65E+03	6.00E+03
5.7	1.42E+00	3.97E+02	1.58E+02	2.58E+03	2.29E+03	9.10E+02	4.73E+03	5.88E+03
5.8	1.24E+00	3.97E+02	1.58E+02	2.18E+03	2.27E+03	8.77E+02	3.97E+03	5.78E+03
5.9	1.09E+00	3.97E+02	1.57E+02	1.84E+03	2.24E+03	8.39E+02	3.35E+03	5.70E+03

pH	Benzoic Acid	2-Chloro-phenol	2,4-Dichloro-phenol	Pentachloro-phenol	2,4,5-Trichloro-phenol	2,4,6-Trichloro-phenol	Dinoseb	2,3,5-TP (Silvex)
6.0	9.69E-01	3.96E+02	1.57E+02	1.56E+03	2.21E+03	7.96E+02	2.84E+03	5.64E+03
6.1	8.75E-01	3.96E+02	1.57E+02	1.33E+03	2.17E+03	7.48E+02	2.43E+03	5.59E+03
6.2	7.99E-01	3.96E+02	1.56E+02	1.15E+03	2.12E+03	6.97E+02	2.10E+03	5.55E+03
6.3	7.36E-01	3.95E+02	1.55E+02	9.98E+02	2.06E+03	6.44E+02	1.83E+03	5.52E+03
6.4	6.89E-01	3.94E+02	1.54E+02	8.77E+02	1.99E+03	5.89E+02	1.62E+03	5.50E+03
6.5	6.51E-01	3.93E+02	1.53E+02	7.81E+02	1.91E+03	5.33E+02	1.45E+03	5.48E+03
6.6	6.20E-01	3.92E+02	1.52E+02	7.03E+02	1.82E+03	4.80E+02	1.32E+03	5.46E+03
6.7	5.95E-01	3.90E+02	1.50E+02	6.40E+02	1.71E+03	4.29E+02	1.21E+03	5.45E+03
6.8	5.76E-01	3.88E+02	1.47E+02	5.92E+02	1.60E+03	3.81E+02	1.12E+03	5.44E+03
6.9	5.60E-01	3.86E+02	1.45E+02	5.52E+02	1.47E+03	3.38E+02	1.05E+03	5.43E+03
7.0	5.47E-01	3.83E+02	1.41E+02	5.21E+02	1.34E+03	3.00E+02	9.96E+02	5.43E+03
7.1	5.38E-01	3.79E+02	1.38E+02	4.96E+02	1.21E+03	2.67E+02	9.52E+02	5.42E+03
7.2	5.32E-01	3.75E+02	1.33E+02	4.76E+02	1.07E+03	2.39E+02	9.18E+02	5.42E+03
7.3	5.25E-01	3.69E+02	1.28E+02	4.61E+02	9.43E+02	2.15E+02	8.90E+02	5.42E+03
7.4	5.19E-01	3.62E+02	1.21E+02	4.47E+02	8.19E+02	1.95E+02	8.68E+02	5.41E+03
7.5	5.16E-01	3.54E+02	1.14E+02	4.37E+02	7.03E+02	1.78E+02	8.50E+02	5.41E+03
7.6	5.13E-01	3.44E+02	1.07E+02	4.29E+02	5.99E+02	1.64E+02	8.36E+02	5.41E+03

pH	Benzoic Acid	2-Chloro-phenol	2,4-Dichloro-phenol	Pentachloro-phenol	2,4,5-Trichloro-phenol	2,4,6-Trichloro-phenol	Dinoseb	2,3,5-TP (Silvex)
7.7	5.09E-01	3.33E+02	9.84E+01	4.23E+02	5.07E+02	1.53E+02	8.25E+02	5.41E+03
7.8	5.06E-01	3.19E+02	8.97E+01	4.18E+02	4.26E+02	1.44E+02	8.17E+02	5.41E+03
7.9	5.06E-01	3.04E+02	8.07E+01	4.14E+02	3.57E+02	1.37E+02	8.10E+02	5.41E+03
8.0	5.06E-01	2.86E+02	7.17E+01	4.10E+02	2.98E+02	1.31E+02	8.04E+02	5.41E+03

