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ALTERNATE CONCENTRATION LIMIT GUIDANCE BASED ON §264.94(b) CRITERIA

PART I

INFORMATION REQUIRED IN ACL DEMONSTRATIONS

DRAFT

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CONTENTS

EXECUTIVE SUMMARY

The hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA) require owners and operators of hazardous waste facilities to utilize design features and control measures that prevent the leaking of hazardous waste into ground water. Further, all regulated units (i.e., all surface impoundments, waste piles, land treatment units, and landfills that received hazardous waste after July 26, 1982), are also subject to the ground-water monitoring and corrective action standards of 40 CFR Part 264, Subpart F. The ground-water protection standard (GWPS) under Subpart F (40 CFR 264.92) requires the Regional Administrator to establish in the facility permit, for each hazardous constituent entering the ground water from a regulated unit, a concentration limit beyond which degradation of ground-water quality will not be allowed. The concentration limits determine when corrective action is required.

There are three possible concentration levels that can be used to establish the GWPS:

1. Background levels of the hazardous constituents,
2. Maximum concentration limits listed in Table 1 of Section 264.94(a) of the regulations, or
3. Alternate concentration limits (ACL).

The first two levels are established in the facility permit unless the facility owner or operator applies for an ACL.

To obtain an ACL, a permit applicant must demonstrate that the hazardous constituents detected in the ground water will not pose a substantial present or potential hazard to human health or the environment at the ACL levels. ACLs are granted through the permit process under Parts 264 and 270 and are established in the context of the facility GWPS. This document provides guidance to RCRA facility permit applicants and writers concerning the establishment of alternate concentration limits (ACLs).

The factors that are used to evaluate ACL requests, or demonstrations, are listed in Section 264.94(b) of the regulation. These factors are:

1. Potential adverse effects on ground-water quality considering:

   - The physical and chemical characteristics of the waste in the regulated unit, including its potential for migration,
   - The hydrogeological characteristics of the facility and surrounding land,
   - The quantity of ground water and the direction of ground-water flow,
   - The proximity and withdrawal rates of ground-water users,
   - The current and future uses of ground water in the area,
   - The existing quality of ground water, including other sources of contamination and their cumulative impact on the ground-water quality,
   - The potential for health risks caused by human exposure to waste constituents,
   - The potential for damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents,

- The persistence and permanence of the potential adverse effects, and

2. Potential adverse effects on hydraulically-connected surface water quality, considering:

   - The volume and physical and chemical characteristics of the waste in the regulated unit,
   - The hydrogeological characteristics of the facility and surrounding land,
   - The quantity and quality of ground water and the direction of ground-water flow,
   - The patterns of rainfall in the region,
   - The proximity of the regulated unit to surface waters,
   - The current and future uses of surface waters in the area and any water quality standards established for those surface waters,
   - The existing quality of surface water, including other sources of contamination and the cumulative impact on surface-water quality,
   - The potential for health risks caused by human exposure to waste constituents,
   - The potential for damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents, and
   - The persistence and permanence of the potential adverse effects.

Information on each of these criteria is not required in every ACL demonstration because each demonstration requires different types and amounts of information, depending on the site-specific characteristics. A separate chapter of this document is devoted to each of these criteria. The criteria are briefly discussed, along with the type, quantity, and quality of information that should be provided depending on the site-specific characteristics.

Chapter I is an introduction to the ACL guidance. This chapter discusses the purpose, intent, and organization of the document. It also defines an ACL and describes how ACLs fit into the RCRA permitting process. A major portion of the information required for an ACL demonstration is also required for a RCRA Part B permit application. This chapter points out the overlap between these two informational requirements.

Chapter II discusses the data that the permit applicant must submit on the physical and chemical characteristics of the waste constituents. The permit applicant should already know about the hazardous constituents present in the ground water at the facility by the time an ACL demonstration is submitted. Additional ground-water sample collection is probably not necessary for ACL purposes. The permit applicant should submit the hazardous constituent information in terms of three-dimensional representations of constituent concentrations. The permit applicant needs to submit data on any factors relating to the stability and mobility of the waste constituents in the ground water. These factors may include density, solubility, vapor pressure, viscosity, and octanol-water partitioning coefficient of each constituent for which an ACL is requested.

Chapter III discusses the data needed to describe the hydrogeologic properties of the site. The geologic and hydrologic properties of each of the individual strata beneath a site that are likely to affect ground-water contaminant migration should be submitted in the ACL demonstration. Much of the data should already be available to the permit applicant if other RCRA permitting requirements have been fulfilled. The important geologic attributes of a site include:

1. Soil and rock characteristics,
2. Geologic structure, and
3. Geomorphology and topography.

In ACL demonstrations where soil and other matrix attenuation mechanisms are used to justify that exposure to ground-water contaminants will be minimal or prevented, data on attenuative properties must be discussed. The near-surface stratigraphic units located in the zone of saturation must be characterized for the hydrologic parameters of hydraulic conductivity (vertical and horizontal), specific yield (unconfined aquifer) or specific storage (confined aquifer), and effective porosity.

Chapter IV discusses ground-water quantity and flow direction which are used to assess contaminant transport. The general RCRA permit requirements specify the submittal of ground-water flow information. This data should be adequate for ACL demonstration purposes and the permit applicant probably will not have to collect additional field data. Ground-water quantity can be estimated from hydrologic parameters such as specific yield for unconfined aquifers and specific storage for confined aquifers. The use of Darcy's law for determining ground-water flow quantity is acceptable.

The hydrogeologic portion of the ACL demonstration must include an adequate description of both horizontal and vertical ground-water flow components. The horizontal ground-water flow description should include a flow net based on ground-water elevation measurements taken from monitoring wells or peizometers, screened at the same elevation in the same saturated zone. Facilities should have several nested piezometers for vertical gradient determinations. Facilities that are located in environmental settings that exhibit temporal variation in ground-water flow direction should define the extent to which the flow change occurs.

Chapter V discusses man-made hydraulic barrier systems that may be used to augment natural attenuation. Although man-made barriers are not listed in the Section 264.94(b) criteria, they are discussed in this guidance document because they can be an important factor in assessing exposure to hazardous constituents. Ground-water control structures that can be used to justify ACLs are plume management mechanisms that either steer contaminated ground water away from exposure points or reduce the ground-water transport velocity so that a natural attenuation mechanism can reduce contaminant concentrations to acceptable levels. The engineered ground-water control measures that will be considered include low permeability barriers such as slurry walls. These measures can be used either separately or together to prevent or limit exposure to the contaminated ground water. Design and construction considerations must be evaluated in order to assess the adequacy of all subsurface barrier systems. In cases where ground-water control structures are proposed for preventing or limiting exposure, the applicant must submit a plan detailing a methodology that will demonstrate the effectiveness of the engineered system.

Chapter VI discusses the types of precipitation data that should be submitted in an ACL demonstration. The permit applicant should focus the discussions of precipitation around the site's hydrologic regime. If the applicant's ACL demonstration clearly shows that ground-water discharge to surface waters is unlikely, then the discussion of precipitation events can be limited to effects on infiltration and ground-water recharge. However, if ground-water discharge to surface water is an important element of the ACL demonstration, then precipitation events should be related to ground-water recharge and discharge.

Chapter VII discusses the proximity of surface water and ground-water users and the information that should be submitted on these users. The level of information necessary to satisfy the proximity of users requirement depends on the basis of the ACL. If a downgradient surface water body is the primary focus of a demonstration, then data related to the specific characteristics of the surface water body are necessary. If the permit applicant argues that downgradient surface water bodies are unaffected by the ACL constituents, then general information on the distance of the surface water bodies from the facility is necessary. In order to assess the likelihood of exposure of current ground-water users, every ACL demonstration must discuss the proximity of ground-water users to the facility.

Chapter VIII discusses the factors needed to determine current and future uses of ground water and surface water in the vicinity of the facility. The permit applicant should examine pertinent aspects of both ground-water and surface water uses. Permit applicants must submit information on the types of ground-water uses in the vicinity of the facility, unless they can successfully argue that no exposure to the contaminated ground water will occur. The permit applicant should discuss the ground water in the vicinity of the facility in terms of the three classes discussed in the U.S. EPA Ground-Water Protection Strategy.

Surface water uses should be discussed by the permit applicant if contaminated ground water can migrate to surface waters. Surface water use information is especially critical for ACLs based on surface water dilution.

Chapter IX is concerned with the existing quality of ground water and surface water and other sources of contamination. In order for "benchmark" levels of contamination to be set, the background levels of hazardous constituents in the ground water and surface water must be established. For ACL purposes, background water quality is the quality that would be expected to be found if the facility's regulated unit(s) was not leaking contaminants. Background monitoring wells must yield ground-water samples from the uppermost aquifer representative of the quality of ground water that has not been affected by leakage from a facility's regulated unit. Background surface water quality need only be assessed in cases where surface waters are likely to receive contaminated ground-water discharges.

The permit applicant should also examine the possibility of other sources of contamination if the upgradient waters in the vicinity of the facility are contaminated. This will give the permit applicant information for assessing cumulative impacts associated with any contamination emanating from the facility.

Chapter X discusses the health risk assessment. A health risk assessment should be submitted if human exposure to the ground-water contaminants is not prevented. The purpose of the health risk assessment is to determine acceptable concentrations at a point of exposure for the constituents for which ACLs are requested. There are two major components to a determination of health risks. First, the applicant must perform an exposure assessment characterizing the populations that may be exposed to the contaminants, and the potential pathways to human exposure. Second, the health effects associated with exposure to each contaminant and mixture of contaminants must be examined.

The potential point of exposure to the ground-water contaminants is assumed to be at the facility waste management boundary unless use restrictions have been implemented. If there are ground-water use controls beyond the facility waste management boundary that will prevent use of the affected resource, the potential ground-water exposure point will be at any point downgradient of the waste management boundary. In order to designate the property boundary as the point of exposure, a facility must ensure that there are permanent prohibitions on the use of on-site ground water as a source of drinking water or for any other use that would not be protective of human health or the environment. These restrictions must apply to the owner of the facility, as well as to any successive owners. In order to designate a potential point of exposure beyond the facility property boundary, ground-water use restrictions must be in place off-site to prevent any use of the contaminated ground water. The point of exposure for surface water bodies is assumed to be the water body closest to the facility in the pathway of contaminant migration.

If human exposure can occur, the permit applicant is responsible for providing information on the health effects of the hazardous constituents present in the ground water for which ACLs are requested. The health risk assessment should be based on conservative health assumptions. The applicant should distinguish between ground-water contaminants having threshold (toxic) and non-threshold (carcinogenic) effects. The Agency is currently compiling toxicity information on many of the hazardous constituents and this information should be useful in preparing ACL demonstrations.

Chapter XI discusses data that should be submitted on the potential impacts to the environment. The initial step in assessing possible environmental impacts is to determine the probable exposure pathways for hazardous constituents to reach environmental receptors. For ACL purposes, the receptors of concern include wildlife and vegetation in aquatic and terrestrial environments; agricultural crops, products, and lands; and physical structures. The permit applicant must examine the potential impacts to all of the receptors discussed above if exposure to hazardous constituents is likely to occur. Otherwise, the permit applicant should discuss specific data that support no probable exposure and explain why the potential environmental impact assessment is not needed. If there is a likely pathway for wildlife and vegetation to become exposed to contaminants, then environmental toxicity factors should be examined.

The permit applicant is responsible for surveying the area near the facility and determining the presence of any endangered or threatened species in terrestrial or surface water environments. If any endangered or threatened species are in the area, then the potential impacts of the contaminated ground water on the species, including critical habitat impacts, should be discussed.

Physical structures can also be adversely affected by hazardous constituents in the ground water. The determination of potential impacts to and contamination of physical structures in the area around the facility requires the examination of exposure pathways, waste characteristics, and construction materials and techniques. Physical structures of concern include buildings, buried cables and pipes, railroad beds, roads, parking areas, and machinery.

Chapter XII discusses data needed to determine the persistence of the contaminants in the environment and the permanence of the adverse effects. The applicant should discuss the process by which each ACL constituent will degrade, either from a ground-water perspective, surface water perspective, or a combination of both depending on the site-specific situation. Information on the permanence of the adverse effects resulting from exposure to the ACL constituents will be required only if the ACL demonstration is based on an acceptable level of exposure to receptors. Information on permanence is needed to determine the long-term effects associated with exposure to the ACL constituents.

Chapter XIII discusses institutional controls that can be used to prevent or minimize exposure by controlling access to the contaminated ground water. Institutional ground-water use controls are not specifically listed in the Section 264.94(b) criteria but they can be important factors in assessing exposure to hazardous constituents. However, they are discussed in this document because use controls are frequently implemented in situations concerning ground-water contamination. The permit applicant must submit evidence supporting all use controls that are being proposed as a means of preventing exposure. The use controls must prevent contact with the contaminated ground water as well as encompass the existing and projected areal extent of the ground-water contamination plume. The institutional controls used to prevent exposure to the ACL constituents must contain some type of enforcement provision to guarantee the existence of the use control for as long as the ground-water protection standard is exceeded.

Chapter XIV presents the summary and conclusions of the ACL guidance document. This chapter emphasizes the independent nature of each ACL demonstration and presents the time frame of the ACL process. Information on each of the criteria discussed in this guidance document is not required in every ACL demonstration. Each ACL demonstration must reflect site specific environmental properties and waste characteristics. As part of the ground-water protection standard, an ACL is in effect during the compliance period. If, at the end of the compliance period, the owner or operator is engaged in a corrective action program, the compliance period is extended until the owner or operator can demonstrate that the GWPS, which may contain ACLs, has not been exceeded for a period of three consecutive years.

