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ALTERNATE CONCENTRATION LIMIT GUIDANCE

PART I

ACL POLICY AND INFORMATION REQUIREMENTS

INTERIM FINAL

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DISCLAIMER

This document is intended to assist Regional and State personnel in exercising the discretion conferred by regulation in evaluating applications for ACLs submitted pursuant to 40 CFR 264.94. Conformance with this guidance is expected to result in ACL applications that meet the regulatory standard of protecting human health and the environment. However, EPA will not in all cases limit its review to demonstrations that comport with the guidance set forth herein. This document is not a regulation (i.e., it does not establish a standard of conduct which has the force of law) and should not be used as such. Regional and State personnel must exercise their discretion in using this guidance document as well as other relevant information in determining whether an ACL demonstration meets the regulatory standard.

ACKNOWLEDGEMENTS

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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. To establish the facility's ground- water protection standard (GWPS) under Subpart F (40 CFR 264.92), the Regional Administrator is required to establish in the facility permit, for each hazardous constituent entering the ground water from a regulated unit, a concentration limit that cannot be exceeded. The concentration limits are the "triggers" that determine when corrective action is required.

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

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

The first two levels are established in the facility permit as the GWPS, unless the facility owner or operator applies for an ACL. However, some States have non-degradation policies (which are either regulatory or statutory requirements) that prohibit the release of any pollutants into the ground water. These policies may prevent the use of an ACL altogether if the State has an authorized program for 40 CFR Part 264, Subpart F.

This document provides guidance to RCRA facility permit applicants and writers concerning the establishment of ACLs. 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. The 19 factors, or criteria, that are used to evaluate ACL requests are listed in Section 264.94(b) of the regulation. Detailed 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; it describes the purpose, intent, and organization of the document. The chapter also defines an ACL, describes Agency policy, and describes how ACLs fit into the RCRA permitting process. A procedure is presented that allows a permit applicant to employ either Agency- established maximum contaminant levels (MCLs) set under the authority of the Safe Drinking Water Act, or Agency-reviewed reference doses or risk-specific levels directly, or after a simple manipulation, as ACLs. For use as ACLs, these levels would have to be approved by EPA for the specific site. This chapter also points out that data from the RCRA Part B permit application may be cross- referenced in the ACL demonstration.

Experience gained over the last several years has allowed the Agency to develop a better understanding of ground-water contamination problems. This has led EPA to develop general policy guidelines for the use of ACLs at RCRA hazardous waste disposal facilities. These guidelines are designed to ensure that ACLs will be protective of human health and the environment.

Three basic policy guidelines have been identified to assist the permit writer and applicant in implementing the ACL process for useable ground water:

1. Ground-water contaminant plumes should not increase in size or concentration above allowable health or environmental exposure levels,

2. Increased facility property holdings should not be used to allow a greater ACL, and

3. ACLs should not be established so as to contaminate off-site ground water above allowable health or environmental exposure levels.

These guidelines are further described in the first chapter. Also described are the ways in which ACLs should be determined for five types of situations.

Chapter I also discusses how the ACL process fits into the rest of the RCRA ground-water protection program. The applicant is cautioned that an ACL based on attenuation mechanisms may not be acceptable to the permitting authority at the end of the post-closure care period. At the conclusion of post-closure care, a more stringent ground-water standard, based only on an allowable exposure level, may be needed because the facility owner has no further RCRA obligations for managing or monitoring the facility.

EPA is also in the process of developing a ground-water protection program for all solid waste management units at RCRA permitted facilities. This program is mandated by Section 3004(u) of the Hazardous and Solid Waste Amendments of 1984 (HSWA). The ACL process, as described in this document, may be useful when assessing corrective action measures at these solid waste management units. In developing this corrective action program, EPA will assess the need to promulgate some additional Subpart F regulations.

Chapter II discusses the data that the permit applicant must submit on the physical and chemical characteristics of the waste constituents. If the permit application sufficiently defines the extent of contamination, additional ground-water sample collection is probably not necessary for ACL purposes. The permit applicant should submit ground-water contamination 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 if the point of exposure is different from the point of compliance. 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. General descriptions of the geologic and hydrologic conditions at the facility should be part of all ACL demonstrations. 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 the ground-water quantity and flow direction information that is used to assess contaminant transport. The general RCRA permit requirements specify the submittal of ground-water flow data. This data should be adequate for on-site determinations of ground-water quantity and flow direction; however, additional data may be required if off-site determinations of quantity and flow are needed for the ACL demonstration. 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 for homogeneous and isotropic aquifers.

The hydrogeologic portion of all ACL demonstrations should include a general description of both horizontal and vertical ground-water flow components. ACL demonstrations based on attenuation arguments need a more in-depth discussion of ground-water flow. In these situations, the horizontal ground-water flow description should include a flow net based on ground-water elevation measurements taken from monitoring wells or piezometers screened at similar elevations in the same saturated zone. Facilities should have several clusters of piezometers for vertical gradient determinations. Facilities that are located in environmental settings that exhibit temporal variation in ground-water flow direction should describe the extent to which the flow change occurs.

Chapter V discusses the types of precipitation data that should be submitted in an ACL demonstration. ACL demonstrations based on contaminant attenuation need to include a discussion of precipitation, which should be focused on 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 effects can be limited to 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, discharge, and surface water hydrology.

Chapter VI 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. Only a general discussion of surface water and ground-water users is necessary if ACLs are based on exposure to the contaminants at the point of compliance, immediately at the edge of the waste management area. However, specific data on the physical characteristics of a surface water body are necessary if the applicant is attempting to show that the contaminants will safely and quickly attenuate into a surface water body. In order to assess the likelihood of exposure of ground-water users, ACL demonstrations should discuss the proximity of ground-water users to the facility.

Chapter VII 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 needs to examine only the pertinent aspects of 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 base the ACL on allowable exposure levels at the point of compliance. Surface water uses should be discussed by the ACL applicant if contaminated ground water can migrate to surface waters.

Chapter VIII 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 should 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 the facility's regulated unit. Background surface water quality needs to be assessed only in cases where surface waters are receiving 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 and ACLs are requested above allowable exposure levels. This will give the permit applicant information for assessing cumulative impacts associated with any contamination emanating from the facility.

Chapter IX discusses the health risk assessment. The purpose of the health risk assessment is to determine allowable concentrations at the point of exposure for the constituents for which ACLs are requested. A detailed health risk assessment should be submitted in all ACL demonstrations, unless the point of exposure is established at the point of compliance and either Agency-established MCLs or Agency-reviewed allowable dose levels are used at this point. If human exposure could 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 which should be useful in preparing ACL demonstrations.

Chapter X 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 should examine the potential impacts to the receptors discussed above if the ACLs are based on attenuation and 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 should discuss the presence of any endangered or threatened species in terrestrial or surface water environments near the facility. If any endangered or threatened species are in the area, then the permit applicant should discuss the potential impacts of the contaminated ground water, including critical habitat impacts, on the species.

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 XI discusses data needed to determine the persistence of the contaminants in the environment and the permanence of the adverse effects. If ACLs are based on attenuation arguments, 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. Data 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 attenuation arguments. Data on permanence is needed to determine the long-term effects associated with exposure to the ACL constituents.

Chapter XII 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 will 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 XIII is a list of references cited throughout the guidance. The permit applicant is advised to use these documents since approval of an ACL is highly dependent upon the technical strength of the demonstration.

CHAPTER I

INTRODUCTION

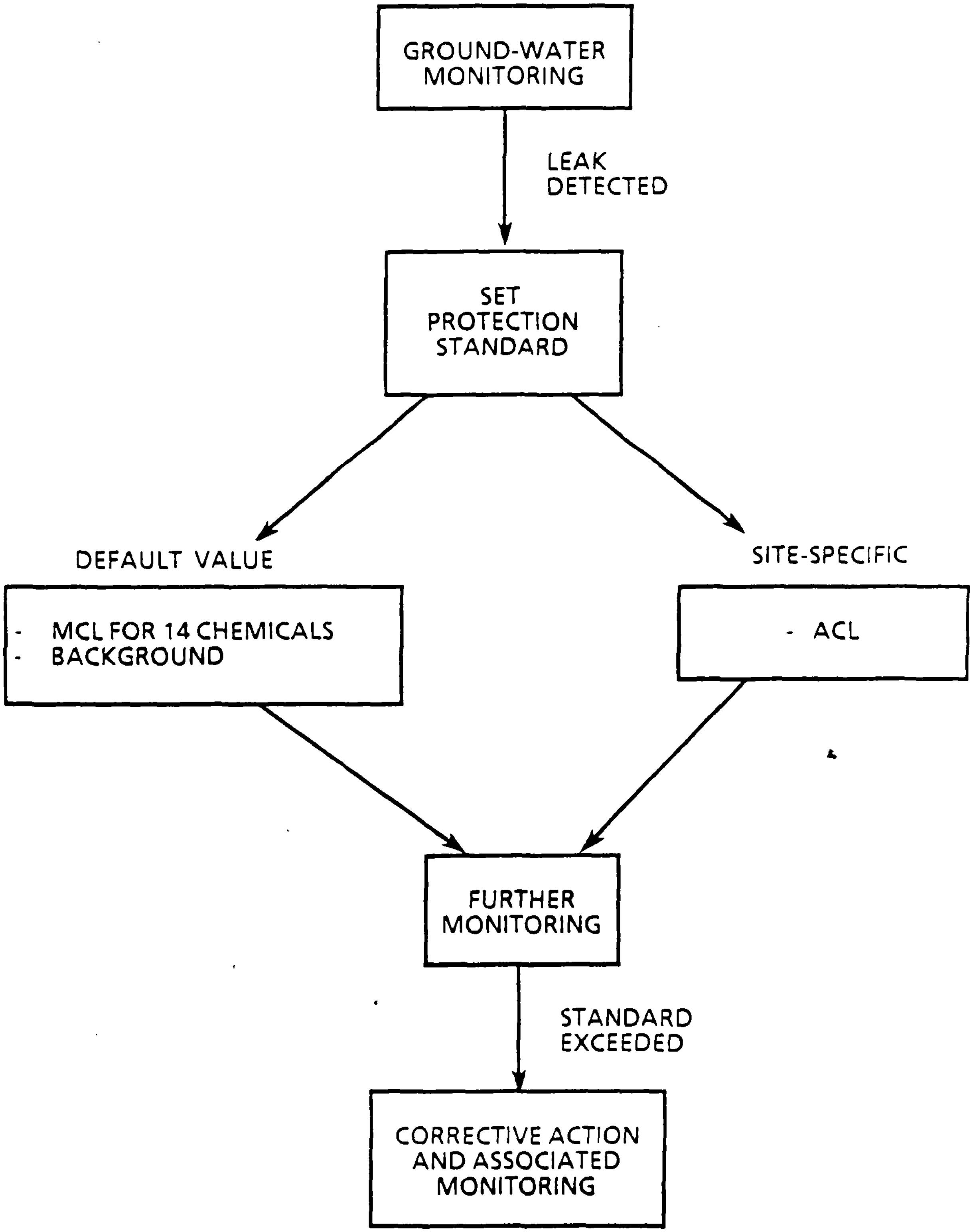
Hazardous waste facilities permitted under the Resource Conservation and Recovery Act (RCRA) regulations (40 CFR Parts 264 and 270) are required to be designed and operated in a manner that will prevent ground-water contamination. If leakage of hazardous constituents into the ground water is detected at a RCRA facility, the regulations require the establishment of a ground-water protection standard at that facility. This standard establishes a limit on the amount of ground-water contamination that can be allowed. 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 ground-water clean-up is necessary to control contamination that has emerged from a hazardous waste facility.