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

TABLE J: Values to be Substituted for k_s when Evaluating Inorganics as a Function of pH (cm^3_{water}/g_{soil})

pH	As	Ba	Be	Cd	Cr (+3)	Cr (+6)	Hg	Ni	Ag	Se	Tl	Zn
4.9	2.5E+01	1.1E+01	2.3E+01	1.5E+01	1.2E+03	3.1E+01	4.0E-02	1.6E+01	1.0E-01	1.8E+01	4.4E+01	1.6E+01
5.0	2.5E+01	1.2E+01	2.6E+01	1.7E+01	1.9E+03	3.1E+01	6.0E-02	1.8E+01	1.3E-01	1.7E+01	4.5E+01	1.8E+01
5.1	2.5E+01	1.4E+01	2.8E+01	1.9E+01	3.0E+03	3.0E+01	9.0E-02	2.0E+01	1.6E-01	1.6E+01	4.6E+01	1.9E+01
5.2	2.6E+01	1.5E+01	3.1E+01	2.1E+01	4.9E+03	2.9E+01	1.4E-01	2.2E+01	2.1E-01	1.5E+01	4.7E+01	2.1E+01
5.3	2.6E+01	1.7E+01	3.5E+01	2.3E+01	8.1E+03	2.8E+01	2.0E-01	2.4E+01	2.6E-01	1.4E+01	4.8E+01	2.3E+01
5.4	2.6E+01	1.9E+01	3.8E+01	2.5E+01	1.3E+04	2.7E+01	3.0E-01	2.6E+01	3.3E-01	1.3E+01	5.0E+01	2.5E+01
5.5	2.6E+01	2.1E+01	4.2E+01	2.7E+01	2.1E+04	2.7E+01	4.6E-01	2.8E+01	4.2E-01	1.2E+01	5.1E+01	2.6E+01
5.6	2.6E+01	2.2E+01	4.7E+01	2.9E+01	3.5E+04	2.6E+01	6.9E-01	3.0E+01	5.3E-01	1.1E+01	5.2E+01	2.8E+01
5.7	2.7E+01	2.4E+01	5.3E+01	3.1E+01	5.5E+04	2.5E+01	1.0E-00	3.2E+01	6.7E-01	1.1E+01	5.4E+01	3.0E+01
5.8	2.7E+01	2.6E+01	6.0E+01	3.3E+01	8.7E+04	2.5E+01	1.6E-00	3.4E+01	8.4E-01	9.8E+00	5.5E+01	3.2E+01
5.9	2.7E+01	2.8E+01	6.9E+01	3.5E+01	1.3E+05	2.4E+01	2.3E-00	3.6E+01	1.1E+00	9.2E+00	5.6E+01	3.4E+01
6.0	2.7E+01	3.0E+01	8.2E+01	3.7E+01	2.0E+05	2.3E+01	3.5E-00	3.8E+01	1.3E+00	8.6E+00	5.8E+01	3.6E+01
6.1	2.7E+01	3.1E+01	9.9E+01	4.0E+01	3.0E+05	2.3E+01	5.1E-00	4.0E+01	1.7E+00	8.0E+00	5.9E+01	3.9E+01
6.2	2.8E+01	3.3E+01	1.2E+02	4.2E+01	4.2E+05	2.2E+01	7.5E-00	4.2E+01	2.1E+00	7.5E+00	6.1E+01	4.2E+01
6.3	2.8E+01	3.5E+01	1.6E+02	4.4E+01	5.8E+05	2.2E+01	1.1E+01	4.5E+01	2.7E+00	7.0E+00	6.2E+01	4.4E+01
6.4	2.8E+01	3.6E+01	2.1E+02	4.8E+01	7.7E+05	2.1E+01	1.6E+01	4.7E+01	3.4E+00	6.5E+00	6.4E+01	4.7E+01
6.5	2.8E+01	3.7E+01	2.8E+02	5.2E+01	9.9E+05	2.0E+01	2.2E+01	5.0E+01	4.2E+00	6.1E+00	6.6E+01	5.1E+01
6.6	2.8E+01	3.9E+01	3.9E+02	5.7E+01	1.2E+06	2.0E+01	3.0E+01	5.4E+01	5.3E+00	5.7E+00	6.7E+01	5.4E+01