Chapter I

Introduction

Hazardous waste facilities permitted under the Resource Conservation and Recovery Act (RCRA) regulations (40 CFR Parts 264 and 270) are required to be designed and operated in a manner that will prevent ground-water contamination. Therefore, the concentration limits for hazardous constituents detected in ground water at RCRA facilities (the "ground-water protection standards") will generally be set at background levels or RCRA adopted maximum concentration limits. These maximum concentration limits are established for 14 hazardous constituents, as set by the National Interim Primary Drinking Water Standards, and are listed in Table 1 of Section 264.94(a) of the regulations. Variances are available from these standards if the permit applicant can demonstrate that the constituents will not pose a substantial present or potential hazard to human health or the environment. In such cases, the applicant may ask for an "alternate concentration limit" (ACL) under Section 264.94 of the regulations. This section of the regulations lists 10 criteria to be applied in ACL demonstrations.

This guidance document serves to elaborate on these 10 criteria and thus provide guidance to permit applicants seeking ACLs and permit writers evaluating ACL demonstrations. The document is divided into 14 chapters which include an introduction, an explanation of each of the 10 criteria in the regulation, a discussion of the use of man-made barriers, a review of the use of institutional ground-water use controls, and a conclusion.

This document is intended to be used by RCRA permit applicants and permit writers. It may also be useful for Record of Decision preparations pursuant to the EPA Superfund program (CERCLA) or for State permit writers. In applying this guidance for Superfund or for State permits, the users must be cognizant of any differences between the requirements of their programs and the RCRA regulations and permitting programs.

Alternate concentration limits are discussed in the RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities under Subpart F: Ground-water Protection (U.S. EPA 1982a). ACLs are granted through the permit process under Parts 264 and 270. The permit applicant and reviewer should become familiar with the ground-water protection regulations and supporting preamble before proceeding with this guidance. The Subpart F Ground-Water Protection regulations and applicable parts of the preamble to the July 26, 1982, Federal Register are reprinted in Appendix 1 (U.S. EPA 1982b). These documents will give the permit applicant and reviewer a proper perspective on both the requirements and the intent of the ground-water protection regulations.

Alternate concentration limits are established in the context of the facility ground-water protection standards. The standard establishes a limit on the amount of ground-water contamination that can be allowed without endangering public health or the environment. The ground-water protection standard is an essential element in the Agency's strategy to ensure that public health and the environment are not endangered by any contamination of ground-water resulting from the treatment, storage, or disposal of hazardous wastes. As such, the standard will indicate when corrective action will be necessary to control contamination that has emerged from a regulated unit.

The principal elements of the ground-water protection standard are discussed in Section 264.92. For each hazardous constituent entering the ground water from a regulated unit, a concentration limit must be established that will serve as a limit beyond which degradation of ground-water quality will not be allowed. There are three possible concentration levels that can be used to establish the ground-water protection standard:

1. Background levels of the constituents,
2. Maximum concentration limits listed in Table 1 of Section 264.94(a), or
3. Alternate concentration limits as described in this guidance.

Section 264.94 establishes the criteria that must be used to specify concentration limits. The approach used by the regulation is to adopt widely accepted environmental performance standards, when available, as concentration limits. However, because of the lack of currently available standards, specific concentration limits for only a few specific constituents have been included in the regulations. These limits are those standards that were established by the National Interim Primary Drinking Water Regulations. If a constituent is not one of these compounds, then no degradation beyond background water quality becomes the standard. In such cases, the concentration limit should be set at background. However, a specified amount of degradation beyond background levels can be allowed by establishing alternate concentration limits. Alternate concentration limits can be established only after the applicant successfully shows that these concentrations of hazardous constituents will not adversely affect public health or the environment.

The criteria that the applicant must use when preparing requests for ACLs are specified in Section 264.94(b). Essentially, the applicant must be able to demonstrate that as long as the concentration of the hazardous constituent does not exceed the requested alternate concentration limit at the point of compliance, no substantial current or potential hazards to human health or the environment will result.

An ACL demonstration is essentially a risk assessment and risk management process in which a determination of acceptable ground-water contamination is made. Site specific information, such as local hydrogeological characteristics, the facility's waste constituents, and local environmental factors, is needed to assess the potential impact of each hazardous constituent present in the ground water on human health or the environment. There are two approaches that an applicant can take in an ACL demonstration:

1. There will be no exposure to the ground-water contaminants, or

2. The exposure to the ground-water contaminants will be at concentration levels that do not pose a substantial current or potential hazard to human health and the environment.

In the second approach, the ACL demonstration depends upon determining concentration levels of the ground-water contaminants that do not pose a substantial current or potential hazard to human health and the environment at a potential point of exposure. The ACLs for the ground-water contaminants are derived from these acceptable concentrations and are set at the facility's point of compliance.

All Agency published acceptable exposure levels for the protection of human health and the environment can be used as ACLs without going through elaborate exposure pathway analyses or fate and transport modeling. For example, a health based acceptable ground-water exposure concentration for a constituent detected in the ground water can be used as an ACL at the point of compliance. However, the acceptable level used as an ACL may need to be modified to include an assessment of any cumulative effects associated with exposure to the ACL constituent. It is anticipated that the Agency will periodically publish and update a list of acceptable dose levels that can be used by permit applicants in preparing ACL demonstrations.

The type and amount of information needed for an ACL demonstration depends on site-specific characteristics and which approach (either no exposure or acceptable risk) is chosen. Both approaches require information on the physical and chemical characteristics of the waste, flow direction and quantity of the ground water, and hydrogeological characteristics of the site. An ACL demonstration based on the second approach requires additional information. Depending on the basis for the demonstration, one or more of the following must be addressed in greater detail:

1. Current and future uses of ground water and surface water (if applicable),

2. The proximity of the user of the water resources to the facility,

3. The existing ground-water quality,

4. The potential human health risks and environmental damage from exposure to the contaminants, and

5. The permanence of the potential adverse effects resulting from exposure to the contaminants.

For any of the above factors that are not part of the ACL basis, justification is required to explain why they do not need to be addressed. Depending on the site characteristics, either approach may require information on the engineered characteristics of the facility, the rainfall patterns in the area, the existing quality of ground-water and surface water (if applicable), and any current or future institutional ground-water use restrictions.

The ACL demonstration for each constituent must be independent. It may cross reference many sections of the Part B Permit Application and it will cross reference each individual ACL constituent demonstration. Information required from the following sections of the Part B Permit Application portion of the regulations should be included in all ACL demonstrations:

270.14(b) General information requirements for all hazardous waste management facilities.

(1) General description of the facility.

(2) Chemical and physical analyses of the hazardous waste, in accordance with Part 264.

(8) Description of the procedures, structures, or equipment used at the facility to prevent contamination of water supplies.

(11) Facility location information:

(i) Identification of the political jurisdiction (e.g., county or township) in which the facility is located,

(ii) If the facility is located in an area listed in Appendix VI of Part 264, information must be submitted to demonstrate compliance with the seismic standard under §264.18(a),

(iii) Identification of whether a facility is located within a 100-year floodplain,

(iv) Information required if a facility is located in a 100-year floodplain.

(19) A topographic map clearly showing:

(i) Map scale (at least one inch: 200 feet) and date,

(ii) 100-year floodplain area,

(iii) Surface waters including intermittent streams,

(iv) Surrounding land uses,

(vi) Orientation of the map,

(vii) Legal boundaries of the facility,

(ix) Injection and withdrawal wells both on-site and off-site,

(x) Buildings; treatment, storage, or disposal operations, or other structures,

(xi) Barriers for drainage or flood controls, and

(xii) Location of operational units within the facility site, where hazardous waste is or will be.

270.14(c) Additional information required for the protection of ground water for hazardous waste surface impoundments, piles, land treatment units, and landfills.

(1) A summary of the interim status ground-water monitoring data.

(2) Identification of the uppermost aquifer and aquifers hydraulically interconnected beneath the facility property, including ground-water flow direction and rate, and the basis for such identification.

(3) Additional information to be included on the topographic map:

(a) Delineation of the waste management area, the property boundary, and the proposed "point of compliance";

(b) The location of ground-water monitoring wells;

(c) The hydrogeologic information required under §270.14(c)(2).

(4) A description of any plume of contamination that has entered the ground water that:

(i) Delineates the extent of the plume on the topographic map, and

(ii) Identifies the concentration of each Part 261 Appendix VIII constituent throughout the plume, or identifies the maximum concentrations of each Appendix VIII constituent in the plume.

(7) Information needed to establish a compliance monitoring program under §264.99:

(i) A description of the wastes previously handled at the facility;

(ii) A characterization of the contaminated ground water, including concentrations of hazardous constituents;

(iii) A list of hazardous constituents for which compliance monitoring will be undertaken in accordance with §§264.97 and 264.99;

(iv) Proposed concentration limits for each hazardous constituent, based on the criteria set forth in §264.94(a), including a justification for establishing any ACLs;

(v) Detailed plans and an engineering report describing the proposed ground-water monitoring program to be implemented to meet the requirements of §264.97; and

(vi) A description of the proposed sampling, analysis, and statistical comparison procedures to be utilized in evaluating ground-water monitoring data.

The following sections of the Part B permit application could be used in an ACL demonstration, if they apply to the site-specific characteristics:

270.14(b)(5) General inspection requirements under §264.15(b), if applicable to the ACL demonstration.

(13) A copy of the closure plan and the post-closure plan, if applicable to the ACL demonstration.

(20) Additional information necessary to satisfy other Federal law requirements under §270.3. These laws may include:

(a) The Wild and Scenic Rivers Act (16 USC 1273),

(b) The National Historic Preservation Act of 1966 (16 USC 470),

(c) The Endangered Species Act (16 UC 1531),

(d) The Coastal Zone Management Act (16 USC 1451), or

(e) The Fish and Wildlife Coordination Act (16 USC 661).

270.14(c)(8) Information needed to establish either a corrective action program which meets the requirements of §264.100, if applicable to the ACL demonstration, or a compliance monitoring program which meets the requirements of §264.99 and §270.14(c)(6).

The information presented in the demonstration on proposed concentration limits is only one source that should be reviewed by the permit writer. Independent research by the permit writer is essential in reviewing the applicant's ACL demonstration. The permit writer should examine references that are listed both in this document and in the applicant's demonstration. The reviewer should also consult U.S. EPA headquarters for the latest policy guidance concerning ACLs.

The permit applicant will not receive an ACL by showing that adverse effects on human health and the environment will be delayed. The permit applicant should provide evidence that adverse impacts will be prevented. A consideration that must be remembered is that if data on which the demonstration is based is subject to considerable uncertainty, the U.S. EPA may not establish the requested concentration limits.

Organization of the Guidance

This document provides guidance on the specific factors involved in the preparation of an ACL demonstration. Since ACLs are based upon combinations of one or more criteria listed in Section 264.94(b), a separate chapter is devoted to each of the Section 264.94(b) criteria. Basically, the criteria are designed around four major topics:

1. The potential for ground-water contaminant migration,
2. The quality of the contaminant plume as it migrates,
3. The current and future uses of ground water and surface water in the area, and
4. The health and environmental effects associated with exposure to the ground-water contaminants.

The criteria are briefly discussed, along with the type, quantity, and quality of information that should be provided by the permit applicant. Each chapter of this document discusses how each criterion fits into one or more of the four main topics.

Chapter II

Physical and Chemical Characteristics of the Waste Constituents (§264.94(b)(1)(i) and (2)(i))

The first step in an ACL demonstration is to identify the chemicals of concern. These "hazardous constituents" are chemicals listed in Appendix VIII of Part 261 of the regulations that have been detected in the ground water and may reasonably be expected to be related to the hazardous waste facility. Once the hazardous constituents are identified, their physical and chemical characteristics must be determined in order to effectively model their transport through the environment and their ultimate fate. This chapter discusses the information that is needed to adequately characterize the physical and chemical properties of the hazardous constituents.

The permit applicant should already know which hazardous constituents are present in the ground water at the facility by the time an ACL demonstration is submitted. The Section 270.14(c) permitting requirements specify that the permit applicant must determine the extent of ground-water contamination when a significant increase in a ground-water contaminant occurs at the compliance point. Additional ground-water sample collection and analysis is usually not necessary for ACL purposes.

The hazardous constituents of concern during the permitting process can be any of the 375 contaminants listed in 40 CFR Part 261, Appendix VIII. The Agency does not require sampling for Appendix VIII substances that are unstable in ground water or for which no EPA-approved analytical method exists (U.S. EPA, 1984a). An Appendix VIII determination is required whenever any leakage from a facility's unit is detected by Section 264.98 monitoring because it is difficult to assure the absence of particular hazardous constituents emanating from a regulated unit simply by recordkeeping. Wastes other than those that are currently received might have been placed in the unit in pre-recordkeeping times. In addition, there is the potential for unpredicted reactions and the formation of breakdown products.

The fulfillment of the Section 270.14(c) permitting requirements should result in the spatial characterization of each hazardous constituent found at the site. The permit applicant should submit, as part of the ACL demonstration, the data gathered to satisfy these requirements and present the information in terms of three-dimensional representations of constituent concentrations. The three-dimensional representation of ground-water contamination may not necessitate three-dimensional modeling of the contaminant plume. A two-dimensional model in the vertical and longitudinal planes may be sufficient in many cases if the site hydrogeology is fairly homogeneous, and if sufficient monitoring data exists to describe the plume.