The principal elements of the ground-water protection standard are discussed in Section 264.92 of the regulations. 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 limits that can be used to establish the ground-water protection standard:

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

FIGURE 1

RCRA GROUND-WATER PROTECTION PROCESS



Section 264.94 contains the regulatory framework for these concentration limits. The approach used by the regulations is to adopt widely accepted environmental performance standards (i.e., MCLs in Table 1), 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.

Maximum contaminant limits are established for 14 hazardous constituents under the National Interim Primary Drinking Water Standards and are listed in Table I of Section 264.94(a) of the regulations. If a constituent is not listed in Table 1, the standard becomes no degradation beyond background water quality. In such cases, the concentration limit is set at background level. However, variances from these standards are available where 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(b) of the regulations. This section of the regulations lists nineteen criteria to be applied in ACL demonstrations. The applicant should, however, be aware of any State or local laws regulating ground water. Many States prohibit the release of any pollutants into the ground water. If the State has an authorized program for 40 CFR Part 264, Subpart F and does prohibit such releases, ACLs may not be allowed.

This document serves to provide guidance to permit applicants seeking ACLs and permit writers evaluating ACL demonstrations. The document describes EPA's implementation guidelines and elaborates on the application of the 19 criteria. Nine of the criteria are for ground-water contamination pathways, and ten are for surface water pathways. The document is divided into 13 chapters that include an introduction, an explanation of each of the criteria in the regulation, a conclusion, and references.

This guidance may also be useful for Record of Decision preparations pursuant to the EPA CERCLA program (Superfund), for State permit writers, for performing remedial facility investigations, or for evaluating corrective action programs for other types of waste management facilities. In applying this guidance to Superfund sites 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.

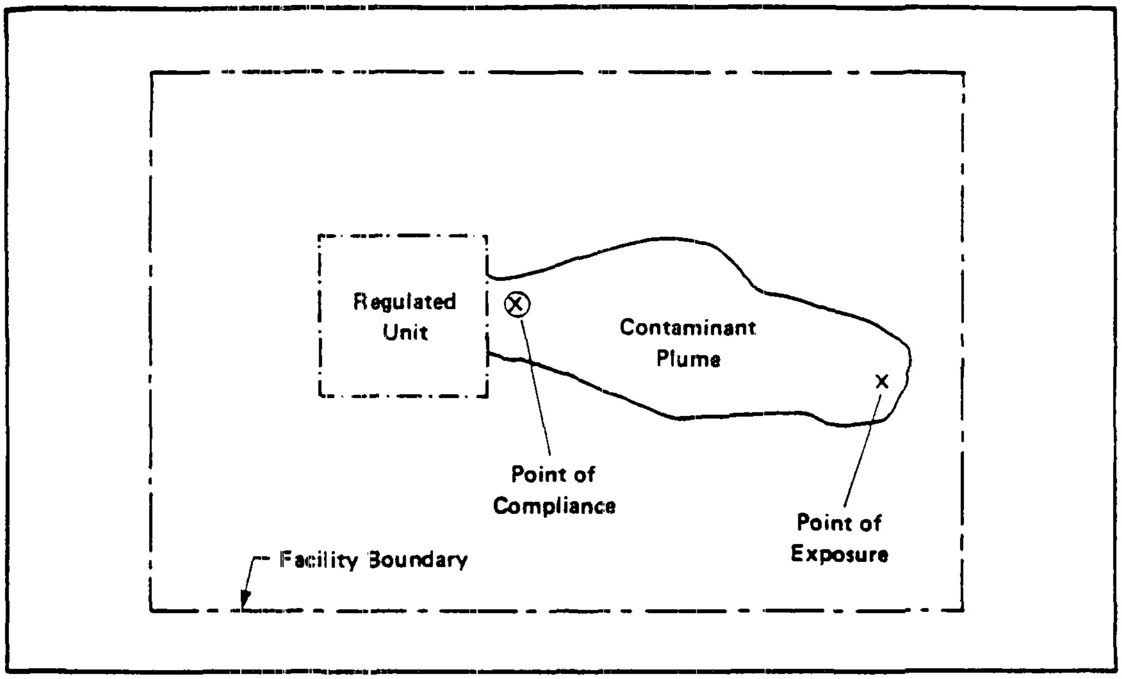
Alternate concentration limits are discussed in the RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities under Subpart F: Ground-water Protection (U.S. EPA l982a). The permit applicant and the reviewer should become familiar with the ground-water protection regulations. ACLs are granted through the permit process under Parts 264 and 270. Through this process, the public is afforded opportunity to participate in the establishment of ACLs.

The Agency is developing a strategy for implementing corrective action at solid waste management units. The overall goal of this strategy is consistent with that of the Agency's Subpart F ground-water protection program: the protection of human health and the environment. The ACL process described in this document may be useful when evaluating the corrective action programs at these solid waste management units.

ACL Definitions

To establish ACLs, two points must be defined on a RCRA facility's property (see Figure 2): the Point of Compliance (POC) and the Point of Exposure (POE). The POC is defined in the Subpart F Regulations (40 CFR § 264.95) as a "vertical surface" located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated unit. The POC is the place in the uppermost aquifer where ground-water monitoring takes place and the ground-water protection standard is set. The ACL, if it is established in the permit, would be set at this point.

The point of exposure (POE) is the point at which it is assumed a potential receptor can come in contact, either now or in the future, with the contaminated ground water. Therefore, the ground-water quality at the POE must be protective of that receptor. For example, a facility may have a ground-water contaminant plume restricted to a small portion of its property. In this case, it may be appropriate to assume that people will be exposed through a drinking water well to the ground water immediately at the edge of the plume. The ground water at that



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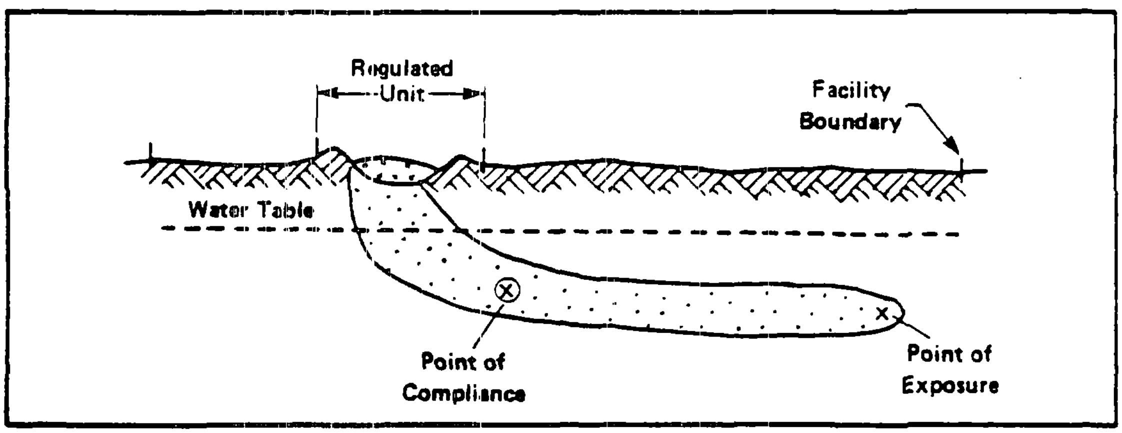


CROSS-SECTION VIEW

POINT OF EXPOSURE (POE) – Point at which potential exposure to contaminants is assumed. Location is site specific. Allowable exposure is met here.

POINT OF COMPLIANCE (POC) – The point on the downgradient side of the unit where the ground-water protection standard is met. The ACL is set here.

CONTAMINANT PLUME – The volume of ground water that contains the leaking pollutants.

FACILITY BOUNDARY – The property boundary of the facility.

REGULATED UNIT – The area where the hazardous wastes are kept (landfill, surface impoundment).

Figure 2. Definitions

point, the POE, must then be safe for human consumption. Likewise, if the ground-water contamination is discharging to on-site surface water, the potential receptor may, in some cases, be an aquatic organism. In this example, the aquatic organisms must be protected from adverse effects of the discharging contaminants.

Understanding and identifying the spatial relationship between the POC and the POE is critical in the establishment of an ACL. Mechanisms that attenuate contaminants may be considered only over the area between the POC and the downgradient POE. If the POE is established at the POC, then no form of attenuation will be considered in setting the ACL. In such a case (POC = POE), the ACL would be equal to the allowable health or environmental exposure level, with the assumption that exposure would occur at the waste management unit boundary. However, if the POE is removed a specified distance from the POC, then appropriate and conservative estimates of contaminant attenuation may be used in calculating the ACL. These mechanisms of attenuation would only be considered over that distance between the POC and the POE. For example, if the POE is 50 meters downgradient of the POC, then attenuation could be conservatively estimated from the volumetric transport of ground water in relation to the mass loading of the leaking constituents over that 50 meters. The attenuation factor could then be applied to the allowable health or environmental exposure level at the POE to derive the ACL.

The following section discusses EPA's ACL policy. After presenting the basic philosophy and guidelines of the policy, five case examples are described. These examples tell the reader where the POE should be established in similar real-world situations. Following these examples is a guide for employing this document to prepare an acceptable ACL demonstration.