pH	As	Ba	Be	Cd	Cr (+3)	Cr (+6)	Hg	Ni	Ag	Se	Tl	Zn
6.7	2.9E+01	4.0E+01	5.5E+02	6.4E+01	1.5E+06	1.9E+01	4.0E+01	5.8E+01	6.6E+00	5.3E+00	6.9E+01	5.8E+01
6.8	2.9E+01	4.1E+01	7.9E+02	7.5E+01	1.8E+06	1.9E+01	5.2E+01	6.5E+01	8.3E+00	5.0E+00	7.1E+01	6.2E+01
6.9	2.9E+01	4.2E+01	1.1E+03	9.1E+01	2.1E+06	1.8E+01	6.6E+01	7.4E+01	1.0E+01	4.7E+00	7.3E+01	6.8E+01
7.0	2.9E+01	4.2E+01	1.7E+03	1.1E+02	2.5E+06	1.8E+01	8.2E+01	8.8E+01	1.3E+01	4.3E+00	7.4E+01	7.5E+01
7.1	2.9E+01	4.3E+01	2.5E+03	1.5E+02	2.8E+06	1.7E+01	9.9E+01	1.1E+02	1.6E+01	4.1E+00	7.6E+01	8.3E+01
7.2	3.0E+01	4.4E+01	3.8E+03	2.0E+02	3.1E+06	1.7E+01	1.2E+02	1.4E+02	2.0E+01	3.8E+00	7.8E+01	9.5E+01
7.3	3.0E+01	4.4E+01	5.7E+03	2.8E+02	3.4E+06	1.6E+01	1.3E+02	1.8E+02	2.5E+01	3.5E+00	8.0E+01	1.1E+02
7.4	3.0E+01	4.5E+01	8.6E+03	4.0E+02	3.7E+06	1.6E+01	1.5E+02	2.5E+02	3.1E+01	3.3E+00	8.2E+01	1.3E+02
7.5	3.0E+01	4.6E+01	1.3E+04	5.9E+02	3.9E+06	1.6E+01	1.6E+02	3.5E+02	3.9E+01	3.1E+00	8.5E+01	1.6E+02
7.6	3.1E+01	4.6E+01	2.0E+04	8.7E+02	4.1E+06	1.5E+01	1.7E+02	4.9E+02	4.8E+01	2.9E+00	8.7E+01	1.9E+02
7.7	3.1E+01	4.7E+01	3.0E+04	1.3E+03	4.2E+06	1.5E+01	1.8E+02	7.0E+02	5.9E+01	2.7E+00	8.9E+01	2.4E+02
7.8	3.1E+01	4.9E+01	4.6E+04	1.9E+03	4.3E+06	1.4E+01	1.9E+02	9.9E+02	7.3E+01	2.5E+00	9.1E+01	3.1E+02
7.9	3.1E+01	5.0E+01	6.9E+04	2.9E+03	4.3E+06	1.4E+01	1.9E+02	1.4E+03	8.9E+01	2.4E+00	9.4E+01	4.0E+02
8.0	3.1E+01	5.2E+01	1.0E+05	4.3E+03	4.3E+06	1.4E+01	2.0E+02	1.9E+03	1.1E+02	2.2E+00	9.6E+01	5.3E+02

Section 742.APPENDIX C: Tier 2 Tables and Illustrations

TABLE K: Parameter Estimates for Calculating Water-Filled Soil Porosity (θ_w)