The permit applicant should also submit, as part of the ACL demonstration, information on the chemical and physical characteristics of the wastes in the regulated unit which was gathered pursuant to Section 264.13. This general waste analysis provision should result in an assessment of the ability of the waste constituents to migrate based on the quantity and special characteristics of the waste. This data will enable the ACL reviewer to have a better understanding of what may be expected to show up in the ground water. Generally, additional waste constituent analyses need not be conducted for the ACL demonstration if the applicant has fulfilled the requirements of Section 264.13.

Several physical and chemical characteristics of hazardous constituents are critical to the modeling of contaminant transport in ground water. Permit applicants need to submit data on the following characteristics of the constituents for which ACLs are requested: density, solubility, vapor pressure, viscosity, and octanol-water partitioning coefficient. For example, consider a facility that is leaking a hazardous constituent at a concentration level near to or above the constituent's solubility level. In this situation, there is a good possibility that a two-phase plume could result. One phase would be the dissolved constituent plume in the ground water, and the other would consist of relatively pure hazardous constituent. This later phase could either be floating on top of the water table or sinking to an aquitard, depending on its density. The two phases would probably move at different rates due to viscosity differences.

Even when there is only one phase present, transport modeling results for plumes with mixtures of contaminants are dependent on the physical and chemical characteristics of the constituents. This is because attenuation parameters for transport models depend on specific characteristics of the hazardous constituents. The permit applicant should submit density, solubility, vapor pressure, viscosity, and octanol-water partitioning coefficient values of the hazardous constituents in tabular form. Appendix 2 contains an example of a summary sheet that can be used to list the important properties of the ground-water ACL constituents.

An ACL demonstration that is based on attenuation must be supported by data on fate-related characteristics of the ACL constituents. The objective of any ACL demonstration is to show either no exposure or acceptable exposure to hazardous constituents. If a permit applicant argues that the presence of an ACL constituent at the point of compliance presents no possibility for exposure because it is not persistent in the ground water, then special fate and stability related characteristics of the constituent must be discussed in the ACL demonstration.

The stability of waste constituents in the subsurface environment can be affected by chemical, biological, and physical processes. Important subsurface chemically mediated processes may involve oxidation, reduction, and hydrolysis. Important biologically mediated processes include biodegradation and biotransformation reactions. The subsurface physically mediated processes can involve ion exchange, precipitation, and complexation reactions. If the ACL demonstration is based on any of these processes, then the results of site-specific tests should be submitted. Most of the degradation processes depend on the properties of contaminants as well as environmental factors such as microbial populations, solid surfaces, and dissolved constituents present in the ground water. Because the relevant environmental factors are unevenly distributed in nature, degradation and reaction rates are not constant in ground-water environments and must be assessed on a site-specific basis. Therefore, the use of general information gathered from the literature will be of limited value when assessing the stability of waste constituents.

It may be possible to group hazardous constituents that are detected in the ground water at a facility according to stability characteristics. If site specific tests support the grouping of constituents, then the fate and mobility of each constituent within a group can be based on the stability characteristics of the most mobile and most persistent compounds in the group. This would result in the fate and mobility coefficients for each constituent being set at the coefficient values for the most mobile and most stable compounds in the group. Although it is difficult to decide on which groupings of constituents are appropriate, the grouping of constituents can reduce the amount of predictive modeling necessary for quantifying environmental concentrations and exposure pathways.

Chapter III

Hydrogeologic Characteristics (§264.94(b)(1)(ii) and (2)(ii))

The assessment of ground-water movement near a facility is essential to every ACL demonstration. The main route of exposure to ground-water contaminants usually involves the movement of the hazardous constituents through the soil to the ground water and on to an existing or potential point of use. This chapter describes the information needed to adequately determine the hydrogeologic properties required for characterizing ground-water movement at a site.

During the general RCRA permitting process, the permit applicant is required under Section 270.14(c) to identify the uppermost aquifer. The uppermost aquifer is defined in the regulations as the geologic formation nearest the natural ground surface that is an aquifer as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Saturated zones above the uppermost aquifer are also of interest as contaminant migration pathways. Therefore, the geologic and hydrologic properties of each of the individual strata beneath a facility that are likely to influence ground-water contaminant migration should be submitted in the ACL demonstration. This information is needed to adequately characterize ground-water transport mechanisms. Much of the data should already be available to the permit applicant if the Section 270.14(c) requirements have been fulfilled.

The important geologic attributes of a facility include:

1. Soil and rock characteristics,
2. Geologic structure, and
3. Geomorphology and topography.

When describing the soil characteristics of a facility, the permit applicant should use the Unified Soil Classification. Each soil type beneath the site and within the areal extent of the ground-water contaminant plume should be investigated along with soils that are in the expected path of contaminant migration. The permit applicant should submit data describing the thickness, areal extent, and hydraulic properties of each soil type. The soil information should be submitted in both tabular and graphic form. The areal extent of soil types should be presented on a map with a scale no greater than one inch:200 feet. Vertical profiles and cross-sections of soil types should be provided by the applicant to present three-dimensional perspectives of the soils.

If the applicant uses soil or other matrix attenuation mechanisms to justify a claim of no exposure or minimal exposure to the ground-water contaminants, the applicant must submit additional data and calculations used to define the attenuative properties. Otherwise, the applicant needs only to present the soil data previously discussed.

Attenuation mechanisms that may be relevant to an ACL demonstration are:

1. Dispersion, including hydrodynamic dispersion,
2. Retardation, including all sorptive properties, and

3. Degradation, including mechanisms of biodegradation, oxidation, reduction, and hydrolysis.

The permit applicant should submit data describing the organic and mineral content, the cation and anion exchange capacity, and the grain size of each soil type in the expected path of contaminant migration. Aquifer matrix characteristics that affect the stability of the ACL constituents (see Chapter II) should also be described if they are used to support attenuation claims. The results of tests to substantiate any attenuation claims should be submitted by the applicant. Likewise, sampling and laboratory procedures used to determine the attenuation properties should be presented and results tabulated. Brady (1974), Black (1965), and Freeze and Cherry (1979) provide in-depth discussions of these specific soil characteristics. The permit applicant and reviewer should consult these references for assistance.

The permit applicant should submit a set of maps that adequately depicts the subsurface stratigraphy. The near-surface stratigraphic units in the zone of saturation that affect or are likely to affect ground-water contaminant migration should be described. The areal and vertical extent of the hydrogeologic units can be presented in several ways. For complex settings, the most desirable presentation is a series of structural contour maps for the top or bottom of each unit. Vertical sections and isopach maps can also be used since they are generally more graphic and are useful as supplements to the structural contour maps. Because the construction of any of these diagrams involves interpolation and extrapolation of limited data, the diagrams should show the location of control points and the corresponding value at each control point. The site maps should include the depth, thickness, and areal extent of each stratigraphic unit. The maps should also adequately depict all stratigraphic zones and lenses within the near-surface zone of saturation. The site-specific stratigraphic maps should be detailed and have a scale no greater than one inch:200 feet. The applicant should also submit regional stratigraphy maps in order to show unique regional characteristics and their relationships to the site, and to justify claims concerning the ultimate fate of a contaminant plume. A table that summarizes the subsurface geologic information should be submitted.

Each of the stratigraphic units located in the zone of saturation must be characterized for the hydrologic parameters of hydraulic conductivity (vertical and horizontal), specific yield (unconfined aquifer) or specific storage (confined aquifer), and effective porosity. Hydraulic conductivity and porosity of aquifer material can be determined by using laboratory or field methods. It is recommended that all tests that are conducted to define the hydraulic properties of each stratigraphic unit be performed in the field. Laboratory tests may be used to substantiate field test results, but should not be the sole basis for determining aquifer characteristics. Only in special cases will the submittal of laboratory analyses be considered adequate for describing aquifer characteristics. Literature value estimates for these parameters will rarely be acceptable.

Each of the hydrologic parameters can vary from point to point, even within the same aquifer. Therefore, the areal variations of the parameters within the stratigraphic units should be determined. The amount of data necessary to characterize a stratigraphic unit will increase with the increasing heterogeneity of the unit. As an example, an aquifer of extensive homogeneous beach sand will require less investigation than a glacial unit consisting of lenticular deposits of outwash sand and gravel interbedded with clayey till.

There are many field methods for measuring hydraulic conductivity and porosity. Hydraulic conductivity is most effectively determined from the analysis of pump test data. For units having low hydrologic conductivity, single well tests are generally used (i.e., a slug test). For hydraulic units having high hydraulic conductivity, multi-well pumping tests are necessary. The pump test methods are normally designed to evaluate the transmissivity and storativity (storage coefficient) of the aquifer. Hydraulic conductivity is determined by dividing transmissivity by the aquifer thickness. More information on determining aquifer characteristics can be found in Freeze and Cherry (1979), Kruseman and De Ridder (1979), U.S. EPA (1983a), Walton (1970), and Appendices 3 and 4 of this document.

Different laboratory methods can be used to substantiate field data. Hydraulic conductivity may be determined on a core sample of the aquifer by using either a constant-head or a falling head permeameter. A description of the method can be found in Todd (1980) and Bouwer (1978) (see Appendices 3 and 4). In the laboratory, effective porosity can be determined as the ratio of the volume of water yielded by gravity flow to the volume of soil or rock material.

If an aquitard separates two distinct ground-water zones, then the physical and hydraulic characteristics of that aquitard must be provided in sufficient detail to illustrate the degree of interconnection between the two aquifers. This requirement can be fulfilled by providing the results of an aquifer pump test designed to show the effect of the pumping of the deeper aquifer has on the shallow aquifer (see Appendix 4). The shallow aquifer will exhibit significant drawdown during the pump test if the two aquifers are interconnected.

A summary of the hydraulic properties of each stratigraphic zone within the zone of saturation should be submitted by the permit applicant. This data should be provided in a table that includes the aquifer name, stratigraphic zone, vertical conductivity, horizontal conductivity, specific yield, transmissivity, and storage coefficient.

Chapter IV

Ground-Water Flow Direction and Quantity (§264.94(b)(1)(iii) and (2)(iii))

The amount or quantity of ground water at a site and the direction in which it flows are two essential components of an analysis of the fate and transport of hazardous constituents in the ground water. The ultimate fate of contaminated ground-water is a principal topic of every ACL demonstration. A contaminate plume can discharge into and mix with other ground water or a surface water body. This chapter describes methods that can be used to determine ground-water flow direction and quantity at a site.

The primary processes that control the migration of contaminants in subsurface environments include:

1. Advection (movement of the ground water),
2. Hydrodynamic dispersion (mixing of ground water having different levels of contamination), and
3. Chemical reactions.

For ACL purposes, advection is defined as the migration of hazardous constituents by actual motion or flow and is generally assumed to be caused by natural ground-water flow. Consideration of advection alone presents the worst-case calculations in terms of peak arrival times and concentration strengths. Furthermore, qualitative and quantitative evaluation of advection in terms of flow pathways is possible.

The Section 270.14(c) permit requirements specify the submittal of ground-water flow information. This data should be adequate for ACL demonstration purposes and the permit applicant probably will not have to collect additional field data. The permit applicant should evaluate ground-water flow in terms of the flow regime that is present at the facility. Flow from the facility to the water table will generally occur in the unsaturated zone, although it may go via surface water. Where subsurface heterogeneities are not significant, it is reasonable to assume that flow through the unsaturated zone will be predominantly downward. This assumption is justified because gravity is the primary force acting on a fluid in the unsaturated zone.

Once in the saturated zone, dissolved constituents will move with the ground water. Evaluation of advective transport in the saturated zone for miscible constituents can generally be based on the observed ground-water flow field and hydraulic properties (hydraulic conductivity and effective porosity). The observed flow field can be determined by a combination of areal water level maps and vertical sections showing water levels.

Calculations of ground-water quantity will require the use of the subsurface hydrogeologic parameters described in Chapter III. Ground-water quantity can be estimated from the hydrologic parameters, which are specific yield for unconfined aquifers and specific storage for confined aquifers. The use of Darcy's law for determining ground-water flow quantity is acceptable, and can be found in any standard ground-water textbook (e.g., Freeze and Cherry (1979)). Darcy's law can be used to calculate specific discharge or volume rate of flow through a cross sectional area perpendicular to the flow direction.

The determination of ground-water flow rates and directions, in concept, is simple. If the distribution of hydraulic head and the hydrologic properties at the site are known, then a flow net or water level contour map in conjunction with the use of Darcy's law can be used to determine flow rates and directions.

The permit applicant should be aware of a number of factors that can make accurate determination of ground-water flow difficult. These include:

1. Low horizontal gradients,
2. High vertical gradients,
3. Temporal variations in water levels,
4. Heterogeneous properties, and,
5. Anisotropic properties.

In areas of low horizontal gradients, small errors in water level measurements or small transient changes in water levels can make determination of flow direction and rates unreliable. High vertical gradients often exist in surficial units. In recharge areas, head decreases with depth; whereas in discharge areas, it increases with depth. Often, a shallow water table aquifer may overlie an aquifer of higher permeability, resulting in vertical head gradients. A very common mistake is made when water level contour maps are constructed using wells or piezometers at different depths, since calculated horizontal flow directions may be inaccurate.