ACL Policy

Experience gained over the last several years has allowed the Agency to develop a better understanding of ground-water contamination problems. This has led EPA to develop general policy guidelines for the use of ACLs at RCRA hazardous waste disposal facilities. These guidelines are designed to establish an ACL procedure that will be protective of human health and the environment.

Three basic policy guidelines have been identified to assist the permit writer and applicant in implementing the ACL process for useable ground water:

1. Ground-water contaminant plumes should not increase in size or concentration above allowable health or environmental exposure levels;

2. Increased facility property holdings should not be used to allow a greater ACL; and

3. ACLs should not be established so as to contaminate off-site ground water above allowable health or environmental exposure levels.

Useable ground water is either a current or potential drinking water resource or ground water that has some other beneficial use (see Chapter VII for more discussion). ACLs in unuseable ground water will be assessed on a case-by-case basis.

Regardless of where the POE is established, there is one overriding policy. That is, contaminant plumes in useable ground water will not be allowed to increase in size above acceptable levels. This "no growth" policy applies both to the mass of contaminants releasing to ground water and to the volumetric extent of the plume itself. The implementation of source control measures may be necessary to prevent the release of contaminants above their permissible level, the ACL. This may require that a regulated unit meet the appropriate Part 264 minimum technology requirements if the unit has significant leakage. All facilities with RCRA units that have plumes in useable ground water must prevent these plumes from expanding out and contaminating more ground water. This will require that the leading edge of the plume not move. The leading edge of the plume is identified by ground water that does not exceed an allowable health or environmental exposure level.

The policy of not allowing plumes to increase in size or concentration is protective of human health and the environment by eliminating continued, uncontrolled releases of hazardous constituents. By limiting the growth of ground-water contamination, the degradation of the ground-water resource is restricted and the uncertainty of eventually cleaning up the contamination is reduced. This effect applies to both the areal extent of the contamination and the contaminant concentrations within the plume. If the extent of the contamination increases in size, the probability of ever capturing and withdrawing the contamination is significantly reduced. Likewise, if the contaminant concentrations within the plume increase, then the aquifer matrix may leach contaminants into the ground water over a long period of time. If this is the case, then eventual cleanup of the contamination may be impossible.

In determining the extent of an on-site plume, the permitting authority should consider only property that the facility owned at the time of initial permit application. A facility may not use recently purchased property to encompass a plume in order to allow the use of larger attenuation factors in their ACL calculations. The permit writer should consider only the original property, as defined in the initial Part B application, in determining an allowable ACL.

Corrective Action

The Agency is in the process of developing a corrective action program for all solid waste management units (SWMUs) at RCRA permitted facilities. This program is mandated by Section 3004(u) of the Hazardous and Solid Waste Amendments of 1984 (HSWA). The ACL process, as described in this document, may be useful in determining the appropriate corrective measures for ground-water contamination at these other solid waste management units.

In developing this SWMU corrective action program, EPA will also assess the need to promulgate some additional regulations for ground-water corrective action at regulated units.

Closure

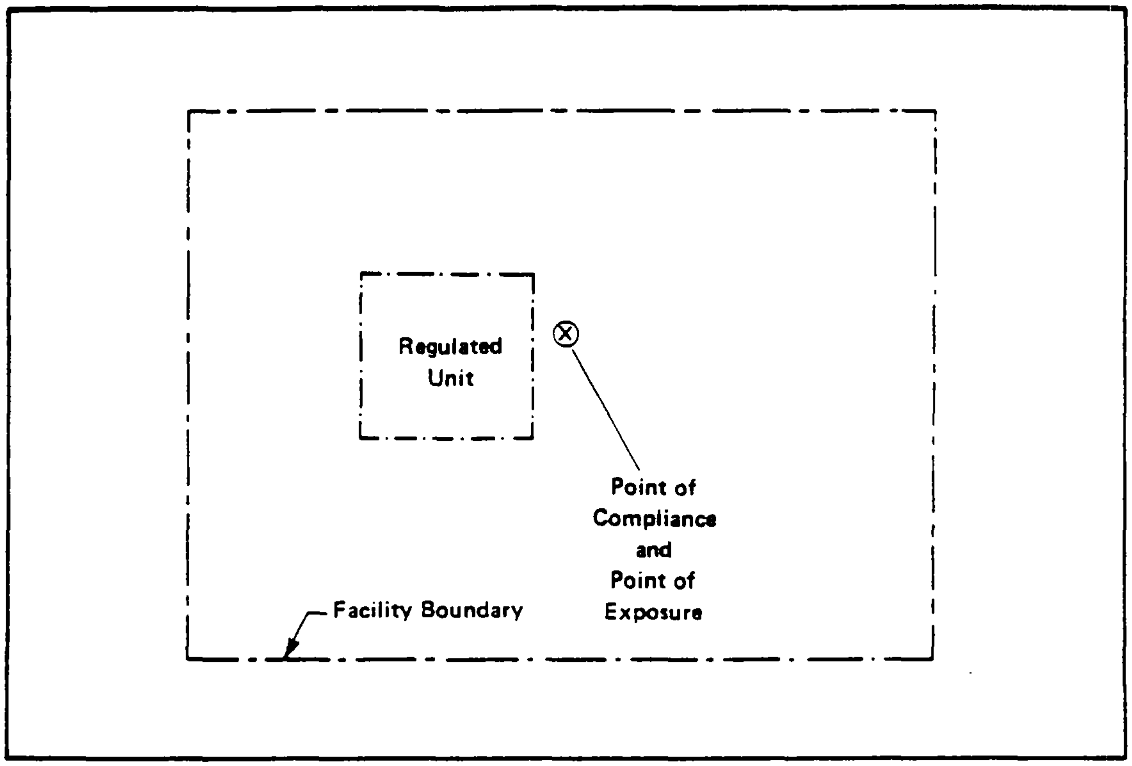
If a RCRA facility owner or operator is considering applying for an ACL, he or she should be aware of EPA's closure and post-closure regulations and policy as they apply to ground-water monitoring. It is likely that if a contaminant is left in useable ground water above a health or environmental exposure level, as might be the case with an ACL based on attenuation arguments, the post-closure care period for the facility may be extended beyond 30 years (40 CFR §264.117(a)(2)(ii)). In this situation, an owner or operator may discontinue post-closure care and ground-water monitoring only after successfully demonstrating that all the ground water at a site is safe for all potential receptors. A more stringent ground-water standard, based only on allowable exposure levels for units above useable ground water, may be needed because the facility owner has no further RCRA obligations for managing and monitoring the facility at the end of post-closure care. If, at any time during the post-closure care or the compliance period under §264.96, a substantial threat to human health or the environment is identified, the permit can be modified to include a lower ground-water protection standard and an extended post-closure care program.

Examples

To provide national consistency in calculations used to estimate the potential impacts of releases of hazardous constituents to ground water from regulated units, Agency policy is that the points of exposure be assumed as discussed below. These POEs were chosen because the Agency believes that they are realistic and conservative estimates of where environmental or human receptors would likely be exposed to the contaminants.

The Agency believes that this method is conservative enough to be protective of human health and the environment in situations that would be encountered during the setting of ACLs. These POEs were also deemed necessary because of both the persistent nature of many toxic chemicals in the environment and the need to prevent the further migration of these compounds.

Case 1: For regulated units located above useable ground water that have not detected ground-water contamination at the time of permit issuance, the potential POE will be assumed to be directly at the POC (Figure 3). That is, for units at which no ground-water contaminant plume exists, the potential point of exposure is assumed to be at the waste management unit boundary. Therefore, no attenuation can be presumed for contaminants that leach from a unit in the future. Fate and transport arguments cannot be used to support ACL demonstrations if no ground-



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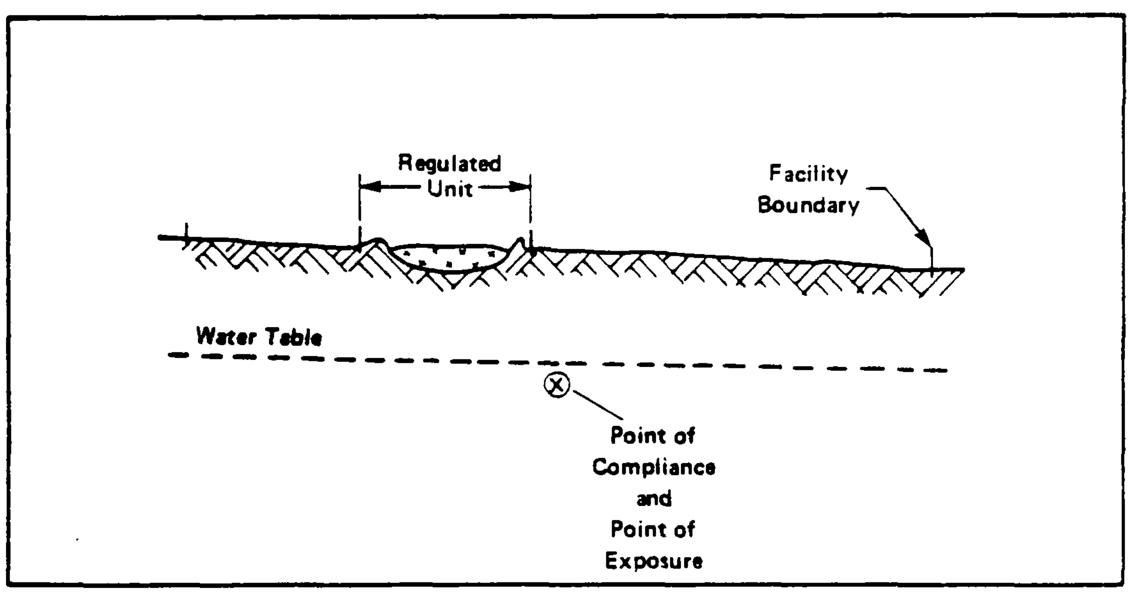