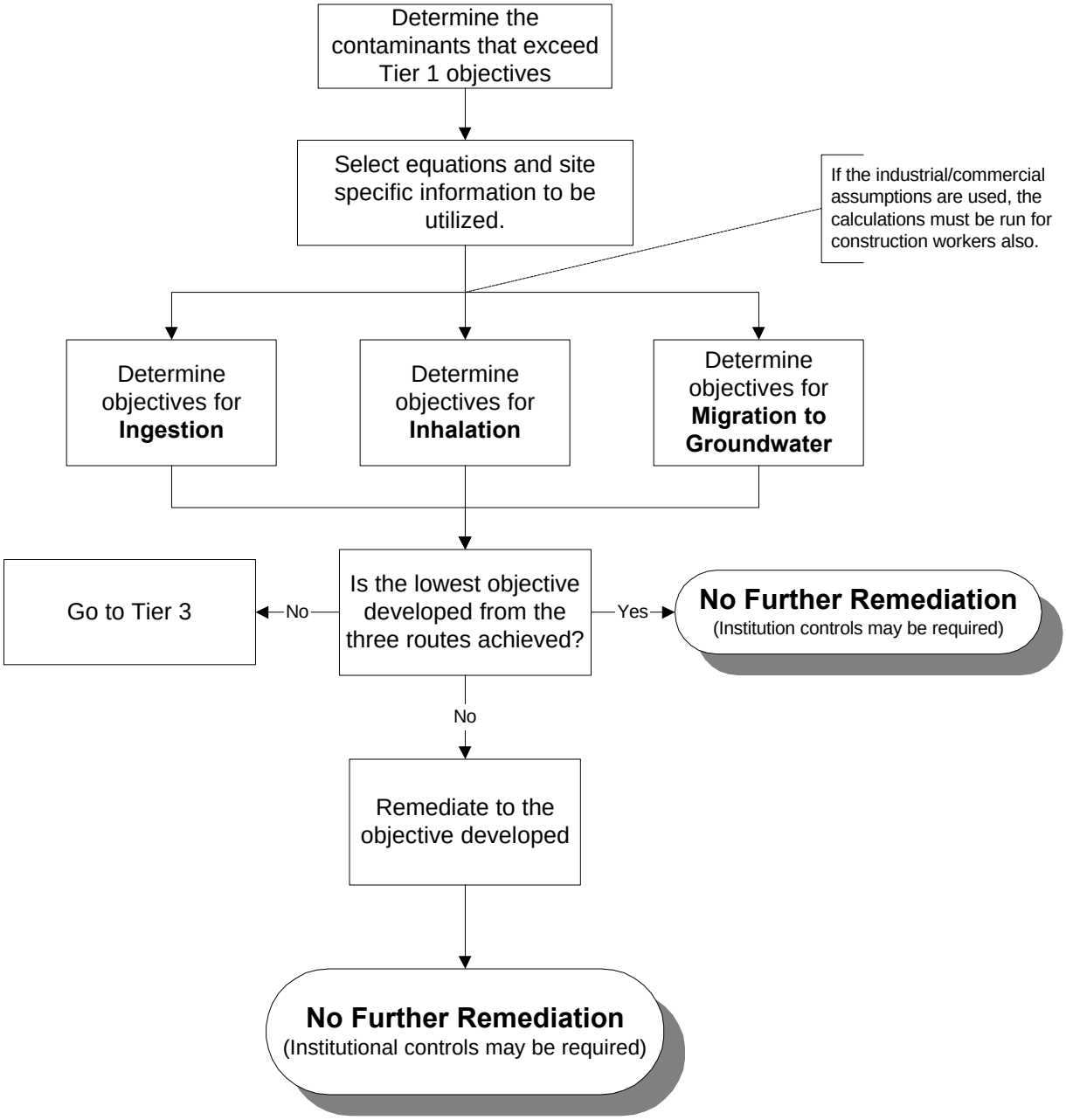
Soil Texture[a]	Saturated Hydraulic Conductivity, K_s (m/yr)	$1/(2b+3)$[b]
Sand	1,830	0.090
Loamy Sand	540	0.085
Sandy Loam	230	0.080
Silt Loam	120	0.074
Loam	60	0.073
Sandy Clay Loam	40	0.058
Silt Clay Loam	13	0.054
Clay Loam	20	0.050
Sandy Clay	10	0.042
Silt Clay	8	0.042
Clay	5	0.039

[a] The appropriate texture classification is determined by a particle size analysis by ASTM D2488-93 as incorporated by reference in Section 742.210 and the U.S. Department of Agriculture Soil Textural Triangle shown in Appendix C, Illustration C.