Water levels can vary temporally because of short-term stresses, tidal effects, seasonal effects, and long-term trends. In determining flow direction, the annually averaged water levels are of primary interest. Consideration of short-term effects is more important at sites with low hydraulic gradients. In evaluating any water level data, the uncertainty introduced by neglecting short-term effects must be estimated. Seasonal variations in recharge can result in significant water level variations in unconfined aquifers. Artificial recharge and certain types of ground-water pumpage often lead to seasonal changes in water levels. These changes may occur under both confined and unconfined conditions.

The degree of heterogeneity in aquifers may range from fairly moderate to extreme. The potentiometric surfaces or water levels in heterogeneous aquifers are not smooth regular surfaces. At the contact between two geologic materials, the hydraulic gradient will be discontinuous. For some aquifers, such as fractured rock and karst aquifers, the heterogeneity is much more complex.

Another property of an aquifer is its anisotropy. Hydraulic conductivity is a property that is dependent on direction and has three principal components. If the principal components are equal, then the aquifer is isotropic. If not, the aquifer is anisotropic. For anisotropic aquifers, flow lines are not perpendicular to equipotential lines or water levels. Many aquifers display a horizontal-vertical anisotropy. However, if the two horizontal components of hydraulic conductivity are equal, then, from an areal perspective, flow lines will be perpendicular to lines of equal potential. Aquifers that may demonstrate horizontal anisotropy include aquifers in fractured rocks or steeply inclined strata. Ground-water flow direction is difficult to determine from water level data in these types of anisotrophic aquifers.

The factors that make the determination of flow rates and directions unreliable can often be overcome by an expanded effort in water level monitoring. For seasonal variations in water levels, a higher frequency monitoring schedule is necessary. For low horizontal gradients, the effects of short-term changes in water levels can be analyzed by installation of continuous recorders in selected wells. In aquifers having significant vertical gradients, piezometers completed at various depths may be required in order to provide a three-dimensional description of the flow field. For heterogeneous and anisotropic aquifers, more water level monitoring wells and more field tests for hydraulic properties are required.

The hydrogeologic portion of the ACL demonstration must include an adequate description of both horizontal and vertical ground-water flow components. This requirement has very obvious implications from the standpoint of determining where the hazardous constituents may migrate. The horizontal ground-water flow description should include a flow net based on ground-water elevation measurements taken from monitoring wells or peizometers, screened at the same elevation in the same saturated zone. It must be designed to provide reliable results of the ground-water flow direction in the zone of saturation. There may be sites that will require the applicant to monitor for hazardous constituents at more than one ground-water elevation. When this situation occurs, the permit applicant must be especially careful to ensure that the monitoring plan is designed correctly.

Information obtained from analyses of the hydrogeological properties and flow direction will allow the calculation of the interstitial flow velocity. The use of flow nets is described in Appendix 4. Well identifier codes, well depths, screened intervals, ground water elevations, and sampling data should be presented in tabular form. The flow net data should be graphically portrayed on a site map that includes ground-water elevations, isopleths, and flow vectors. As discussed before, the interstitial ground-water velocity can be determined by a simple modification of Darcy's equation (see Appendix 4). All calculations and assumptions should be included in the discussion of flow rates.

Vertical ground-water gradients and flow should also be described. Facilities should have several nested piezometers for vertical gradient determinations. Vertical flow gradient will aid in determining discharge and recharge zones, aquitard characteristics, and whether the monitoring wells are located and screened at the appropriate depths. The permit applicant should refer to Appendices 3 and 4 for further discussion of nested piezometers. The data that should be submitted in tabular form for each well nest includes well identification code, well depth, screened interval, ground-water elevation, and sampling date. All calculations and assumptions should be described in detail.

Facilities that are located in environmental settings that exhibit temporal variation in ground-water flow direction should define the extent to which the flow change occurs. The main causes of ground-water flow variation are:

1. Seasonality of recharge or discharge,
2. Ground-water withdrawals,
3. Underground injection, and
4. Surface water elevation changes.

In cases of seasonal ground-water flow variation, the permit applicant should provide information that describes those temporal changes in ground-water flow direction using records compiled over a period of no less than one year.

The rate of withdrawal of ground water is an important factor that influences ground water and contaminant movement, and exposure to contaminated water. The rate of ground-water withdrawal in the vicinity of the facility should be summarized in tabular form and include well location, depth, type of user, and withdrawal rates. The zone of impact created by any major well or well field withdrawal should be identified on a USGS topographic map. The map should include drawdown isolines out to the 10 centimeter drawdown level. Modeling of drawdown curves should use low recharge assumptions such as drought conditions.

Chapter V

Engineered Characteristics of the Site

While the two previous chapters dealt with natural hydrogeologic characteristics of a facility's site, this chapter discusses man-made hydraulic barrier systems that may be used to alter the natural hydrogeology. Man-made hydraulic barriers are not specifically mentioned in the criteria listed in Section 264.94(b) of the regulation but they can be an important factor in assessing exposure to hazardous constituents (see Section 264.94(b)(viii and ix)). However, they are discussed in this document because man-made barriers to ground-water movement, such as slurry walls, frequently come into consideration as control devices in cases of ground-water contamination. Man-made ground-water control structures must meet one of the following criteria before they will be accepted as the basis for ACLs:

1. Exposure to the ACL constituent will be prevented by the control structure, or
2. Exposure levels to the ACL constituents will be reduced to levels that are protective of human health and the environment by the use of hydraulic barriers.

It must be stressed that a demonstration that claims perpetual containment of contaminated ground water is not acceptable for purposes of justifying ACLs. This is because engineered systems eventually leak and therefore by themselves do not preclude the ACL constituent from "posing a substantial present or potential hazard" as specified by Section 264.94(a) of the regulation.

This is not to say that containment measures (e.g., slurry walls) cannot be used as part of a corrective action measure for a facility. For example, a containment structure could be used in conjunction with withdrawal wells to remove contaminants from the ground water. Such corrective action measures must be initiated and completed within a "reasonable period of time" under Section 264.100. The permit writer may specify the duration of such corrective action measures after considering the need for prompt action at the site and the technical capacity of the owner or operator.

Any owner or operator that uses man-made hydraulic barriers to restrict exposure or augment attenuation must demonstrate that there will be a permanent monitoring system present to ensure that the proposed control technology functions according to the specified performance standards. Appendix 5 contains information on the types of monitoring systems needed to ensure the effectiveness of slurry walls. Similar monitoring systems are required for other types of engineered structures.

The permit applicant has the opportunity to demonstrate that a ground-water control structure will augment natural attenuation of the ACL constituents in the ground water, thereby limiting exposure. Ground-water control structures that can be used to justify ACLs are plume management mechanisms that either steer contaminated ground water away from exposure points or reduce the ground-water transport velocity so that natural attenuation mechanisms can reduce contaminant concentrations to acceptable levels.

Demonstration Objectives

Attenuation of ground-water contaminants occurs naturally through several mechanisms:

1. Dilution of contaminants by mixing with "uncontaminated" ground water,

2. Adsorption of contaminants by the aquifer matrix, or

3. Degradation of contaminants by processes occurring in the ground water.

These processes depend on both spatial and temporal factors. A ground-water control system can act to delay ground-water transport so that natural attenuation is enhanced, aiding adsorption or degradation by increasing the time for processes to occur or by increasing the contact time with the aquifer matrix. Control systems can also act to increase the distance of travel to exposure points or to prevent short-circuits via fractures, sand lenses, or other hydrologic channels. An increase in transport distance can be effective in attenuating contaminants because of greater dilution or increased adsorption. Greater dilution could result from an increase in the volume of ground water and increased adsorption would result from more aquifer matrix coming in contact with the hazardous constituents.

The objective of an ACL demonstration based on man-made control mechanisms is to show that the control system is effective in reducing contaminant concentrations to acceptable levels. Control structures could result in acceptable exposures if they steer ground-water contaminants to major surface water dilution sources where the effects of the contaminants are minimal.

Engineered Ground-Water Controls

The various methods of engineered ground-water control that will be considered include barriers of low permeability such as slurry walls, cutoff walls, and grout curtains. The low permeability barriers can be used to limit exposure to the contaminated ground water. Low permeability barrier systems will be considered in ACL demonstrations only when they are used to steer or manage ground-water plumes.

Slurry walls and cutoff walls are subsurface barriers that can reduce, retard, or redirect the flow of ground water. In general, they consist of an excavated trench that is refilled with either a soil-bentonite mixture, a bentonite-cement mixture, or an asphalt mixture. In most instances, they will be keyed into an impermeable layer or bedrock. There are several design and construction considerations that must be evaluated in order to assess the adequacy of such a system. The permit applicant must submit the results of a thorough hydrogeologic and geotechnical investigation (see Chapters III and IV). The applicant must also submit detailed information regarding:

1. Hazardous constituent compatability;
2. Barrier wall constituent mixture ratios, and method of mixing;
3. Method of excavation;
4. Method of keying the slurry wall into the aquitard or bedrock;
5. Method of determining the effectiveness of the barrier wall;
6. Location;

7. Length, width, and depth;

8. Hydraulic conductivity and sorption capacity; and,

9. Changes in the hydrologic regime.

All information submitted to the agency describing the design considerations should be accompanied by the signature of a professional engineer or qualified geologist or geotechnical engineer attesting to the appropriateness of the barrier wall system to the site geohydrology.

Grout curtains are another method of ground-water control. In general, grouting is accomplished by drilling holes to the desired depth and injecting the grout under pressure into the holes. The grout mixture itself may be one of two types, either suspension grout or chemical grout. For a more detailed description of grout types, see Appendix 5.

As with designing a slurry wall system, hydrogeologic and geotechnical testing must be performed prior to installing a grout curtain. All the information needed for an evaluation of a slurry wall system must be submitted by the permit applicant. In addition, the following information is needed:

1. Detailed drilling information,

2. Grid design,

3. Type of grout used,

4. Grout losses and injection pressure, and

5. Curing time (if applicable).

Ground-water pumping systems that are considered corrective action measures may be used to augment plume management. Again, the permit applicant must submit the detailed hydrogeologic and geotechnical information as described in Chapters III and IV. In addition, the applicant must submit an analysis describing the predicted effect that the ground-water pumping system will have on the natural flow regime. The applicant must consider the effects that the pumping system has on:

1. Production wells in the site vicinity,
2. Injection wells in the site vicinity, and
3. Facility withdrawal and/or injection wells.

A computer modeling analysis should be performed to predict the above effects.

All hydrogeological parameters used for the computer modeling analysis should be field-determined values. Parameter values that are taken from the literature or represent "reasonable" assumptions should not be accepted in lieu of actual facility-specific parameter values except in those rare instances when the literature data is unquestionably applicable to the site.

In cases where ground-water control structures are proposed for limiting exposure, the applicant must submit a plan detailing a methodology that will demonstrate both the effectiveness of the engineered system and the steps that will be taken if the system fails. This plan must include a ground-water monitoring program, a control structure testing plan, a modeling plan assessing effectiveness, and an exposure assessment describing the consequences of system failure. Failure of the system to meet specifications for its effectiveness is a violation of the permit equally as serious as exceeding the ACL at the point of compliance. Such failure will require reevaluation of the ground-water protection standards and possibly corrective action.

Chapter VI

Patterns of Rainfall
(§264.94(b)(2)(iv))

Precipitation is a driving factor for ground-water recharge and ground-water discharge. These processes are basic components of the hydrogeology at a facility. To verify a claim of no exposure or exposure to acceptable levels of contaminants, precipitation data in support of ground-water flow and contaminant transport information must be submitted. This chapter describes the type of precipitation data that should be submitted in support of an ACL demonstration.

The permit applicant should focus the discussion of precipitation around the site's hydrologic regime. If the applicant's ACL demonstration clearly shows that ground-water discharge to surface waters is unlikely, then the discussion of precipitation events can be limited to effects on infiltration and ground-water recharge. However, if ground-water discharge to surface water is an important element of the ACL demonstration, then precipitation events should be related to recharge and discharge of ground water.

Precipitation events are variable and occur with different intensities, volumes, and durations. The geographical distribution of rainfall also varies from one area to another within a region. However, over a long period of time (years), the precipitation data for an area can be represented by events with definite volumes that occur at various frequencies. These frequencies are classified in terms of duration and yearly return periods. For example, a one day/10-year storm event is defined as the amount of rainfall that is expected to occur during a 24-hour period, once every 10 years. The precipitation volume of a storm of specific return period and duration is used to produce an estimate for the volume of precipitation for a given geographical area.

All permit applicants must submit general information on the precipitation characteristics of a site. This includes data on rainfall and snowfall, expressed as its equivalent in rainfall. Monthly precipitation data gathered over a period of at least 12 months should be submitted. Historical data can be used if it is from an area within 15 km of the facility. The regional rainfall data from areas greater than 15 km of the facility should be correlated with available on-site data. The National Oceanographic and Atmospheric Administration or climate data in Ruffner (1980 and 1981) may be a source of this precipitation information if on-site data is unavailable. The monthly mean and range of this data, the specific time period the data comes from, and the location of the rain gauge(s) in relation to the facility should be provided. The permit applicant should discuss the precipitation data in terms of temporal effects on infiltration and seasonal ground-water recharge. These processes should be related to any effects on contaminant transport.

If the facility is located near surface water bodies (see Chapter VII), or if surface water dilution is used as an argument in an ACL demonstration, then more detailed information on precipitation events should be submitted. Otherwise, the permit applicant can proceed to the next chapter. The permit applicant should submit data on specific storm frequency patterns and discuss how these storms relate to flood and infiltration/discharge characteristics of the facility.