CROSS-SECTION VIEW

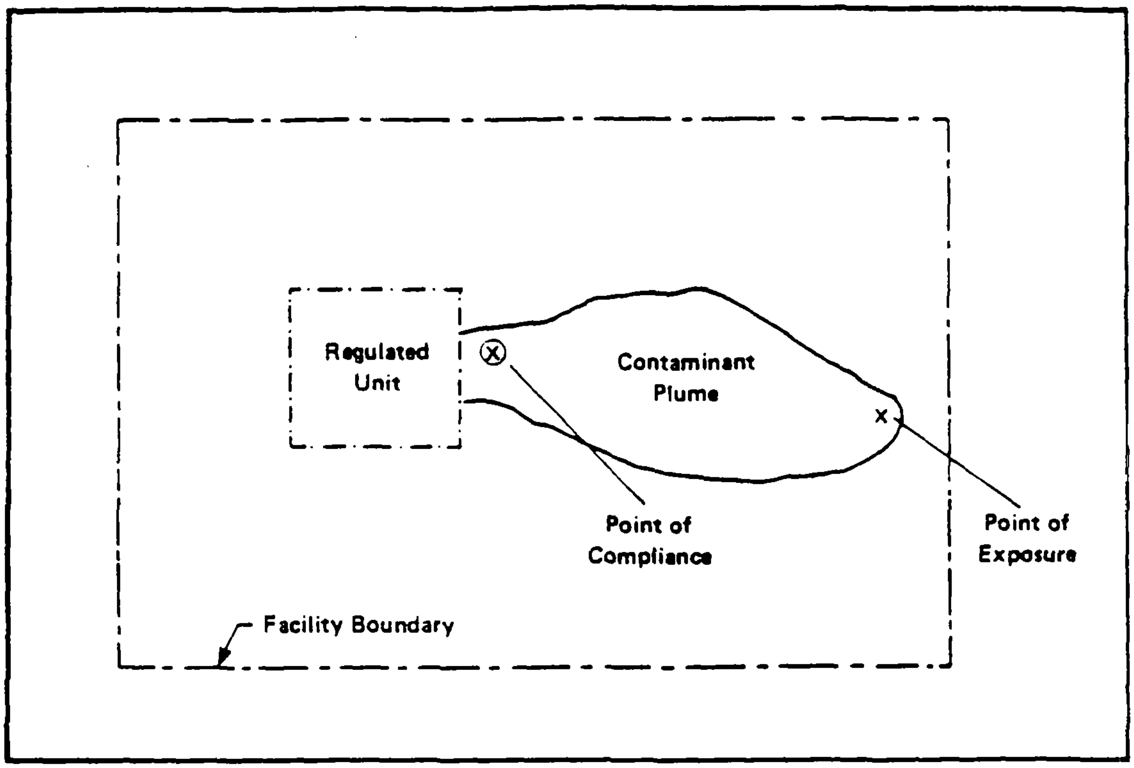
Figure 3. Case 1: No Contamination at Original Permit Issuance

water contamination plume exists at the time of permit issuance. This policy will help to prevent contaminants from entering the ground water above allowable health and environmental levels. All new units seeking permits for operation and old units that have not detected contamination will be held to this policy.

Case 2: For units located above useable ground water that already have existing contamination that is confined to the facility property, the POE will be assumed to be no farther from the POC than the outer edge of the existing plume (Figure 4). If the permitting authority concludes it is protective of human health and the environment, then the point of exposure may be set at the leading edge of the plume. In this situation, mechanisms of contaminant attenuation (fate and transport) may be considered in establishing the ACL at the point of compliance. Monitoring for the ACL constituents at the POE should be performed to verify the attenuation mechanisms that were accounted for.

Case 3: For units located over useable ground water, if the leading edge of the plume extends off the facility property, the point of exposure will be assumed to be no farther from the POC than the facility property boundary (Figure 5). Fate and transport arguments may then be applied to the ground-water contamination between the POC and the POE at the facility boundary, assuming there is no possible route of exposure on the facility property. At no time may the designated POE be beyond the original facility boundary.

Case 4: ACLs may be based on contaminant discharge into a surface water body if a facility owns the property up to the surface water body (Figure 6). The permitting authority should allow this only if: (1) the contaminant plume has already reached the surface water body, (2) the contaminants do not cause a statistically significant increase over background in the surface water concentrations of those contaminants, and (3) the contaminants will not reach a receptor at an unsafe level before they reach the surface water body. Though it may be acceptable to allow some contaminants in the ground water to discharge into a nearby surface water body, in no case may the ACL be derived so as to allow releases into that surface water body that result in a statistically significant increase in the concentration of the contaminants in the surface water body.



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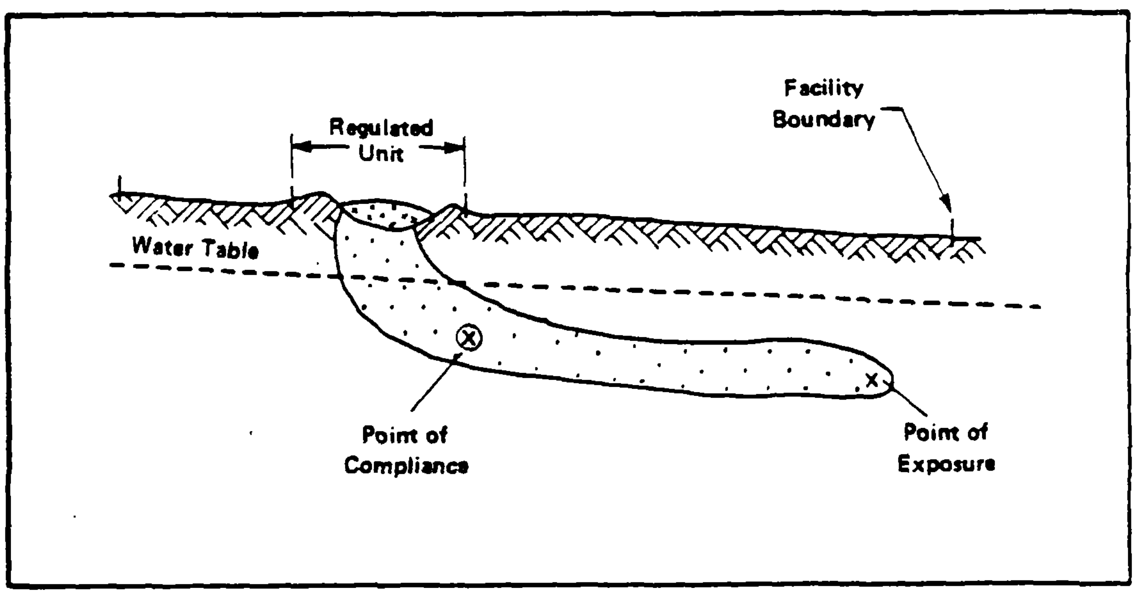
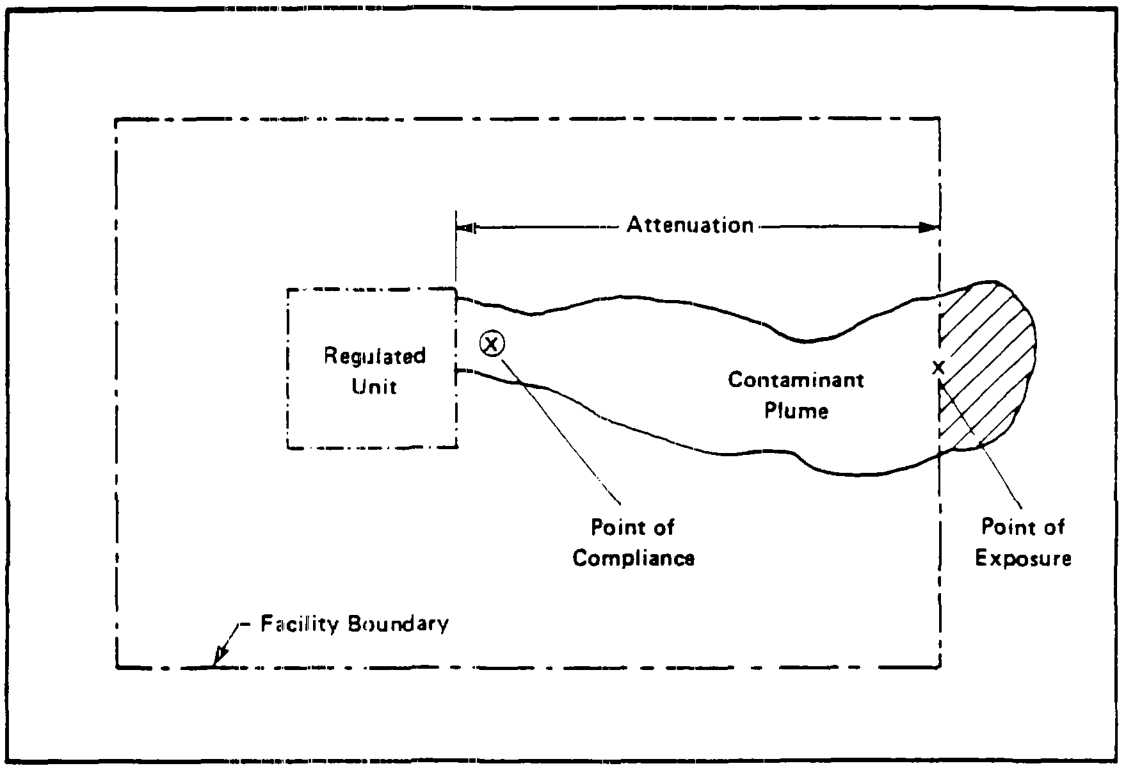