[b] Where b is the soil-specific exponential parameter (unitless)

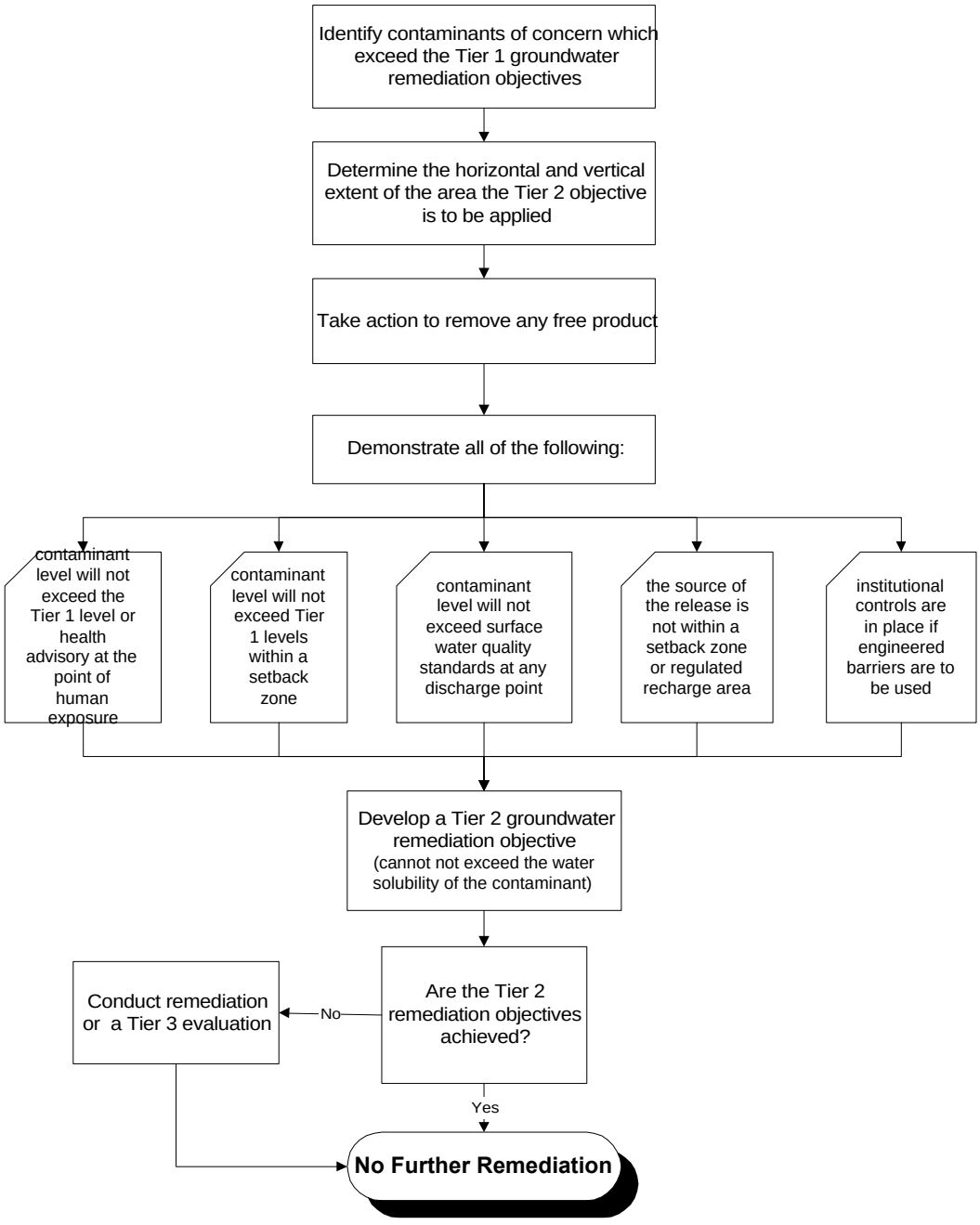
Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Illustration A: Tier 2 Evaluation for Soil