The predicted volume of precipitation produced over a 24-hour period by storms of return frequencies of 1, 10, 25, and 100-years should be submitted. The 1-year and 10-year storm frequency information gives insight into ground-water infiltration and discharge patterns. The 25-year and 100-year storm frequency data are useful in assessing discharge during flood conditions.

The 100-year floodplain should be described on a USGS topographic map. The floodplain information should be readily available to the applicant since it is required by Section 270.14(b) permitting requirements. Federal Insurance Administration flood maps can be a useful source for this information. If the facility has any special flood prevention devices, they should also be shown on the map. These devices could include any dikes, berms, and special flood retention walls. The effect of these devices on ground-water infiltration and discharge should be discussed. Furthermore, any special site conditions that affect infiltration and discharge should be discussed. These include site topography, solar orientation of the regulated unit, and wind patterns.

The ground-water discharge patterns at the facility should also be delineated on a topographic map. All streams, ditches, culverts, and sewers that receive ground water should be clearly identified. Normal ground-water discharge patterns (1-year storm) and discharge during flood conditions (25 and 100-year storms) should be clearly marked. Snow melt pathways should be identified, if appropriate. Any discharge abatement or collection devices, such as detention basins, swales, and canals, should be described.

Chapter VII

Proximity of Surface Water and Ground-Water Users
(§264.94(b)(1)(iv) and (2)(v))

This chapter and the next chapter discuss important factors necessary for assessing probable exposure pathways for the ACL constituents through surface and ground water. This chapter discusses the location of surface water and ground-water users in the vicinity of the facility. The uses of surface and ground water in the vicinity of the facility are discussed in Chapter VIII.

A key factor involved in assessing exposure is the proximity of surface water and ground-water users to the facility. This factor is considered in the evaluation of existing or potential off-site migration of hazardous constituents and in the assessment of the uses of the specific water resources. For ACL demonstrations, "proximity" is liberally defined to include both spatial and temporal concepts. Linear distance may be more appropriate for judging potential surface water exposures, while time of travel is important for ground-water exposures. Proximity should be expressed in terms of both linear distance and time required for ground-water flow and contaminant transport.

The level of information necessary to satisfy the proximity of users requirement depends on the basis of the ACL. If a down-gradient surface water body is the primary focus of a demonstration, then data related to the specific characteristics of the water body are necessary. The permit applicant may use surface water dilution as an argument for acceptable exposure limits for an ACL constituent.

An ACL demonstration based on dilution should be supported by data on specific physical attributes of the surface water body. This includes information necessary to estimate the dilution potential and mixing mechanisms of the water body. If the permit applicant argues that no exposure will take place in downgradient water bodies, then general information on the distance of the water bodies from the facility is necessary, along with time of travel estimates for contaminant migration to the water bodies. Likewise, the same arguments apply to the level of information necessary to assess exposure of ground-water users. This will be discussed further in the following sections.

Surface Water

All ACL demonstrations should include a discussion of the potential effects of the facility on surface waters. The initial evaluation includes assessing the facility's proximity to surface waters and involves:

1. Identifying each surface water body in the vicinity of the facility,

2. Determining the distance from the waste management area boundary to each surface water body,

3. Identifying ground-water discharge pathways to surface waters, and

4. Estimating time of travel of waste constituents to water bodies.

Each water body within five kilometers downgradient (or downstream) of the facility boundary should be identified. The owner or operator of the facility must supply a USGS topographic map identifying each water body. All streams, rivers, ponds, lakes, estuaries, and marine waters should be clearly marked. All ditches, streams, sewers, and runoff pathways that serve as ground-water discharge or infiltration areas should be delineated on the topographic map. A table specifying the name of each water body and the distance from the waste management area to the closest part of each water body should be provided by the owner or operator of the facility.

The travel time of the ACL constituents from the facility to the discharge areas should be discussed by the permit applicant. Ground water and hazardous constituents may move at different rates due to different physical and chemical properties. Therefore, discharge calculations should include estimates of both hydraulic transport and waste transport. The ground-water transport models and methods discussed previously in Chapter IV should be used to estimate the hydraulic and hazardous constituent loading rates. Actual seepage measurements may be necessary to verify model estimates if ground-water discharges are estimated to be a significant portion of the annual hydraulic load to a water body.

A greater level of detail on characteristics of surface water bodies is needed in ACL demonstrations that include dilution in surface waters as an argument or in cases where surface waters are likely to be exposed to ACL contaminants due to their proximity to the facility. In these cases, the physical characteristics of each identified downgradient (or downstream) water body should be included in a table. Important lake and pond characteristics are:

1. Surface area,

2. Mean depth,

3. Volume,

4. Temperature stratification, and

5. Hydraulic residence time.

Information on estuarine and marine areas should include:

1. Surface area,

2. Mean depth, and

3. Tidal periodicity and amplitude.

Pertinent stream and river characteristics are:

1. Mean width;

2. Mean depth;

3. Flow rate, including average flow and lowest flow that would be expected to occur during a continuous 7-day period, once every 10 years (Q7-10); and

4. Lowest recorded flow rate.

This information is necessary to estimate the dilution potential and mixing mechanisms of each type of surface water in the vicinity of the facility. The temporal and spatial variability of flow rates, tidal factors, and hydraulic residence times are also essential factors for establishing dilution potential.

The permit applicant should synthesize this information to support arguments of acceptable surface water exposures or no significant exposures due to dilution in surface waters. The expected amount of dilution and the mixing zones of probable discharge areas should be factored into this discussion. The permit applicant should be aware that certain States have approved surface water dilution models that are used in the NPDES permitting program. If approved models are available, they should be used by the applicant to determine mixing zones and dilution in surface waters.

Ground Water

As a matter of general policy for ACL demonstrations, the potential ground-water exposure point is the waste management boundary of the facility. If there are ground-water use controls beyond the facility waste management boundary, the potential groundwater exposure point will be at any point downgradient of the waste management boundary. In order to designate the property boundary as the point of exposure, a facility must ensure that there are permanent prohibitions on the use of on-site ground water. These restrictions must apply to the owner of the facility, as well as to any successive owners. In order to designate a potential point of exposure beyond the property boundary, ground-water use restrictions must be in place off-site to prevent any use of the contaminated ground water. Ground-water use restrictions are discussed in Chapter XIII.

In order to assess the likelihood of exposure of current ground-water users, every ACL demonstration must discuss the proximity of ground-water users to the facility. This requires determining:

1. The distance of each ground-water user from the facility, and

2. The hydrologic transport time for the contaminants to reach the closest users.

The users of ground water within a five kilometer radius of the facility boundary must be identified. The applicant should delineate each ground-water withdrawal or injection well on a USGS topographic map. The distance of each well from the waste management area should be given in a table. The following uses of each well should be clearly marked:

1. Potable (municipal and residential),
2. Domestic, non-potable,
3. Industrial,
4. Agricultural, and
5. Recharge.

The permit applicant has the opportunity to discuss the likelihood of exposure at the facility's property boundary. Although it is not required in every ACL demonstration, it may be to the permit applicant's advantage to submit information on the projected future users of the ground water. Several factors should be examined:

1. Demography of the surrounding area,
2. Zoning patterns and projected changes in zonings,
3. Projected population growth,
4. Projected ground-water use, and
5. Restrictions on ground-water use.

Each of these factors should be concisely described in a narrative format. The projections in zoning changes, population growth, and ground-water use should include median and maximum estimates. Discussions of ground-water use restrictions should explicitly state the legal nature of any restrictions and the duration of such restrictions.

Chapter VIII

Current and Future Uses of Ground Water and Surface Water in the Area (§264.94(b)(1)(v) and (2)(vi))

Once the location of the surface water and ground-water users has been determined, the nature of the use must be considered. A major objective of an ACL demonstration can be to show that ground-water contamination at a facility will not adversely affect any water use. The supporting arguments for the ACL can center around the fact that the ground-water contamination at the facility is not degrading the designated beneficial uses of the water resources. This requires the permit applicant to review federal, state, and local standards or guidelines that govern the uses of both ground and surface water to ensure that the presence of a contaminant plume is not inconsistent with any published regulations, ordinances, or guidelines. This chapter points out the types of water uses that should be investigated, and the information that should be submitted on those water uses to support an ACL demonstration.

An ACL demonstration based on a claim of no degradation of a water resource should discuss the current uses of all water resources near the facility. Information gathered to satisfy data requirements on the proximity of water resource users (see Chapter VII) will be adequate to identify major water resources near the facility. In order to aid the permit reviewer, the water resource use information should be structured around the following general categories:

1. Agricultural - irrigation and animal watering;
2. Industrial - process, cooling, and boiler water;

3. Domestic and municipal - potable and lawn/garden watering;

4. Environmental - ground-water recharge or discharge, fish and wildlife propagation, unique areas; and

5. Recreational - fishing, swimming, boating, and other contact uses.

The permit applicant should examine pertinent aspects of both ground water and surface water uses. Both the current uses and the likely future uses of the water resources should be examined. Permit applicants must submit information on the ground-water uses in the vicinity of the facility, unless they can successfully argue that no exposure to the contaminated ground water will occur. The specific type of ground-water use information is described in the following section.

Ground-Water Uses

The U.S. EPA has developed a Ground-Water Protection Strategy (U.S. EPA, 1984b). An important part of this strategy is to adopt guidelines for consistency in the Agency's ground-water protection efforts. The strategy states that ground water should be protected to its highest beneficial use. Guidelines for classifying ground water should be available in the fall of 1985. Three general classes of ground water are recognized:

Class I: Special ground waters are those that are highly vulnerable to contamination because of the hydrological characteristics of the areas under which they occur, and that are also characterized by either of the following two factors:

a) Irreplaceable--no reasonable alternative source of drinking water is available to substantial populations, or

b) Ecologically vital--the aquifer provides the base flow for a particularly sensitive ecological system that, if polluted, would destroy a unique habitat.

Class II: Current and potential sources of drinking water and waters with other beneficial uses include all other ground waters that are currently used or potentially available for drinking water or other beneficial uses.

Class III: Ground waters not considered potential sources of drinking water and of limited beneficial use are those that are heavily saline, with total dissolved solids (TDS) levels over 10,000 mg/l, or are otherwise contaminated beyond levels that allow cleanup using methods that are reasonably employed in public water system treatment. These ground waters also must not migrate to Class I or II ground waters or have a discharge to surface water that could cause degradation.

The permit applicant should discuss the ground water classification in the vicinity of the facility in terms of these three classes or other appropriate State approved classification schemes. This classification information may be found in State ground-water plans (208 plans) or State ground-water classification documents. The data should be presented in tabular form in order to expedite its review. Certification by the state and/or local government as to the beneficial use of the ground water should be included if the State has classified the ground water. Otherwise, the permit applicant should have its ground-water classification data reviewed by the State. The State's review should be included in the ACL demonstration.

It should be obvious that the ground-water use can be critical in the setting of ACLs at a facility. Facilities that are contaminating, or have the potential to contaminate, Class I or Class II ground waters must incorporate human health factors into their ACL demonstration (see Chapter X). The Agency's Ground-Water Protection Strategy states that the Agency's policy is to not grant ACLs at hazardous waste facilities situated above Class I ground waters. Before this policy can be fully implemented in the ACL process, it will be necessary to define Class I ground waters in regulations and to appropriately amend the ACL regulations. In the interim, this guidance document emphasizes the careful consideration of contaminant impacts on Class I ground waters during the ACL process.

If the ground water is Class III, then health-based concerns may be secondary to environmental-based concerns in the setting of ACLs. More information on ACLs in Class III ground water is presented in Appendix 6. Two situations are envisioned in which ACLs could be proposed based on poor ground-water quality:

1. The existing risk from potential consumption or use of the ground water may be already so great that the increase of the concentration of a specific constituent would pose no additional risk, or

2. The ground water has been declared unfit for use by the State government, and controls are in place to prevent its use (see Chapter XIII).

Surface Water Uses

Surface water uses should be discussed by the permit applicant if contaminated ground water can migrate to surface waters. Surface water use information is especially critical for ACLs based on surface water dilution. The previous chapter on proximity of surface waters should aid in deciding which water bodies are of interest. If no surface water impacts are likely, then the data discussed in this section are not required to be submitted.

The statutory established guidelines, criteria, and/or standards for each water body identified in Chapter VII must be examined. The permit applicant should list in a table the designated use of each water body, a citation of the local, state, or federal regulations governing the use, and the agency responsible for implementing the regulation. The following general use categories should be used by the permit applicant in preparing the table:

1. Drinking water source,
2. Fish and wildlife propagation area,
3. Industrial or agricultural water source,
4. Area of special ecological concern, and
5. Recreational area.

It should be noted that many States have generic restrictions on the discharges of "toxic pollutants in toxic amounts" and of "potential carcinogens" to surface waters.

The surface water use information will aid in determining appropriate ACLs by identifying surface water exposures that can occur. The data gathered to fulfill the requirements of this section will be used to prioritize the likely exposure pathways and to determine whether human health and environment factors should be assessed in further detail (see Chapters X and XI).

Chapter IX

Existing Quality of Ground Water and Surface Water, and Other Sources of Contamination (§264.94(b)(1)(vi) and (2)(vii))

In order for "benchmark" levels of contamination to be set, the background levels of hazardous constituents in the ground water must be determined in every ACL demonstration. If surface water exposure to the ground-water contaminants is part of the ACL demonstration, the background levels of the ground-water contaminants in the surface water must also be determined. If the ground water and surface water sampled for background levels appear to be contaminated, the facility owner or operator should examine the possibility of other sources of contamination in the vicinity of the facility. This chapter discusses the type of background water quality data that should be submitted in an ACL demonstration in order to adequately assess the cumulative impacts associated with any contamination emanating from the facility.