CROSS-SECTION VIEW

Figure 4. Case 2: Contamination Confined to Facility Property



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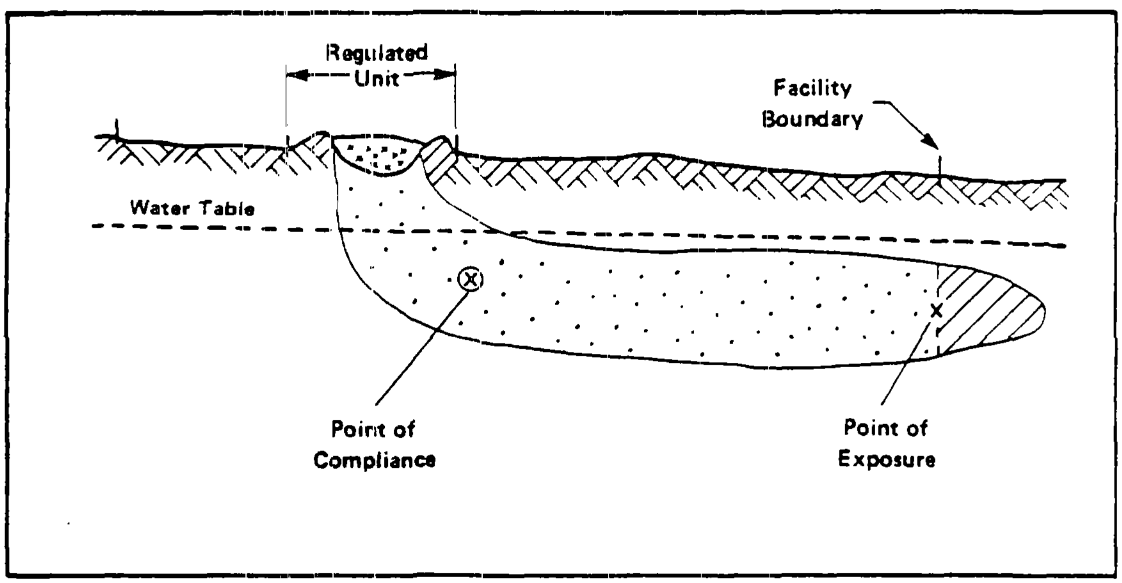
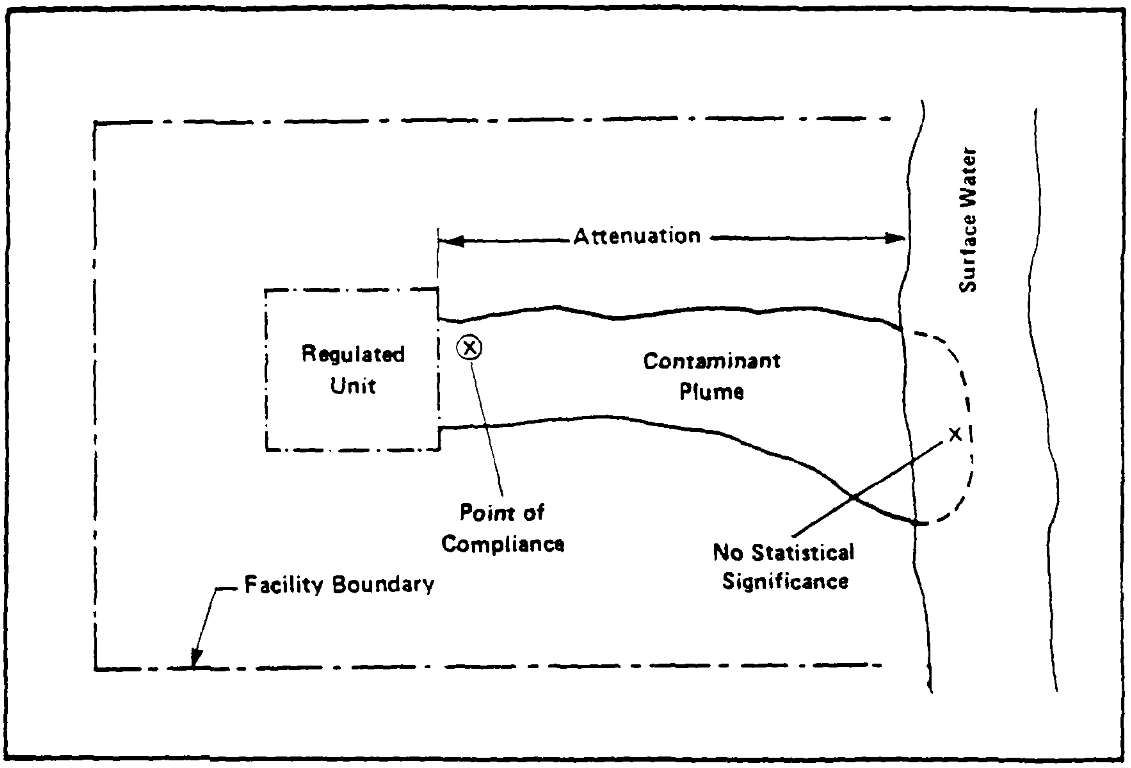


CROSS-SECTION VIEW

Figure 5. Case 3: Contamination that Extends Off-Site



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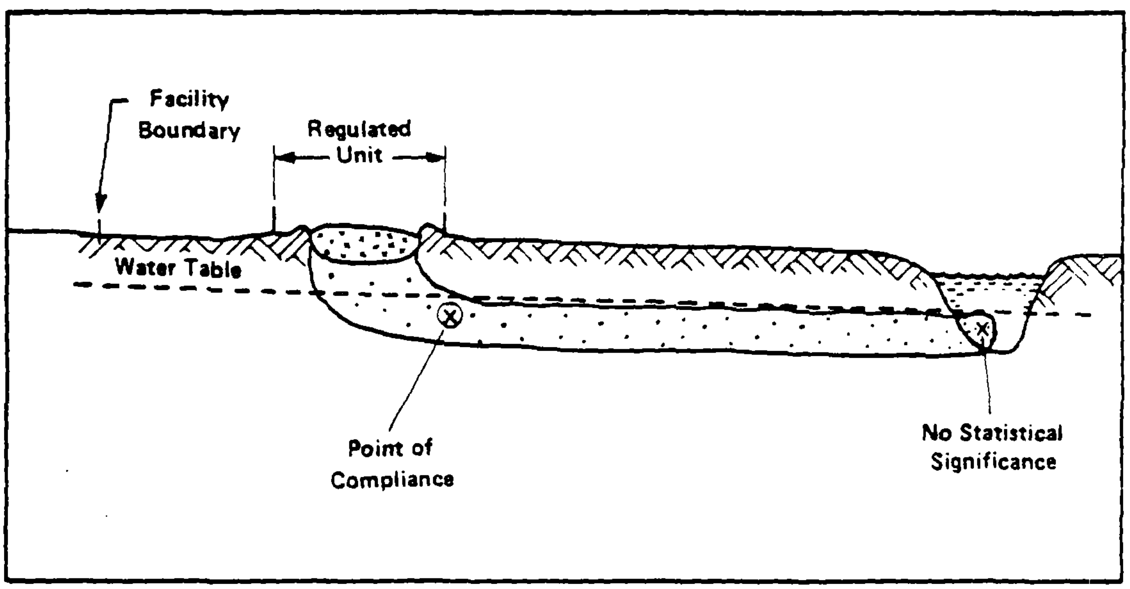


CROSS-SECTION VIEW

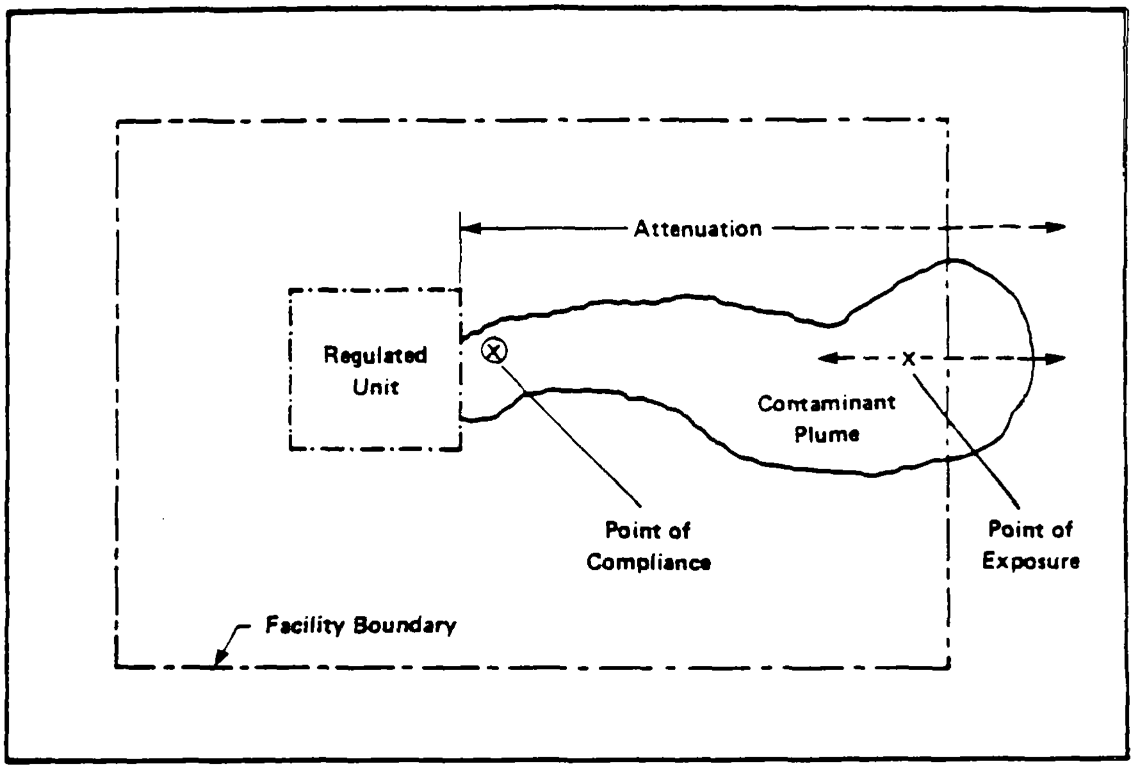
Figure 6. Case 4: Contamination Discharging into a Surface Water Body

Case 5: For those units over a nonpotable aquifer, the location of the POE will be established on a case-by-case basis (Figure 7). Such non-potable aquifers will usually be highly saline, containing more than 10,000 ppm total dissolved solids. In such situations, protection of environmental receptors may be the overriding factor. In any case, the ACL must be established so as to pose no unacceptable risk to public health and the environment. To apply this option, the permit applicant must thoroughly demonstrate that the nonpotable aquifer is isolated from any potable aquifer.