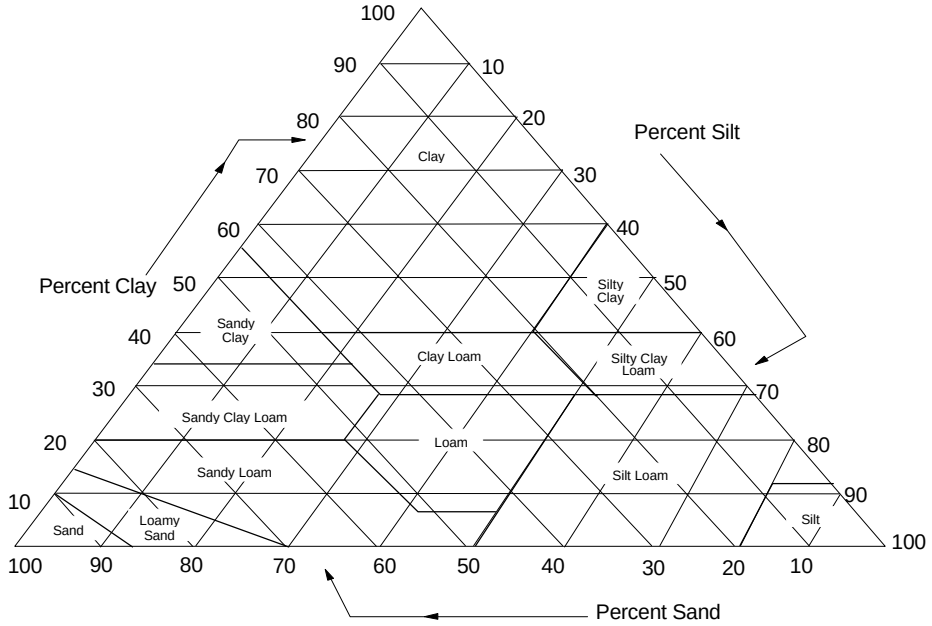
Section 742.APPENDIX C: Tier 2 Tables and Illustrations

Illustration B: Tier 2 Evaluation for Groundwater



Section 742.APPENDIX C: Tier 2 Tables and Illustrations

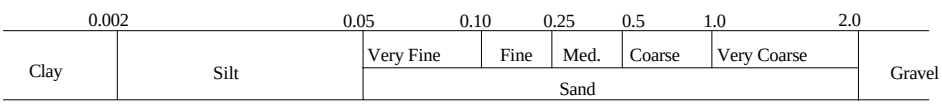
Illustration C: U.S. Department of Agriculture Soil Texture Classification



Criteria Used with the Field Method for Determining Soil Texture Classes

Criterion	Sand	Sandy loam	Loam	Slit loam	Clay loam	Clay
1. Individual grains visible to eye	Yes	Yes	Some	Few	No	No
2. Stability of dry clods	Do not form	Do not form	Easily broken	Moderately easily broken	Hard and stable	Very hard and stable
3. Stability of wet clods	Unstable	Slightyl stable	Moderately stable	Stable	Very stable	Very stable
4. Stability of "ribbon" when wet soil rubbed between thumb and fingers	Does not form	Does not form	Does not form	Broken appearance	Thin, will break	Very long, flexible

Particle Size, mm



Section 742.APPENDIX D: Procedures for Determination of Class II Groundwater

The following is a procedure to demonstrate that groundwater beneath a site does not meet the Class I criteria set forth in 35 Ill. Adm. Code 620.210 and therefore, need only meet the Class II groundwater quality standards. Groundwater is classified in 35 Ill. Adm. Code 620 as a Class II, general resource groundwater when it:

1) Does not meet the provisions of 35 Ill. Adm. Code 620.230 (Class III) or 35 Ill. Adm. Code 620.240 (Class IV); (Determining whether the groundwater is Class III or Class IV is relatively straight forward, as is the requirement to determine if the groundwater has previously been classified as Class II groundwater by the Illinois Pollution Control Board (Board).) or,

2) Has been found by the Board to be a Class II groundwater, pursuant to the petition procedures set forth in 35 Ill. Adm. Code 620.260; (if a continuous zone containing groundwater begins within 10 feet of the ground surface and extends greater than ten feet below the ground surface it will not be considered a Class II groundwater if an additional criterion is met under 35 Ill. Adm. Code 620.210, in this case it would be considered Class I groundwater. Although it may be possible, it is unrealistic to try to designate two distinct classes of groundwater within the same saturated hydrogeologic unit. But, if the person conducting the remediation can demonstrate that by cleaning the groundwater within ten feet of the surface to Class II specifications will not degrade the groundwater greater than 10 feet below the ground surface above Class I standards, the Agency may approve both Class I and II standards in accordance with the location of the groundwater.) or,

3) Is located less than ten feet below the ground surface; or,

4) Does not meet the provisions of 35 Ill. Adm. Code 620.210, which is further discussed in paragraphs (A) through (D) below.