Background Water Quality

For ACL purposes, background water quality is the quality that would be expected to be found if the facility was not leaking contaminants. Careful planning must be used in deciding where representative background water samples should be taken. Under Section 264.99, the regulations specify a procedure for establishing background levels for hazardous constituents for purposes of setting ground-water standards. Essentially, background monitoring wells must yield ground-water samples from the uppermost aquifer that represent the quality of ground water that has not been affected by leakage from a facility's regulated unit. For most sites, this is an upgradient area that can be determined readily from the water level data. The permit applicant is directed to the Draft RCRA Permit Writers' Manual for Ground-Water Protection (U.S. EPA, 1983a) for further guidance on ground-water monitoring and station locations. Background surface water quality must be assessed only in cases where surface waters are likely to receive contaminated ground-water discharges (see Chapter VIII). Background surface water quality should be determined upstream of the facility to ensure that any leakage from the facility is not affecting the monitoring results.

The permit applicant should submit a site map that identifies the location of background sampling stations and monitoring wells, and the direction of both ground-water movement and stream flow. Any flood discharge pathways and directions should also be shown on the site map.

The permit applicant may find historical ground-water monitoring studies and ambient surface water monitoring programs to be useful when assessing background water quality. The USGS, U.S.EPA, State, and local environmental program offices can be good sources of historical data. The background concentrations in both ground water and surface water of Appendix VIII constituents for which ACLs are being proposed should be included in a summary table. Each distinct aquifer and surface water body that is likely to be exposed to contaminants should be listed separately. If additional monitoring studies are necessary for determining background water quality, the EPA Regional Office may assist by reviewing the monitoring work plans. Regardless of the source of the background water quality data, the permit applicant should submit available quality assurance and quality control information on sample collection, sample analysis, well construction, and environmental conditions. Documents from which any data were taken should be available for review if they are requested by the permit writer.

Ground-Water Contamination Sources

The permit applicant should investigate other sources of ground-water contamination if background monitoring wells exhibit contamination. If no contamination is found, the permit applicant can omit the following discussion and proceed to the surface water discussion. The types of upgradient pollution sources and the impacts of the contamination on ground-water use are important and should be considered. Identifying potential pollution sources is necessary in order to assess the cumulative impact of pollution sources on human health and the environment. The following potential pollution sources should be identified within a five kilometer radius of the site:

1. Other RCRA facilities,
2. Superfund sites,
3. Landfills,
4. Industrial areas,

5. Surface impoundments,
6. Chemical storage areas,
7. Deep well injection sites,
8. Agricultural areas,
9. Septic tanks, and
10. Underground storage tanks.

Each potential contamination source should be delineated on a USGS topographic map. The distance of each source from both the facility and the upgradient monitoring wells should be discussed. All pertinent ground-water data on any of the identified sources should also be discussed.

Some areas may have hazardous constituents present in the ground water because of natural processes occurring in the ground water. For example, some metals may be found at fairly high levels in certain ground waters. However, natural sources of synthetic organic compounds (e.g., chlorinated solvents) are not expected. If synthetic organic compounds are found in background samples, then the permit applicant should attempt to to identify the the source of contamination.

The water-use impacts from the contamination should be discussed by the permit applicant if upgradient ground water is impaired by any source of contamination. In Chapter VIII of this guidance, the current and future uses of ground water are discussed in more detail.

Surface Water Contamination Sources

The permit applicant should examine other sources of surface water contamination if the applicant's facility affects surface water resources. Consideration should be given to both point and non-point sources of contamination. Any point sources of pollutant loading to surface waters should be identified on a USGS topographic map. The point sources should include:

1. Discharges from industrial facilities,
2. Discharges from Publicly Owned Treatment Works (POTW), and
3. Past waste discharges.

The permit applicant should submit a table that includes the name of each point source and the water body into which the point source discharges. The discharge rate and NPDES permit number of each point source should also be included in this table. Any waste load allocations, permit discharge conditions, and mixing zones should be discussed. The applicant should focus these discussions around the impact of the facility's discharge on these factors. For example, a lake may have an established waste load of 5 grams of lead/day, of which 4 grams are allocated to a NPDES permitted facility. The discharge of lead from the applicant's facility to the lake is estimated to be 3 grams/day. In this situation, an appropriate ACL for lead may be one that results in a loading rate of one gram/day to the lake, thus requiring some type of corrective action to reduce the lead concentration to the ACL. Copies of available

NPDES permit compliance and permit application monitoring data should be submitted if they contain information on the specific ACL constituents.

Any non-point sources of pollution to surface waters that may affect the ACL decision should also be discussed. The permit applicant should submit information on:

1. Urban storm run-off,
2. Agricultural run-off,
3. Ground-water infiltration, and
4. Other RCRA facilities.

Actual monitoring data may be submitted along with loading model calculations, if they are applicable.

Chapter X

Potential Health Risks
(§264.94(b)(1)(vii) and (2)(viii))

A health risk assessment should be included in an ACL demonstration if human exposure to the ground-water contaminants is not prevented. There are two major components to a determination of health risks. First, an exposure assessment must be performed that characterizes the current and future populations that may be exposed to the contaminants, and the current and potential human exposure pathways. Second, the health effects associated with exposure to each contaminant and mixture of contaminants must be examined. The purpose of the health risk assessment is to determine acceptable concentrations at a point of exposure for the constituents for which ACLs are requested. These acceptable concentrations can be used as a basis to calculate the ACLs at the point of compliance. This chapter describes the information necessary to sufficiently support proposed acceptable concentrations for constituents in an ACL demonstration.

The type of information needed to satisfy the health risk requirement depends on the exposure pathway. If the contaminated ground water is discharging into a downgradient surface water body that is a source of drinking water and a sustained fishery, the health risk information must be based on exposure from the consumption of contaminated water and aquatic organisms. In this case, an ACL demonstration could be based on surface water dilution of the contaminated ground water to an acceptable level.

If the primary exposure pathway is from a ground-water source of drinking water, the health risk information must be based on the consumption of contaminated drinking water. In this case, attenuation mechanisms in the saturated zone may be the basis for the ACL demonstration.

The health risk assessment may be based on the following types of likely exposure pathways:

1. Drinking water exposure from either a ground water or a surface water source,

2. Ingestion of contaminated food (e.g., aquatic organisms or agricultural products),

3. Dermal contact (e.g., recreational use of surface waters, or bathing),

4. Inhalation of volatile organics, or

5. Any combination of the above pathways.

The inhalation exposure pathway usually does not have to be addressed in great detail in an ACL demonstration. It should only be considered in cases where significant quantities of volatile organic compounds are either likely to degas from the contaminated ground water during use or can be expected to penetrate subsurface structures such as basements. The permit applicant should comment on the probability of the occurrence of these two types of exposures. The applicant will have to address inhalation in the health assessment in these situations where the use of ground water or the presence of subsurface structures allows for probable exposures.

When determining potential health risks, certain assumptions are usually made when complete data on specific human effects are lacking. Both the information that is needed to make a reasonable determination of potential health risks and the areas where assumptions may be necessary are discussed in the following sections.

Exposure Assessment

The location of the potential sources of exposure from surface and ground water is discussed in Chapter VII. The potential point of exposure to the ground-water contaminants is assumed to be at the facility waste management boundary unless use restrictions discussed in Chapter XIII have been implemented. The point of exposure for surface water bodies is assumed to be the water body closest to the facility in the pathway of contaminant migration. Once the location of the potential sources of exposure are identified, the applicant should determine whether a characterization of the populations that may be exposed at each point is necessary. In cases where the probability of exposure is not high because of no current off-site contamination or no large population centers, the exposure assessment can be based on standard assumptions (e.g., a 70 kg adult consuming 2 liters of water per day). The permit applicant does not need to assess population characteristics of the site but should follow the Agency's proposed quidelines for exposure assessments (U.S. EPA, 1984c).

However, the permit applicant should specifically characterize the exposed population in three specific situations:

1. Exposure to hazardous constituents is occurring due to the use of contaminated off-site water resources,

2. Exposure to hazardous constituents is highly probable due to off-site migration of contaminants, and

3. Probability of exposure is high due to a large population near the facility.

These situations of likely exposure are defined for ACL purposes to be cases either where hazardous contaminants have moved off-site via either ground-water or surface water pathways, or where the facility is located within a standard metropolitan statistical area (SMSA) as defined by the U. S. Department of Commerce. The following population characteristics should be determined in these cases:

1. Sex and age distributions,

2. Growth rates, and

3. Sensitive subgroups.

Most of this information can be obtained through the Bureau of the Census, U.S. Department of Commerce.

The presence of sensitive groups such as pregnant women, children, or chronically ill individuals within an exposed population directly affects the assumptions used to determine an acceptable concentration for an ACL constituent (U.S. EPA, 1980). The applicant should identify the most sensitive group within the exposed population. This subgroup should form the basis for the exposure assumptions used in deriving the acceptable concentrations for the ground-water contaminants. The U.S. Department of Health and Human Services, National Center for Health Statistics may be a good source of information on sensitive individuals in the region. All of this information should be presented in tabular form to facilitate easy reference.

Health Risk Assessment

Certain assumptions are usually made when determining health risks. Assumptions must be made concerning either intake rates of food, water, and air, or body surface area and weight. Absorption and excretion rates may be assumed to estimate equivalent oral doses based on data from inhalation or dermal exposure studies. The permit applicant should use generally-accepted standard factors in the exposure assessment. Some of the common factors used are listed in Appendix 7.

The permit applicant should identify the compounds that can be grouped together based on similar physical and chemical properties, since health effects data are sometimes listed for broad groupings such as polynuclear aromatic hydrocarbons (PAHs), halomethanes, or polychlorinated biphenyls (PCBs).

The permit applicant may find it advantageous to use groupings of hazardous constituents in order to simplify the development of ACLs. The acceptable exposure level of each hazardous constituent within a group can be based on the toxicity of the most toxic compound within the group. This would result in the acceptable toxic effect level for each constituent being set at the acceptable level for the most toxic compound within the group. This conservative approach to risk assessment could reduce the amount of data needed to quantify potential human health effects. However, it must be emphasized that the grouping of compounds into specific categories can be difficult, and approved methods are not available.

The applicant should perform a comprehensive literature search for health effects data on the contaminants or groups of contaminants found in the ground water for which ACLs are requested. Health effects data are available for compounds with established concentration levels such as Ambient Water Quality Criteria. Site-specific water quality criteria may be available at the State level. Guidance on modifying national criteria is available in the Water Quality Standards Handbook (U.S. EPA, 1983b). Appendix 8 contains a list of health and environmental effects profiles and assessments, available through the U.S. EPA, Environmental Criteria and Assessment Office. The Agency is currently compiling toxicity information on many of the hazardous constituents and this information should be useful in preparing ACL demonstrations.

In order to account for cumulative impacts of the hazardous constituents for which ACLs are requested, an assessment of the existing concentrations of the ACL constituents in the potentially impacted ground water or surface water should be performed. This information is necessary for determining the total concentration of the ACL constituents in the affected water resource, the health effects associated with the concentrations, and the relative contribution of the ACL constituents emanating from the site to the total concentration.

The applicant should distinguish between ground-water contaminants having threshold (toxic) and non-threshold (carcinogenic) effects. Toxicity data should be submitted for the toxic (threshold) contaminants. Draft guidance on the use of ADIs has been proposed by the Agency (U.S. EPA, 1984d). If Agency compiled data on threshold contaminants are not available, then the submitted data should contain dose/response information reflecting the acute, subchronic, chronic, and "no effect" levels for the threshold contaminants. Acceptable concentrations can be derived by applying appropriate exposure assumptions to established acceptable daily intake values or alternate dose levels derived from the literature. The National Academy of Sciences (NAS, 1977) defines and outlines the use of uncertainty factors in determining acceptable dose levels.

Non-threshold compounds, or carcinogens, should be subjected to the same review as the other toxic compounds. Cancer risk models, such as the linear non-threshold model, produce carcinogen potency factors or unit cancer risk (UCR) values. A UCR value represents the largest possible linear slope at low extrapolated doses that is consistent with the dose-response data (U.S. EPA, 1980). The uncertainties and extrapolation techniques that are used to estimate UCRs from cancer risk models should be clearly stated. Unit cancer risk values are used to estimate hazardous constituent concentrations that correspond to statistical lifetime cancer risk values. For example, a contaminant concentration corresponding to a lifetime cancer risk of 10^{-6}, assuming that a 70 kg adult consumes 2 liters of water per day, is estimated by the following formula:

$$\text{Exposure level (mg/l)} = \frac{70 \times 10^{-6}}{2 \times \text{UCR}}$$

Unit cancer risk values have been derived for many compounds by the Carcinogen Assessment Group (CAG, 1984) and are also available from Ambient Water Quality Criteria. Reference citations should accompany each exposure level based on a UCR.