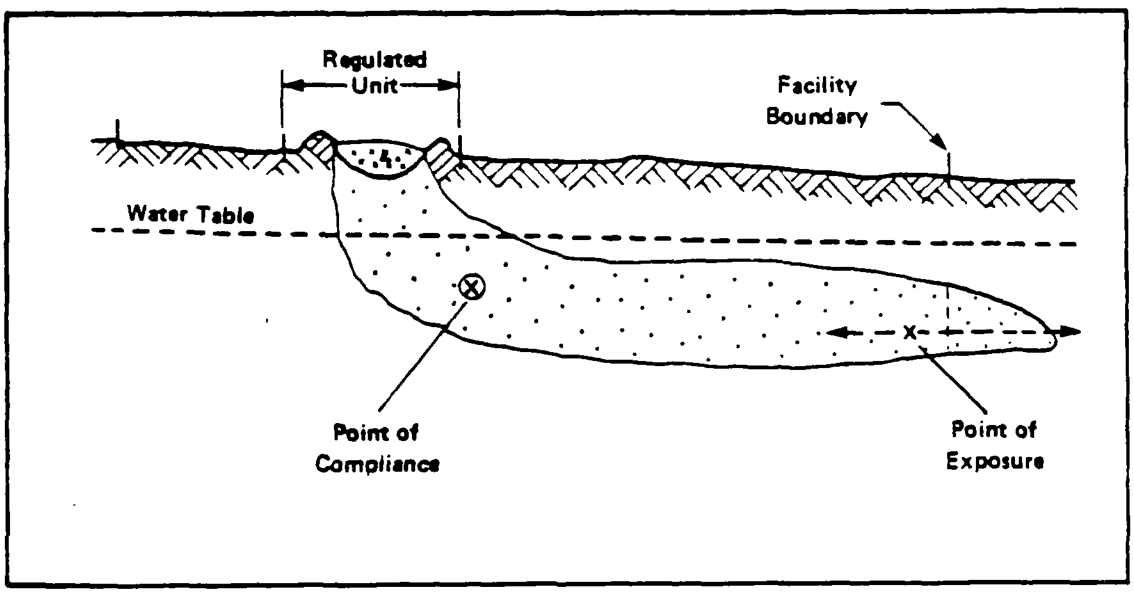
ACL Information Requirements

The type and amount of information needed for an ACL demonstration depends on the placement of the point of exposure (POE) and the site-specific characteristics. An ACL demonstration may cross reference many sections of the Part B Permit Application. Appendix A contains a listing of the types of information that may be cross referenced from the permit application. For new units, units with no ground- water contamination (Case 1), or units for which the owner or operator desires an ACL to be set at the allowable health or environmental exposure level, relatively little additional information beyond that already supplied in the permit application will normally be required. If the unit already has caused ground-water contamination and the owner or operator wishes to take into account mechanisms of attenuation in deriving the ACL (Cases 2-5), more information will be required.

The simplest and quickest method for deriving the ACL in all situations will be to establish the POE at the POC. Even for those sites with gross contamination, setting the POE at the POC may be the least expensive option because high levels of contamination will usually require major source control and corrective action measures, regardless of the ACL. By setting the POE at the POC, the owner or operator may save significant amounts of time and money by not having to gather and organize the additional information required for deriving an ACL that accounts for attenuation mechanisms.



PLAN VIEW



CROSS-SECTION VIEW

Figure 7. Case 5: Contamination in a Non-Potable Aquifer

No matter where the POE is established, an allowable health or environmental exposure level must be determined for each constituent for which an ACL is requested. The following discussion outlines the method used to choose the appropriate health or environmental exposure level, and the types of information necessary to derive the attenuation factor(s). This section is meant to be used as a guide to the rest of this document; detailed technical discussions are reserved for the following chapters. Five ACL Case Studies will be available in the Summer of 1987 to help the owner or operator prepare an acceptable ACL demonstration.

The appropriate allowable health or environmental exposure level will be dependent on the most vulnerable receptor near the facility. The most vulnerable receptor is that receptor, human or environmental, that has the lowest tolerance to the hazardous constituent(s) for which the ACL is being requested. In most cases, the receptors will be humans exposed to the contaminated ground water via ingestion (i.e., drinking). However, at times the most vulnerable receptor will be an environmental receptor.

Agency-reviewed dose levels for humans are available to quickly determine allowable concentration levels for many hazardous constituents. Chapter IX of this document discusses the method for determining an allowable exposure level for humans. Essentially, the applicant can use Maximum Contaminant Limits (MCLs), or if MCLs are not available, obtain the appropriate allowable dose level (Reference Dose (RfD) for systemic toxicant, Risk Specific Dose (RSD) for carcinogens) from EPA and use the appropriate formula on page 9-7 of this document to derive the allowable concentration level for humans.

If environmental receptors exist in the vicinity of the facility, the vulnerability of these receptors must be investigated. Chapter X provides a discussion of these environmental receptors. In many cases, the critical environmental receptor will be aquatic life in the nearest downgradient surface water body (including bogs and wetlands); however, threatened and endangered species, terrestrial organisms, agricultural products, and physical structures should not be overlooked. The applicant should compare the allowable exposure levels for the various receptors near the facility. The lowest level should be chosen as the concentration level at the POE. This method is necessary because the concentration of the contaminants at the point of exposure must be protective of the potential receptor that is most vulnerable to that contaminant.

Once the allowable exposure concentrations for the point of exposure are chosen, the applicant needs to collect and organize any other necessary additional information. The following paragraphs guide the applicant to the relevant chapters of this document that describe the types of information that should be submitted. This discussion is organized around the five case examples described previously in this chapter. Since some sites will not fit neatly into this scheme, some interpolation may be necessary. Appendix B contains a chapter-by-chapter summary of this information.

Case 1

The information requirements for this case are applicable in all situations in which the permit applicant desires a direct health or environmental exposure level without accounting for mechanisms of attenuation. This method of setting the ACL is the standard for new units or for old units with no contamination at the time of permit issuance. If the applicant is dealing with a site that has ground-water contamination, the application must include a description of all plumes, including isopleth maps of all hazardous constituents in the ground water. All ACL demonstrations using allowable exposure levels must include the information necessary to select the appropriate POE level [Chapters IX and X] and information on the general ground-water use [Chapter VI]. If the constituents for which ACLs are requested do not have Agency-reviewed allowable dose or exposure levels, then additional information on human and/or environmental effects will be necessary. The type of information will be dependent on the potential receptors [Chapters IX and X]. A general description of the site and the types and characteristics of the wastes handled is also required [Chapter II]. General ground-water information is also necessary and includes: a description of the horizontal and vertical extent of the uppermost aquifer [Chapter III]; a description of the ground-water flow in the aquifer [Chapter IV]; and a listing of the background concentrations of all hazardous constituents in the aquifer. Most or all of this information should already be available in the permit application.

Case 2

If the facility has on-site ground-water contamination and the permit applicant desires to account for attenuation mechanisms then the ACL demonstration should include all of the information required in Case 1, in addition to the following: a description of the chemical and physical characteristics of the contaminants for which an ACL is requested [Chapter II]; data on the chemical-specific degradation or attenuation rates and/or processes [Chapter II]; a description of each soil type beneath the facility [Chapter III]; any other attenuation-related information, including soil properties [Chapter III]; description of the extent and hydrological properties of each local stratigraphic unit [Chapter III]; aquitard-related data [Chapter III]; if applicable, information on the temporal variations in ground-water flow and any withdrawal drawdown effects [Chapter IV]; if a mathematical simulation model is used, verification that it meets the criteria listed in Chapter IV; monthly precipitation data and effects on seasonal recharge [Chapter V]; any local ground-water discharge pathways [Chapter V]; location of each nearby (5 km) surface water body and an estimate of travel time for ground water from the facility to the water bodies [Chapter VI]; additional information on the current and projected demography and ground-water use when applicable [Chapter VI]; state certification of the ground- water's beneficial use [Chapter VII]; if background ground-water is contaminated, information on the sources and associated ground-water quality data [Chapter VIII]; and an assessment of the degradation of the ACL constituents, including degradation products and rates, when possible [Chapter XI]. It is very important that this information be synthesized to present a conservative attenuation argument.

Case 3

The required information for this case, where the contamination extends off-site and the ACL is based on attenuation mechanisms, is similar to that required for Case 2. However, because the contamination extends off-site, a more in-depth study of the human health and environmental effects will probably be necessary [Chapters IX and X].

Case 4

For this case, information will be necessary to demonstrate both that the proposed ACL is acceptable and that the contaminants allowed to attenuate into the surface water body will not cause any statistically significant increase in concentration in the surface water body. To do this, the demonstration must include the information required in the earlier cases (1, 2, and 3) in addition to the data necessary to show no statistical significance [Chapter X]. If a model is used, it should meet the requirements discussed at the end of Chapter IV. More specific data on the effects of storm events and flooding will also be necessary [Chapter V]. Additional information on the physical characteristics and discharge zone of each water body [Chapter VI] may also be necessary. The uses of these surface waters is also important information that should be documented [Chapter VII] along with a discussion of and data on other sources of surface water contamination [Chapter VII].

Case 5

The required information for this case includes the information specified for Cases 1, 2, and 3 as well as information demonstrating that any off-site contamination will not pose a threat to any potential receptor or degrade any beneficial use. Additional information pertaining to the hydraulic isolation of the uppermost aquifer [Chapter III], the possibility of exposure due to off-site contamination [Chapters VI and VII], the ultimate fate of the contaminants [Chapters II and XI], and the uses of local ground waters [Chapter VII] is also very important. Of course, background ground-water quality data demonstrating that the aquifer is nonpotable, and an assurance from the State that the ground water will not be used, is required.

CHAPTER II

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE WASTE CONSTITUENTS (40 CFR 264.94(b)(1)(i) and (2)(i))

The first step in any 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. The applicant must also account for the degradation products of all ACL constituents, especially if those products have significant toxicological properties. Once the hazardous constituents are identified, an ACL demonstration based on attenuation arguments must determine the physical and chemical characteristics of the constituents in order to effectively determine their transport through the environment and their ultimate fate. This chapter discusses the data 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 being considered. The §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, l984b). The permit applicant should be aware that the Agency has proposed changing Appendix VIII monitoring requirements for ground water (July 24, 1986; 51 FR 26632). When this proposal is finalized (expected in June 1987), the Agency will use this list along with any site-specific additions to the list made by the Regional Administrator as the basis for detection and compliance monitoring programs.

Currently, an Appendix VIII analysis is required whenever any leakage from a facility's unit is detected by §§264.98 and 270.14(c)(4) monitoring. Assuring the absence of particular hazardous constituents emanating from a regulated unit is difficult to do simply by record-keeping. Wastes other than those that are currently received might have been placed in the unit in pre-record-keeping times. In addition, the potential exists for unpredicted reactions between the constituents and the formation of degradation products.

The fulfillment of the §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. See Chapter IV for further discussion of appropriate models.