Initially, the sources of information listed below should be considered to determine the appropriate classification of groundwater:

1) Published data concerning regional and local geologic and hydrogeologic conditions (i.e. geologic surveys, former site investigations, etc.).

2) The locations of all potable water wells located within one mile of the site with the logs and/or dates of well completion attached.

3) Available data on site boring logs which characterize the geology from ground surface to the first saturated unit or, if a perched zone is present, the first saturated unit below the perched zone.

~~If after collecting and reviewing the above information the groundwater is clearly not a Class II groundwater and one still wishes to pursue classification as Class II groundwater, further investigation including site-specific information must be utilized to make a determination that the groundwater is subject to the Class II standards. If the site geology or hydrogeologic properties pass all criteria listed below, the groundwater is a Class II groundwater. The information requirements listed describe the minimum documentation which should be provided to the Agency.~~

~~A) Groundwater cannot be located within the minimum setback of a well which serves as a potable water supply and to the bottom of such well;~~

~~The minimum setback zone of a well extends from the land surface to the bottom of the well as determined by the screen depth. This establishes a three-dimensional zone of protection around the well.~~

~~Section 14 of the Environmental Protection Act (Act) established setback requirements for potable water supply wells and potential sources/routes of contamination. Unless regulatory relief consistent with this Section of the Act has been sought and received, no new sources/routes may be located within 200 feet of a potable water supply well or 400 feet of a vulnerable community water supply well. Further, the converse of this statement also applies (e.g., no new potable water supply well may locate within 200 feet of a current or future source/route). A 400 foot separation is required for a vulnerable community water supply well. In addition, a community water supply may establish maximum setback zones of up to 1,000 feet around the wells. This may cause further siting restrictions for new activities as well as require technology controls under 35 Ill. Adm. Code 615/616 for existing and new activities.~~

~~This requirement may be satisfied by the submission of a scaled map delineating the site and all potable water wells located within a one mile radius from the unit(s) of concern. The Illinois State Water Survey and/or the Division of Public Water Supplies of the Agency should be contacted, as well as other appropriate state and federal entities, to obtain this information. A copy of the state or federal agency s response to an information inquiry should be included with the information submitted by the person conducting the remediation. Also, a visual inspection of the area within 200 feet of the unit(s) of concern should be conducted when possible to detect unplugged private wells.~~

~~B) Formations beneath the site cannot consist of unconsolidated sand, gravel, or sand and gravel which is 5 feet or more in thickness and that contains 12 percent or less in fines (i.e. fines which pass through a No. 200 sieve tested according to ASTM Standard Practice D2488-93);~~

~~This criterion is specific to the type of formations listed. If a zone of saturation fails this Class II criterion, Class II may still apply pursuant to D below.~~

This criterion may be satisfied by the submission of, at a minimum, one site-specific, continuously sampled boring log which clearly identifies the saturated interval from which a representative sample was obtained. Sieve test analysis should be conducted on several samples from each saturated interval which is at least five feet in thickness and composed of sand-sized grains or greater. In addition, the person conducting the remediation should submit the sieve data sheet, plot, and a scaled map which identifies the location of each boring.

C) Formations beneath the site cannot consist of sandstone which is 10 feet or more in thickness, or fractured carbonate which is 15 feet or more in thickness; or

This requirement may be satisfied by the submission of, at a minimum, one site-specific, continuously sampled boring log with a description of the geologic material present. This boring log should extend from the ground surface to a depth which is 10 feet into the uppermost water-bearing unit subject to Class I standards or bedrock, whichever is shallower. The boring(s) should be continuously sampled and located on a scaled site map. A representative sample, as used previously, is a sample obtained from each distinctive saturated unit within the boring. Also, a literature search of regional and local geologic conditions should be conducted with the results submitted to the Agency.