The acceptable concentration of non-threshold compounds, or carcinogens, is determined through the risk management process. In general, the Agency has made decisions to allow concentrations of carcinogens where the individual risk values have been within the range of 10^{-4} to 10^{-8}. In setting ACLs the following factors should be considered in determining an acceptable risk level to any exposed individual within the 10^{-4} to 10^{-8} range:

1. Other environmental health factors borne by the affected population,

2. Level of uncertainty in the data base and models used in the risk analysis,

3. Level of uncertainty involved in predicting exposures including the expected effectiveness and reliability of man-made systems affecting exposure,

4. Current and expected future use of the affected resource, and

5. Impacts upon the environment.

It may be useful to also determine the total population that is currently exposed or likely to be exposed in the future, when weighing the importance of the five factors. As a general matter, a level of 10^{-6}, the middle of the range, should be used as the point of departure when proposing a risk level within the 10^{-4} to 10^{-8} range for a particular facility.

The permit applicant should discuss any other effects associated with the contaminants, including odor and taste effects, mutagenic effects, teratogenic effects, and synergistic or antagonistic effects. At a minimum, an additive approach based on contaminants that produce the same effects by similar mechanisms should be used to estimate health effects from exposure to mixtures of contaminants. The applicant should investigate criteria development for entire classes of compounds. Ambient Water Quality Criteria have been developed for classes of compounds such as polynuclear aromatic hydrocarbons (PAHs) and halomethanes. A reference citation and a summary should be submitted for each study that was used to determine the type of effect for each contaminant.

The permit applicant is responsible for providing information on health effects of the hazardous constituents present in the ground water for which ACLs are requested. Appendix 9 of this document contains a survey sheet on health effect factors that can be used to summarize the toxics information. The applicant should submit available health effects numbers for each ACL constituent. The health risk assessment should be based on conservative health based numbers. If the applicant uses less conservative numbers as a basis for the health risk assessment, the applicant must submit information to justify the use of these numbers. As discussed previously, the acceptable exposure levels for a group of constituents can be based on the toxicity of the most potent constituent within that group, if such a grouping is sufficiently justified. If sufficient toxicity information on any of the compounds has not been submitted, the ground-water protection standard will be set at background levels or at the maximum concentration levels listed in Table 1 of Section 264.94(a) of the regulations.

Chapter XI

Potential Damage to Wildlife, Vegetation, Agriculture, and Physical Structures (§264.94(b)(1)(viii) and (2)(ix))

In addition to risks to human health, environmental risks must be addressed in an ACL demonstration. Unless an ACL demonstration is based on no exposure to hazardous constituents, risks to animals, plants, and structures resulting from exposure to the hazardous constituents must be considered. This environmental risk assessment involves an exposure assessment and an effects assessment similar to the human health risk assessment. This chapter delineates the information needed to perform the assessments of risks other than those to human health.

The initial step in assessing possible environmental impacts is to determine the probable exposure pathways for hazardous constituents to reach environmental receptors. For ACL purposes, the receptors of concern include wildlife and vegetation in aquatic and terrestrial environments; agricultural crops, products, and lands; and physical structures. The exposure assessment involves examining the extent of the hazardous contaminant plume, the potential migration of hazardous constituents, and the location of receptors and environments of concern. The exposure assessment will result in delineation of likely exposure pathways. Information submitted to fulfill requirements discussed in previous chapters should be adequate to determine probable surface water and terrestrial exposure pathways. The permit applicant should examine the data requirements of Chapters VII and VIII, before proceeding with this chapter. The data necessary for assessing the effects of exposure of physical structures and agricultural crops, lands, and products to the hazardous constituents are discussed in subsequent sections of this chapter.

The permit applicant must examine the potential impacts to all the receptors discussed above if exposure to hazardous constituents is likely to occur. Otherwise, the permit applicant should discuss specific data that supports no probable exposure as well as justify why the potential impacts assessment is unnecessary.

Generally, data on chronic toxicity levels of the hazardous constituents are sufficient to characterize potential environmental impacts. However, chronic environmental toxicity data may not be available for many waste constituents likely to be the subjects of ACL requests. In the absence of environmental toxicity data, ACL applicants may be able to argue that a contaminant will have no adverse environmental effects. This argument could be based upon considerations of exposure levels and the toxicities of similar chemical compounds. If environmental receptors are actually being exposed to ACL constituents above chronic toxicity levels, or above background levels if no chronic toxicity levels are established, then field assessments of the impacts can be performed to support the proposed ACLs. The types of field studies that should be carried out are discussed in more detail in the following sections.

Terrestrial Impact Assessment

The quantification of adverse terrestrial environmental effects is difficult. However, examination of several environmental factors will provide an estimate of potential impacts to the environment due to exposure to contaminated ground water.

Potential impacts to terrestrial wildlife and vegetation can be assessed by examining exposure and environmental toxicity factors. The exposure assessment involves determining whether the contaminated ground water at a facility has the potential to impact any terrestrial environment. The specific data necessary to assess exposure are discussed in Chapters II, III, and IV. If there is a likely pathway for wildlife and vegetation to become exposed to contaminants, then environmental toxicity factors should be examined. It is expected that ACL applicants will not need to address terrestrial environmental impacts in detail, where there are no direct exposure routes between terrestrial systems and ground water. In these cases, the permit applicant can omit this section and move on to the endangered species section of this chapter.

The toxicity and bioaccumulation of hazardous constituents by terrestrial flora and fauna should be examined by the permit applicant. Terrestrial species can be exposed to toxicants either directly through assimilation of or contact with contaminated ground water, or indirectly through food web interactions. Toxicants can accumulate in exposed biota and increase to levels that are lethal or have chronic effects. The permit applicant should perform a comprehensive literature search for toxicity and bioaccumulation values for the ACL constituents found in the ground water. The information should be summarized in a table that includes information on the toxicants, the test species, the specific effects, the effect levels, the bioaccumulation potential, and the reference. The permit applicant can base the potential terrestrial toxicity assessment on the most toxic constituent within a group of constituents, if appropriate groupings of constituents exist for a facility. If literature information is sparse or non-existent, then a more thorough analysis of potential environmental impacts may be necessary. This could be based on consideration of exposure levels and the toxicities of similar chemical compounds. Bioassays could also be used to support the proposed ACLs; however, techniques for performing bioassays on terrestrial ecosystems are not an exact science, and they involve considerable time and expense to carry out. If the permit applicant plans to perform bioassays, then he should consult either U.S. EPA (1983c) or U.S. EPA (1984e) for more discussions on the use of bioassays to characterize chemical waste sites.

If terrestrial environments are presently being exposed to contaminants above chronic toxicity levels, or above background levels for constituents without established chronic toxicity levels, then field studies can be used to support the proposed ACLs. The permit applicant should examine the dominant terrestrial habitats in the vicinity of the facility. Evidence of any stressed vegetation should be documented and can be supported with aerial IR photography, or ground photography and vegetation surveys. Both a topographic map and low level aerial photographs delineating any stressed terrestrial environments should be submitted.

Vegetation survey data on species and abundance information on macrofloral types, usually trees and shrubs, should be collected. However, if the dominant habitat is an alpine or prairie environment, grasses and other plants should be examined. The community floral diversity can be calculated from the species information. Discussions of diversity should include species richness and community structure. This diversity information should be summarized in tabular form. Any differences between the background and affected habitats should be explained. The selection of the background habitat should be carefully planned so as to ensure that it is outside the influence of the facility. Sampling protocols for diversity and productivity studies should be submitted by the applicant, along with the data collected and a complete discussion of results.

Endangered Species Impact Assessment

Endangered and threatened species near the facility should be identified. The facility owner or operator should contact the U.S. Department of the Interior, Fish and Wildlife Service, for a current list of endangered or threatened species in the vicinity of the facility. The permit applicant is responsible for surveying the area and determining the presence of these species in any terrestrial or surface water environment. If any endangered or threatened species are in the area, then the potential impacts of the contaminated ground water on the species, including critical habitat impacts, should be discussed. A table should be submitted that lists the endangered and threatened species.

Aquatic Impact Assessment

The permit applicant should assess potential aquatic environmental effects by examining exposure and aquatic toxicity factors. The exposure assessment for surface waters was discussed in Chapters VII and VIII. Ground-water contaminants, flow direction, discharge areas, and proximity of surface waters are important considerations. The permit applicant should examine potential pathways of contaminant migration to surface waters. If exposure to contaminants is likely, then aquatic toxicity factors should be examined. If no hazardous constituents can reach surface waters, then the permit applicant should provide supporting evidence of this fact. The aquatic impact assessment can be omitted if sufficient evidence is available to support a claim of no surface water exposure.

The aquatic toxicity and bioaccumulation of hazardous constituents found in the ground water should be examined by the permit applicant if migration of the constituents to surface waters is likely. The U.S. EPA has published Water Quality Criteria for 64 toxic contaminants or contaminant groups (U.S. EPA, 1980). These water quality criteria specify concentrations of contaminants which, if they are not exceeded, are expected to normally result in aquatic ecosystems suitable for fish and wildlife propagation and water recreation. A summary of the water quality criteria is provided in Appendix 10. The permit applicant should calculate surface water contaminant concentrations from predicted ground-water discharge volumes and hazardous constituent concentrations.

Conservative assumptions should be used, such as low flow (Q7-10) conditions and small mixing zones (see Chapter VII). The predicted contaminant concentrations should be compared to acute toxicity values within the mixing zone and chronic toxicity values outside of the mixing zone. If compounds for which ACLs are requested do not have U.S. EPA or State approved water quality criteria, the permit applicant should complete a comprehensive literature search for aquatic toxicity data. This data may be available from commercial computer data bases. The aquatic toxicity data should be taken from studies that used test species comparable to the aquatic species present in the water body. The toxic data should be summarized in a table that includes information on the toxicant, test species, specific effects, effect levels and the references. The permit applicant can base the potential aquatic toxicity assessment on the most toxic constituent within a group of constituents, if appropriate groupings of constituents exist for a facility.

Bioaccumulation values should also be summarized from the literature. If aquatic toxicity information for an ACL constituent is missing, a more thorough analysis of potential aquatic impacts is necessary. This could include consideration of exposure levels and toxicities of similar chemical compounds. The analysis could also include field studies and possibly bioassays to justify an ACL. If the permit applicant intends to use bioassay data to support ACLs, the aquatic bioassay protocols and guidelines found in U.S. EPA (1980) and U.S. EPA (1983c) should be followed. All aquatic toxicity and bioaccumulation data collected by the permit applicant should be submitted. Appendix 11 contains a survey form that can be used to summarize environmental effects data.

The permit applicant could also submit available information on aquatic community exposure to support an ACL demonstration. Initially, the applicant could perform a literature search for aquatic community effects information on the ACL constituents. Aquatic effects can include fishery impacts, habitat impacts, and productivity changes. Submitted information could contain data on contaminant concentrations, environmental habitats, aquatic effects, and literature citations.

If aquatic environments are being exposed to contaminants above chronic toxicity levels, or above background levels if no chronic toxicity levels are established, field assessments of impacts may be necessary to support the proposed ACLs. Studies can be performed to verify either environmental impact or no impact to the exposed environment. A habitat assessment can be used to identify affected habitats in exposed surface waters. The exposed surface waters must be identified, along with their specific physical characteristics (see Chapter VII). The habitat assessment of such surface waters involves examining habitat alterations that are the result of ground-water contaminants. A control site in an unaffected area should be used for comparative purposes.

A comprehensive examination involving water and sediment sampling of each nearby water body that is downgradient (down-stream) of the facility and likely to receive contaminated ground-water discharges is also required. Each contaminant for which an ACL is requested should be analyzed in each of these media. The resulting data should be presented in a table that identifies the water body, the media, the specific contaminants and corresponding concentrations, the sampling locations and the date of sampling. The data should be discussed in detail. Affected aquatic environments should be delineated on a USGS topographic map. The site-specific sampling protocol and data should also be submitted.

The U.S. EPA publication, Water Quality Standards Handbook (1983b), contains information on evaluating the habitats and water quality of surface water environments. The types of environmental studies that are needed to evaluate the attainability of water quality standards are discussed. This handbook can be used as guidance by the permit applicant during the assessment of surface-water impacts. Appendix 12 contains two chapters of this handbook that may be useful.

The permit applicant should examine community structure parameters for aquatic environments near the facility. Evidence of floral and faunal impacts can include:

1. Stressed vegetation in surface waters or along shorelines,
2. Sparsely populated communitites,
3. Changes in community diversity, and,
4. Altered community structure.

These determinations may require an ecological survey of habitats in each surface water body that is downgradient from the facility and likely to receive contaminants above chronic toxicity levels, or above background levels for constituents without established chronic toxicity levels. Floral surveys of dominant macrophyte vegetation will require information on the number of species and their abundance. Macrobenthic surveys should be used to obtain abundance information on benthic fauna. Sport and commercial fishery impacts should be assessed. The permit applicant should submit all sampling protocols and data used to examine community structure and diversity. The diversity and species abundance information should be summarized in a table. Any difference in diversity between control and impacted areas should be discussed. Data discussions should include both experimental design and sampling protocols.

Agricultural Impact Assessment

The potential impacts of ground-water contamination on agriculture must be examined by the permit applicant. Exposure pathways, crop impacts, and livestock impacts should be included in the assessment. The exposure assessment is used to determine if there are likely pathways for ground-water contaminants to reach any agricultural lands or products. As part of the exposure assessment, data on the agricultural land uses near the facility should be submitted by the permit applicant. Specific uses such as row crops, rangeland, grazing tree farming and timber should be depicted on a USGS topographic map. A table that lists acreages of the specific uses should also be submitted.