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 that was gathered pursuant to §264.13. This data will give the ACL reviewer a better understanding of what may be expected to show up in the ground water. Additional waste constituent analyses may not be needed for the ACL demonstration if the applicant has fulfilled the requirements of §264.13.

Several physical and chemical characteristics of hazardous constituents are critical to the modeling of contaminant transport in ground water. Permit applicants should submit data on the following characteristics of the constituents for which ACLs based on fate and transport are requested: density, solubility, vapor pressure, viscosity, valence state, and octanol-water partitioning coefficient. For example, consider a facility that is leaking a hazardous constituent at a concentration level near or above the constituent's solubility level. In this case, 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 latter phase could either be floating on the water table or sinking to an aquitard, depending on its density. The two phases would probably move at different rates due to viscosity and density differences.

Even when only one phase is present, the transport model results are dependent on the physical and chemical characteristics of the constituents; attenuation parameters for transport models depend on specific characteristics of the hazardous constituents. The permit applicant should submit in tabular form the density, solubility, vapor pressure, viscosity, and octanol-water partitioning coefficient values of the hazardous constituents. The ability for one constituent to mobilize other constituents should also be investigated. Appendix C contains an example of a summary sheet that can be used to list the important properties of the ACL constituents.

An ACL demonstration that is based on attenuation should be supported by data on fate-related characteristics of the ACL constituents. If a permit applicant argues that the presence of an ACL constituent at the point of compliance is not likely to cause exposure because it is not persistent in the ground water, then special fate and stability related characteristics of the constituent should 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 chemically mediated subsurface 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.

Degradation properties of the ACL constituents are also important in determining the effects of the constituents. Since degradation products can be more hazardous than the parent compound, all known and likely degradation products should be discussed when describing the characteristics of the waste constituents.

Grouping ground-water contaminants according to stability characteristics may be possible. 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. Before grouping the constituents, the applicant should investigate possible degradation products associated with the constituents of concern. The ability of one contaminant to facilitate or hinder the movement of another contaminant (co-solvent effects) should also be accounted for when possible. Although it is difficult to decide which groupings of constituents are appropriate, grouping can reduce the amount of predictive modeling necessary for quantifying environmental concentrations and exposure pathways (see U.S. EPA 1986c).

CHAPTER III

HYDROGEOLOGIC CHARACTERISTICS
(40 CFR 264.94(b)(1)(ii) and (2)(ii))

A general description of the hydrogeological characteristics of the facility is needed in all ACL demonstrations. A more detailed assessment of ground-water movement near a facility is essential to a demonstration based on attenuation. 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 §270.l4(c) to identify the uppermost aquifer. The uppermost aquifer is defined under §260.10 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, for an ACL demonstration based on attenuation, information on 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. This data 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.l4(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 System or the U.S. Department of Agriculture's soil classification system. Each soil type beneath the site and within the areal extent of the ground-water contaminant plume should be investigated. 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. The applicant should submit copies of drilling and boring logs from monitoring and water wells that have been installed.

If the applicant uses soil or other matrix attenuation mechanisms to justify the ACL, the additional data and calculations used to define the attenuative properties should be submitted. The following attenuation mechanisms may be relevant to an ACL demonstration:

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 area of contamination. 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) and Freeze and Cherry (1979) provide in-depth discussions of these specific soil characteristics, and the permit applicant and reviewer should consult these references for assistance.

The permitting authority and the applicant should keep in mind the outcome of the different types of attenuation. Although matrix effects (binding) and dispersion act to lower the concentration of the contaminants at the point of exposure, they do not directly reduce their total mass. Constituents that attach to the matrix may become mobilized at a later time. However, degradation mechanisms act to eliminate the contaminants themselves. This form of attenuation is permanent and, assuming the products are harmless, can be a final solution to eliminating the contamination.

If the ACL demonstration is attenuation-based, the permit applicant should submit a set of maps that adequately depict 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 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 data should be submitted.

Each of the stratigraphic units located in the zone of saturation should 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 characterized. 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. However, in order to save time and effort, the applicant may choose to make simplified "worst case" assumptions of hydraulic conductivity and porosity.

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 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), and Walton (1970).

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). 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 on the shallow aquifer. 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
(40 CFR 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 attenuation-based ACL demonstration since a contaminant plume may discharge into and mix with other ground or surface waters. This chapter describes methods that can be used to determine ground-water flow direction and quantity at a site. The EPA publication Ground-Water Monitoring Technical Enforcement Guidance Document (U.S. EPA 1986a) may also be useful in making these determinations. However, if a facility is located over a relatively complex hydrogeologic system (e.g., fractured rock or karst aquifers), setting the POE at the POC may be the only acceptable method for establishing the ACL.

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 on-site determinations of flow; however, additional data may be required if off-site determinations of ground- water flow are needed for the ACL demonstration. The permit applicant should evaluate ground-water flow in terms of the flow regime 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 gradient 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 by calculating the porosity of the aquifer. 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 in relatively homogenous systems.

The determination of ground-water flow rates and directions is simple in concept. 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 or relatively flat gradients,
2. High vertical or relatively steep 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 difficult. 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. In such a case, calculated horizontal flow directions may be inaccurate.

Water levels can vary temporally because of short-term stresses, tidal effects, atmospheric pressure variations, 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 therefore 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 fluvial sandstone, 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 is required because it will help determine 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 piezometers screened at the same elevation in the same saturated zone. The monitoring system 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 ground-water flow velocity. 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 ground-water flow velocity can be determined by a simple modification of Darcy's equation if the aquifer is relatively isotropic. 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 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,
4. Surface water elevation changes, and
5. Artificially induced recharge by basin flooding.

In cases of seasonal ground-water flow variation, the permit applicant should provide information describing 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. In attenuation-based demonstrations, the rate of ground-water withdrawal in the vicinity (5 km radius) of the facility should be summarized in tabular form and should include well location, depth, type of use, and withdrawal rates. The zone of impact created by any major well or well field withdrawal should be identified on a site map. The map should include drawdown isolines out to the 30 centimeter drawdown level. Modeling of drawdown curves should use low recharge assumptions such as drought conditions.

Models

Although not required for an ACL demonstration, mathematical simulation models of ground-water flow and contaminant transport can be extremely useful tools for the applicant. Models are more appropriate for relatively simple geologic environments where conditions do not vary widely; in complex geologic areas, modeling may be less useful.

The permit applicant is responsible for ensuring that the models used simulate as precisely as possible the characteristics of the site and the contaminants and minimize the estimates and assumptions required. All models used in the demonstration should:

1. Be compatible with the quality and type of input data available,
2. Have been demonstrated to be applicable to the environmental conditions at the site,
3. Have been subjected to an independent quality assurance audit or to a level of professional peer review equivalent to that for publication in a scientific or technical journal,
4. Be internally consistent in the use of boundary and initial conditions, time steps, assumptions, and code modifications,
5. Have fully documented support available to the Agency, and
6. Be calibrated and verified for the site before being applied in a predictive mode.

As discussed in Chapter II, a two-dimensional model of a ground-water system may be used; however, all simplifying assumptions must be justified. Whenever possible, input parameters and assumptions should be conservative in nature; worst-case scenarios may save much effort. If models are used, the ACL demonstration should include tables of the assumptions, the input parameters, and any calibration data.

CHAPTER V

PATTERNS OF RAINFALL
(40 CFR 264.94(b)(2)(iv))

Precipitation is a driving factor for ground-water recharge and discharge. These two processes are basic components of the hydrogeology at a facility. To verify a claim of attenuation due to dispersion, precipitation data in support of ground- water flow and contaminant transport information must be submitted. This chapter describes the type of precipitation information that should be submitted in support of an attenuation-based 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, evapotranspiration, 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, amounts, 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 amounts that occur at various frequencies. These frequencies are classified in terms of duration and yearly return periods. For example, a one-day/l0-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 amount of precipitation for a storm of specific return period and duration is used to produce an estimate of the amount of precipitation for a given geographical area.

Attenuation-based demonstrations should contain general information on the precipitation characteristics of a site. This includes data on rainfall and snowfall, expressed as its equivalent in rainfall. The National Oceanic and Atmospheric

Administration, the National Weather Service, or climate data in Ruffner (1980 and 1981) may be sources of this information if on-site data is unavailable. Regional precipitation data may be used if it was generated within 15 km of the facility. Regional data from greater than 15 km of the facility should be correlated with available on-site data. The monthly mean and range of this data, the specific time period from which the data was collected, and the location of the precipitation gauge(s) in relation to the facility should be provided. The permit applicant should discuss this information in terms of temporal effect on infiltration and seasonal ground-water recharge. These processes should be related to any effects on contaminant transport.

If the ACL demonstration does not involve surface water exposures, then the permit applicant can proceed to the next chapter. However, if the facility is located near surface water bodies (see Chapter VI), or if surface water discharge is used as an argument in an ACL demonstration, then more detailed information on precipitation events should be submitted. 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 amount of precipitation produced over a 24-hour period by storms of return frequencies of 1, 10, 25, and 100-years should be submitted. The l-year and 10-year storm frequency information gives insight into ground-water infiltration and discharge patterns. The 25-year and l00-year storm frequency data are useful in assessing discharge during flood conditions.

The l00-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 measures, they should also be shown on the map. These measures could include any dikes, berms, dams, 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 also be described.

Evapotranspiration should also be considered in both recharge and discharge evaluations. Vegetation can use a large amount of water and reduce significantly the amount of infiltration reaching the water table, especially during the growing season.

CHAPTER VI

PROXIMITY OF SURFACE WATER AND GROUND-WATER USERS (40 CFR 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. All ACL demonstrations should contain a discussion of the proximity and types of water uses near the facility. If the demonstration is attenuation-based, then more detailed information will be necessary. The uses of surface and ground water in the vicinity of the facility are discussed in Chapter VII.

A key factor involved in assessing exposure is the proximity of surface water and ground-water users to the facility. 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 the applicant is attempting to show that contaminants will safely attenuate into a surface water body, then data on the specific physical attributes of the surface water body will be necessary. This includes information necessary to estimate the mixing potential and mechanisms of the water body. Likewise, if the aquifer is nonpotable, then data showing that it is not fit for consumption must be supplied.

Surface Water

ACL demonstrations relying on transport mechanisms 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, and
3. Identifying ground-water discharge pathways to surface waters.