D) Class II shall not include any geologic material which is shown capable of either of the following:

- Sustained groundwater yield, from up to a 12 inch borehole, of 150 gallons per day or more from a thickness of 15 feet or less; or

  This requirement may be satisfied by the submission of continuously sampled boring logs which demonstrate aquifer thickness. In addition, as-built well construction diagrams should also be submitted to the Agency for review. Furthermore, a pump test or equivalent must be conducted to determine the yield of the geologic material. Methodology, assumptions, and any calculations performed should also be submitted to meet this requirement. If the aquifer geometry and transmissivity have been obtained through a site-specific field investigation, an analytical solution may be used to estimate well yield. The person conducting the remediation must demonstrate the appropriateness of an analytical solution to estimate well yield versus an actual field test. Well yield should be determined for either confined or unconfined conditions.

  The pump test should consider some minimum pumping rate during the test; the following criteria should be used:

  i) If all areas within 200 feet of the site have access to a water main to provide drinking water from a public water supply system, then a

minimum pumping rate of 4 gallons per minute should be used when performing this test.

ii) If all areas within 200 feet of the site do not have access to a water main to provide drinking water from a public water supply system, then a minimum pumping rate of 0.5 gallons per minute should be used when performing this test.

- Hydraulic conductivity of 1 x 10^{-4} cm/sec or greater using one of the following test methods or its equivalent:

This requirement may be satisfied by performing field and/or lab tests such as a permeameter, slug test, and/or pump test.

An appropriate method of evaluation should be chosen based on the type of wells, the length of time over which data may need to be collected and, if known, the characteristics of the targeted aquifer. Such methods and the suggested information to be submitted to the Agency are outlined below and shall include at least one of the following:

i) Permeameter

If this method is chosen, samples of unconsolidated materials should be left in the field sampling tubes which then become the permeameter sample chamber. Proceeding in this manner should allow as little disruption to the sample as possible. Unconsolidated samples should not be repacked into the sample chamber. An outline of the laboratory test method used and a description of the steps followed (including any calculations) should be submitted to the Agency for review.

ii) Slug tests

This information to be submitted to the Agency should include a description of the slug test method utilized and a discussion of the procedures followed during the tests, including any calculations performed.

A significant drawback to performing a slug test is that it is heavily dependent on a high-quality intake. If a well point is clogged or corroded, measured values may be inaccurate. Also, if a well is developed by surging or backwashing prior to testing, the measured values may reflect increased conductivities in the artificially included gravel pack around the intake. If slug tests are chosen, a sufficient number of tests should be run to ensure that representative measures of

~~hydraulic conductivities have been obtained and that lateral variations at various depths are documented.~~

~~iii) Pump tests~~

~~Preliminary or short-term drawdown tests should be performed initially to assess the appropriate pumping rate for the constant-rate tests. Several methods and/or equations may be used in evaluating data generated from pump tests such as Theis, Hantush-0Jacob, Hvorslev and/or Theim equations. The method(s) of evaluation selected should be provided to the Agency with justification for their use, (explanations of any assumptions made and examples of all calculations performed along with a description of the physical tests performed including the type of pump used.)~~

~~NOTE: It may be beneficial to use laboratory evaluation methods to further support results of field tests; however, field methods provide the best definition of the hydraulic conductivity in most cases. The most appropriate method to determine hydraulic conductivity for most sites will be the pump test, provided proper evaluation of the data obtained from the test is utilized. Pump tests provide in-situ measurements that are averaged over a large aquifer volume and are preferred since they are able to characterize a greater portion of the subsurface compared to the other aquifer tests. Slug tests provide in-situ values representative of a small volume of porous media in the immediate vicinity of a piezometer tip, providing point values only, and may be more appropriate in very low-permeability materials in which conductivity is too small to conduct a pump test.~~

IT IS SO ORDERED.

I, Dorothy M. Gunn, Clerk of the Illinois Pollution Control Board, hereby certify that the above opinion and order was adopted on the _____ day of _____, 1997, by a vote of _____.

_____
Dorothy M. Gunn, Clerk
Illinois Pollution Control Board