The potential exposure pathways that the permit applicant should examine include shallow ground water, ground-water irrigation, and surface water irrigation. The shallow ground-water flow direction, aquifer attenuation mechanisms, and ground-water elevation are important characteristics that are used to determine exposure due to direct crop uptake of ground water. These topics were discussed in Chapters III and IV, and must be evaluated by the permit applicant during this exposure assessment. The irrigation wells near the facility should be identified and delineated on a USGS topographic map. Chapter VIII lists specific use information that is necessary for this assessment of the irrigation wells. Surface waters that are used for irrigation and have the potential to be impacted by ground-water contamination must be evaluated (see Chapter VII). The current and projected irrigation withdrawal rates should be determined from each irrigation source.

Agricultural crop impacts should be assessed by the permit applicant if exposure to ACL constituents is likely to occur. The agricultural damage assessment can be omitted if a condition of no exposure is demonstrated. The following potential agricultural impacts should be assessed:

1. Direct crop impacts and reduced productivity, and
2. Bioaccumulation of contaminants.

The permit applicant may be able to estimate the expected crop and productivity impacts resulting from exposure to hazardous contaminants in the ground water by examining the literature. Literature values that exist on crop impacts from exposure to the contaminants should be summarized in a table that includes the contaminant, the crop tested, the effect level, the bioaccumulation potential, and the specific reference. The U.S. Department of Agriculture (USDA) can be a source of crop effects information and testing methods. If literature information does not exist, and crops are likely to be exposed to ACL constituents, the ACL demonstration may be denied and the ground-water standards may be set at background levels. However, the permit applicant has the opportunity to carry out experiments to estimate potential crop impacts. The applicant should be aware that standard experimental protocols do not exist and that all data to support the ACL demonstration must be submitted in a timely fashion. If tests are performed by the permit applicant, all protocols and data should be submitted.

The permit applicant should describe potential livestock impacts that may occur from direct and indirect exposure to contaminants found in the ground water. Direct exposure would include livestock contact through watering. Indirect exposure could include contact during animal grazing and foraging. The applicant should submit any available information on potential livestock impacts of the ACL contaminants. If literature values exist, the information should be summarized in tabular form and include the factors discussed above in the crop impacts section. The USDA may have information on this topic. Permit applicants are not normally expected to carry out experiments on exposed livestock because of the high costs and long-term nature of such experiments. If exposure modeling shows that livestock exposure occurs and sufficient literature information does not exist to support an ACL, then the ground-water protection standard may be set at background levels.

Physical Structure Impact Assessment

Physical structures can be adversely affected by hazardous constituents in the ground water. The situation at Love Canal, N.Y., where toxicants entered basements of homes, is just one example. The determination of potential damage to and contamination of physical structures in the area around the facility requires the examination of exposure pathways, waste characteristics, environmental factors, and construction materials and techniques.

Potential exposure of the physical structures to waste contaminants requires identifying physical structures in the area and exposure pathways. All manmade structures including buildings, buried cables and pipes, railroad beds, roads, parking areas, and machinery near the facility should be identified and delineated on a vicinity map. The possible exposure pathways of the ground-water contaminants to the physical structures should be identified. The permit applicant should refer to Chapter IV to determine what information should be submitted in order to determine contaminant migration pathways. If the exposure assessment determines that physical structures are likely to come in contact with ACL contaminants, then the potential effects of the contaminants on the physical structures should be examined. Otherwise, the permit applicant needs only to explain why the assessment is not needed.

The hazardous constituent characteristics of primary concern for the physical structure impact assessment are reactivity, ignitability, and migration potential. Two important categories of reactive chemicals are corrosives and solvents. The ground-water contaminants that fall into either of these two categories should be listed in a table by the permit applicant. The potential effects of these compounds on building materials such as concrete, iron, steel, plastic, wood, asphalt, and limerock should be identified and summarized in a table. The ability of the contaminants to permeate these materials should also be discussed. The permit applicant should submit data on the flammability and ignitability of the ACL constituents which have the potential to permeate subsurface structures. Volatile organic compounds should be given special attention since they have been implicated in sewer-line explosions.

Chapter XII

Persistence and Permanence of Potential Adverse Effects (§264.94(b)(1)(ix) and (2)(x))

Many of the chapters in this guidance document discuss informational needs for ACL demonstrations that are related to the persistence and permanence of the ACL constituents. The general ACL policy will be to assume a worst case approach of no degradation of the ACL constituents unless information on the persistence of the ACL constituents in the environment is submitted. Similarly, if there is a potential for exposure to the ACL constituents resulting in adverse effects, the adverse effects will be considered permanent unless it is generally accepted not to be permanent or information is submitted by the permit applicant to justify it is not permanent. This chapter describes the information that is needed to characterize the persistence of the ACL constituents in the environment and the permanence of their adverse effects, if exposure occurs.

Persistence

Information on the persistence of the contaminants in the environment should be discussed in varying detail, depending on the basis of the ACL demonstration. The applicant should discuss the process by which each ACL constituent will degrade, either from a ground-water perspective, surface water perspective, or a combination of both depending on the site-specific situation. Contaminant degradation in ground water occurs predominantly through chemically mediated processes. If the applicant is claiming attenuation as a means of reducing the contaminant concentrations, the applicant must discuss the types of processes that may occur. These processes can include biodegradation, hydrolysis, oxidation, reduction, or precipitation, all of which were discussed in Chapter II.

If surface water exposure is involved, bioconcentration and biotransformation processes are important. Bioconcentration factors are important for evaluating human intake levels of contaminants from consumption of aquatic organisms and for assessing the permanence of ecological effects. Bioconcentration factors can be derived by experimentation or calculation. The applicant should provide justification for the use of any bioconcentration factors. Biotransformation is primarily carried out by microorganisms in the surrounding media. A lag time or acclimation period usually occurs before the biodegradation process begins. If biotransformation is used in the ACL demonstration, the applicant should determine whether the microbes are acclimated to the contaminant. A discussion of biotransformation and the use of bioconcentration factors can be found in U.S. EPA (1980) and U.S. EPA (1979).

If degradation processes are used in the ACL demonstration, the process rates should be calculated. Whether the mechanism of degradation is biological or chemical, all rates describing the processes should be included in the ACL demonstration. The parameters, coefficients, and assumptions used by the permit applicant to calculate the degradation rates for each contaminant should be submitted in tabular form.

Permanence

Information on the permanence of the adverse effects resulting from exposure to the ACL constituents will be required only if the ACL demonstration is risk based. This information should be included in the demonstration's health risk assessment (Chapter X) and the environmental risk assessment (Chapter XI). Permanence information is necessary in order to give the permit reviewer some idea of the long-term effects associated with exposure to each ACL constituent, as well as a better understanding of which ground-water contaminants are of most concern.

Many environmental systems exhibit a high degree of resiliency. If the damage is limited to individuals within the population and the gene pool is not irreparably depleted, the environmental damage may be reversible. However, if irretrievable habitat change has occurred, then environmental damage may be permanent. The permit applicant should examine the literature on the contaminant's environmental effects to determine the permanence of likely ecological impacts. Many biological evaluations can be performed to examine the resiliency and stability of an environmental system. Some examples include tissue analyses to determine bioaccumulation, diversity and recovery studies to estimate elasticity, and intolerant species analyses to determine the degree of degradation. A detailed explanation of these studies is presented in the Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses (U.S. EPA, 1983d). The permanence of the adverse effects is related to the contaminant's concentration level at the point of exposure. The acute and chronic effects levels for each contaminant should be determined if the ACL demonstration is based on risk considerations. The effects should be classified as either reversible or irreversible.

Chapter XIII

Institutional Ground-Water Use Restrictions

Exposure to a contaminant is a function of the pollutant pathway, the type of water resource use, and the proximity of receptors to the water resources. This chapter discusses institutional controls that can be used to prevent or minimize exposure by controlling access to the contaminated ground water. Institutional ground-water controls are not specifically mentioned in the criteria listed in Section 264.94(b) of the regulations but they can be important factors in assessing exposure to hazardous constituents (see 264.94(b)(vii and ix)).

The permit applicant must submit evidence supporting all use controls that are being proposed as a means of preventing exposure. The use controls must prevent contact with the contaminated ground water and encompass the existing and projected areal extent of the ground-water contamination plume. The institutional controls used to prevent exposure to the ACL constituents must contain some type of enforcement provision to guarantee the existence of the use control for as long as the ground-water protection standard is exceeded. In addition, the use and projected uses of the affected ground-water resource must be considered.

States' ground-water allocation rules are generally categorized into three types:

1. Absolute ownership, where the landowner essentially owns the ground-water underlying the landowner's property;

2. Reasonable use, where the courts can place reasonable limits on the use and withdrawal of ground water; and

3. Prior appropriation, where states, through common law and statutory schemes, have the authority to allocate ground-water rights and regulate ground-water use (Henderson, et al., 1984).

States that utilize the reasonable use rule or prior appropriation rule may contain ground-water use restrictions that include state enforced:

1. Ground-water extraction controls,

2. New well prohibitions, and

3. Existing well closures.

If the permit applicant uses arguments that depend on state use controls such as these, then the applicant must submit evidence that the State has authority to prevent exposure to the contaminated ground water.

Another institutional option for preventing exposure to contaminated ground water is a deed restriction. If the permit applicant owns the property over a contaminated ground-water plume, then the applicant may use deed restrictions that prevent the use of the water. These must be enforceable covenants running with the land that prevent exposure to the ground water, and must apply to both current and future property owners. However, if in the future the contamination no longer presents a threat to human health and the environment, a termination provision may be allowed in the deed restriction. In order to remove the deed restriction, the petitioner must submit evidence to the U.S. EPA that the use restrictions are no longer necessary. This evidence must include long-term ground-water monitoring data that supports the removal of the restriction. The permit applicant could also use zoning restrictions to prevent the use of the contaminated ground water.

Chapter XIV

Summary and Conclusions

The factors involved in preparing and supporting an ACL demonstration were discussed in the previous chapters. Information on each of the criteria discussed in this guidance document is not required in every ACL demonstration. Every RCRA facility is unique, with different environmental properties and waste characteristics. This necessitates that each ACL demonstration reflect site-specific conditions and that flexibility be integrated in applying the criteria. Much of the information required for an ACL demonstration may be taken from the facility's Part B permit application. This guidance document points out when additional information that satisfies the criteria should be submitted and also when it may not be necessary. However, the burden is always on the permit applicant to justify all arguments used for not submitting information on specific criteria. Appendix 13 contains a list of tables and figures that can be submitted as part of an ACL demonstration. The use of these tables and figures will greatly facilitate the review of the ACL demonstration by the permit writers. Appendix 14 contains a summary outline of the information that can be required to support an ACL demonstration. The permit applicant should be sure to submit all data necessary to fulfill the information requirements outlined in this Appendix.

Permit applicants who anticipate the need for an ACL demonstration should do some advance planning to enable themselves to make the demonstration quickly if ground-water contamination is detected. However, in recognition of the fact that a permit application requesting an ACL will contain more information and analysis than an application based on the other types of concentration limits, the ground-water regulations allow for additional time to submit the data necessary to justify an ACL. Within 90 days after detecting a significant increase in the concentration of hazardous constituents at the compliance point, the permit applicant must indicate whether he intends to seek an ACL variance for any Appendix VIII constituents detected in the ground water. The permit applicant indicates his choice by proposing established concentration limits, or offering background concentration limits, or giving notice that he intends to seek ACLs. The permit applicant has an additional 90 days to submit the actual information to support the proposed ACLs.

Once the data have been submitted by the permit applicant, the permit writer must assess the quality of the submitted information and determine the appropriateness of the potential point of use, the acceptable concentrations of contaminants at the point exposure, and of the ACLs at the point of compliance. In many cases, the permit writer will have to use professional judgement in determining the adequacy of the submitted information.

The Agency will indicate its decision on the merits of the ACL demonstration when it issues the compliance monitoring permit. The permit will contain a ground-water protection standard (GWPS) for each ground-water contaminant. The GWPS will contain either background values or the National Interim Primary Drinking Water Regulation limits listed in Table 1 of Section 264.94(a) (if EPA rejects the ACL demonstration), or it will contain ACLs. The need for corrective action will be averted if the ACL for each hazardous constituent is established at a level higher than its concentration at the facility's compliance point. If any constituent exceeds its ACL, corrective action will be necessary. The ACL then becomes the benchmark for the intensity and duration of the corrective action.

As part of the ground-water protection standard, an ACL is in effect during the compliance period. The compliance period is the number of years equal to the active life of the waste management area, including the closure period. If, at the end of the compliance period, the owner or operator is engaged in a corrective action program, the compliance period is extended until the owner or operator can demonstrate that the GWPS, which may contain ACLs, has not been exceeded for a period of three consecutive years.

Once the ground-water protection standard has been set in the permit, the permittee can only seek ACLs through permit modifications under the procedures outlined in 40 CFR Part 124. Such modifications are always major and the burden of proof to justify the variance is on the applicant. If a facility owner or operator violates the ground-water protection standards, he cannot postpone corrective action in order to argue for ACL changes.

The cost of ground-water corrective actions can be considerable. Therefore, there is a strong incentive for permit applicants to forestall imposition of corrective action requirements by submitting an ACL demonstration. In balancing the risks of setting ACLs as opposed to requiring corrective action, permit writers must consider that unwarranted and unnecessary corrective actions not only constitute inefficient use of resources but also could cause considerable adverse environmental impacts. Actions necessary to remove hazardous constituents could result in ground-water depletion, subsidence, and ecosystem dewatering. It is essential that the preparation of an ACL demonstration be fully supported, and that decisions on the demonstration be made expeditiously.

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