Each water body within five kilometers downgradient (or downstream) of the facility boundary should be identified. The owner or operator of the facility should supply an appropriately scaled 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 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 various 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 if the applicant is attempting to show that the contaminants will attenuate safely into surface water (i.e., not cause a statistically significant increase in concentration). 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 in order to estimate the discharge zones 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 discharge zones.

The permit applicant should synthesize this information to support arguments of no statistically significant increase in surface water concentrations. The expected amount of attenuation and the zones of probable discharge areas should be discussed. The permit applicant should be aware that certain States have approved surface water models that are used in the NPDES permitting program. If approved models are available, they should be used by the applicant to determine discharge zones in surface waters. The EPA document Technical Support Document for Water Quality-Based Toxics Control (U.S. EPA 1985a) is a good source of this information. In general, one quarter of the cross-sectional area of a stream may be used in estimating the discharge zone. This area could then be applied over the width of the ground-water contaminant plume as it enters the river to derive the discharge zone.

Ground Water

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

1. The distance of the ground-water users' withdrawal point (i.e., well or spring) from the facility, and
2. The hydrologic transport time for the contaminants to reach the closest wells or springs.

The users of ground water within a five kilometer radius of the facility boundary should be identified. Both upgradient and downgradient wells should be included because of their potential to change the direction or quantity of ground-water flow. The applicant should delineate each ground-water withdrawal or injection well on a scaled site 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 nonpotable,
3. Industrial,
4. Agricultural, and
5. Recharge.

CHAPTER VII

CURRENT AND FUTURE USES OF GROUND WATER AND SURFACE WATER IN THE AREA (40 CFR 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 should be considered. A major objective of an ACL demonstration relying on transport arguments is 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 attenuation-based ACL demonstration.

All ACL demonstrations should generally discuss current and likely future uses of water resources near their facility. However, ACL demonstrations based on attenuation arguments need to provide detailed information on these uses. Information gathered to satisfy data requirements on the proximity of water resource users (see Chapter VI) 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, bathing, washing, 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 possible future uses of the water resources should be discussed. The specific type of ground-water use information is described in the following section.

Ground-Water Uses

It should be obvious that ground-water use can be critical in the setting of ACLs at a facility. Facilities that are contaminating or have contaminated ground waters should examine local ground-water uses if their demonstration is attenuation-based.

The U.S. EPA has developed a Ground-Water Protection Strategy (U.S. EPA, 1984a) that states that ground water should be protected to its highest beneficial use. 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 area 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 including 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/1, 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 discharge to surface water that could cause degradation.

Facilities that are contaminating or have the potential to contaminate Class I or Class II ground waters should incorporate human health factors (see Chapter IX) into their ACL demonstration because these resources are either potential or current sources of drinking water. If the ground water is Class III, then health- based concerns may be secondary to environmental concerns in the setting of ACLs. ACLs in Class III ground water will be assessed on a case-by-case basis.

The permit applicant should discuss the ground-water use in the vicinity of the facility in terms of these three classes or other appropriate State-approved classification schemes. The Agency's Office of Ground-Water Protection is developing guidance containing specific criteria for designation of ground water as Class I, II, or III. These draft Guidelines for classifying ground water were available in December 1986. Until this guidance is finalized, we recommend only conservative use of the "unuseable" criterion as a basis for an ACL.

Information from the State and/or local government as to the beneficial use of the ground water should be included if the ground water has been classified. Otherwise, the permit applicant should have its ground-water classification data reviewed by the State. When ground water has been classified on a State, regional, or local level, this classification should be re-evaluated and verified using site specific data. The State's review should be included in the ACL demonstration.

Surface Water Uses

Surface water uses should be discussed by the permit applicant if contaminated ground water can migrate to surface waters. 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 do not have to be submitted.

The established guidelines, criteria, and/or standards for each water body identified in Chapter VI should 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 (including other domestic uses),
2. Fish and wildlife propagation area,
3. Industrial or agricultural water source,
4. Area of special ecological concern, and
5. Recreational area.

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 IX and X).

CHAPTER VIII

EXISTING QUALITY OF GROUND WATER AND SURFACE WATER, AND OTHER SOURCES OF CONTAMINATION (40 CFR 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 should 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 264.97, 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) and the RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (U.S. EPA, 1986a) for further guidance on ground-water monitoring and station locations. Background surface water quality must be assessed only in cases where surface waters receive contaminated ground-water discharges (see Chapters VII and X).

The permit applicant should submit a site map that identifies the location of background sampling stations and monitoring wells, and the direction of both stream flow and ground-water movement. 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 U.S. Geological Survey, 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 constituents for which ACLs are being proposed should be included in a summary table. The uppermost aquifer and any surface water bodies that receive 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 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 and the ACL demonstration is based on attenuation arguments. If no contamination is found, or the POE is set at the POC, 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 and Superfund sites,
2. Solid waste management units,
3. Industrial areas,
4. Deep well injection sites, and
5. Agricultural areas.

Likely sources of contamination should be delineated on a map with an appropriate scale. The distance of each source from both the facility and the upgradient monitoring wells should be discussed. Available ground-water data on any of the identified sources should be submitted and 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 identify 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 VII 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 discharges to a surface water resource and detectable quantities of contaminants are found in the surface water. Consideration should be given to both point and nonpoint sources of contamination. Any point sources of pollutant loading to surface waters should be identified on an appropriately scaled 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 NPDES permit number of each point source should also be included in this table. If they are available, the discharge rate, load allocations, permit discharge conditions, and mixing zones should be provided and discussed. The applicant should focus these discussions around the impact of the facility's discharge on these factors.

Any nonpoint 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 and Superfund sites.

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

CHAPTER IX

POTENTIAL HEALTH RISKS
(40 CFR 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 likely. The applicant need not assess possible health risks in detail if the probability of exposure can be shown to be quite low; such a case may arise if the point of exposure is set at the point of compliance.

The purpose of the health risk assessment is to determine allowable human exposure concentrations at a point of exposure for the constituents for which ACLs are requested. These allowable exposure concentrations can be proposed as ACLs or they can be used as a basis to calculate the ACLs at the point of compliance. When determining potential health risks, certain assumptions are usually made when complete data on specific human effects are lacking. Both the information necessary to sufficiently support proposed allowable exposure concentrations and the areas where assumptions may be necessary are discussed in this chapter. The applicant may find the EPA document Superfund Public Health Evaluation Manual (U.S. EPA, 1986b) useful in making these determinations.

There are four components to an evaluation of health risks. An exposure assessment is the first component of a health risk assessment. The exposure analysis must identify and describe the current and potential human exposure pathways. The second component, usually referred to as hazard identification, involves a qualitative assessment of whether or not a chemical poses a hazard to humans. The third component, the dose-response assessment, attempts to quantitatively describe the expected human response to a given dose of a hazardous constituent, typically relying heavily on data from long-term animal studies. The final component is the risk characterization step. For purposes of developing ACLs, this step involves the integration of the three previous steps to determine allowable human exposure levels for the ACL constituents. Depending on the results of the environmental risk analysis described in Chapter X, the allowable human exposure levels can be used as the ACLs or as the basis to calculate the ACLs.

Exposure Assessment

The exposure assessment should follow the Agency's final guidelines (U.S.EPA, 1986c). The types of likely human exposure pathways that should be investigated include:

1. Drinking water exposure from either a ground-water or a surface water source,
2. Ingestion of contaminated food (e.g., aquatic organisms, agricultural products), and
3. Inhalation of volatile compounds.

The type of information needed to satisfy the health risk requirement depends on the exposure pathway. As an example, if the facility property boundary is located adjacent to a surface water body that is a source of drinking water and a sustained fishery, and the contaminated ground water is discharging into this surface water body, then the health risk information must be based on exposure from the consumption of contaminated ground water and aquatic organisms. In this case, the Ambient Water Quality Criteria for the protection of human health from the consumption of contaminated water and aquatic organisms could be proposed directly as the ACLs (i.e., POE = POC). If an exposure pathway is from a ground- water source of potential drinking water, the health assessment must address the consumption of contaminated drinking water. In this case, the health-based drinking water levels could be proposed as the ACLs.

The inhalation exposure pathway should be considered in cases where volatile compounds are either likely to volatilize from the contaminated ground water during use (e.g., during showering) 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 those situations where the use of ground water or the presence of subsurface structures allows for probable exposures. It should be noted that the Agency is currently examining air releases from hazardous waste facilities. If standard inhalation assumptions are developed, they may be appropriate for ACL decisions concerned with the inhalation pathway.

The location of the potential points of exposure is discussed in Chapter I. The potential point of exposure to the ground-water contaminants is assumed to be at the facility's waste management boundary, the plume boundary, or the property boundary for most cases in which an ACL application is being prepared.

If the applicant is proposing that the POE be at the facility property boundary and there are drinking water wells nearby, or some contaminants will be discharging into a surface water body, then the possibility of multiple exposures should be considered. For instance, if some members of the local population work in a factory where they are exposed to substance X, and the applicant is proposing an ACL for this substance with the POE at the facility boundary, the applicant should account for that workplace exposure in determining an allowable dose for the population. Similarly, if the potentially exposed population uses water that contains some naturally occurring compounds, the interaction of ambient constituents and the constituents for which the ACLs are proposed should be accounted for in the ACL demonstration.

If any population or subgroup is or will be exposed to the ACL constituents, the cumulative effect of multiple exposures should be accounted for whenever possible. The likelihood of such exposure occurring under the Agency's ACL policy is small, but in some situations this may be a factor of concern. The National Center for Health Statistics, U.S. Department of Health and Human Services, may be a good source of information on sensitive populations or individuals.

Hazard Identification

The two principal sources of data for determining hazard potential are epidemio- logical studies and experimental animal studies. 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. This can be as simple as providing the Agency maximum contaminant levels (MCLs), reference doses (RfDs), or risk specific doses (RSDs) for the ACL constituents. Appendix D of this document contains a survey sheet on health effect factors that can be used to summarize the toxics information.

If an ACL constituent has no MCL, RfD or RSD, then the applicant should perform a comprehensive literature search for health effects data on that contaminant. The applicant should distinguish between ground-water contaminants having threshold (toxic) and nonthreshold (carcinogenic) effects. The permit applicant should discuss any other effects associated with the contaminants, including odor and taste, mutagenic, teratogenic, reproductive, fetotoxic, and synergistic or antagonistic effects. A reference citation and a summary should be submitted for each study that was used to determine the type of effect for each contaminant.

In the development of ACLs, the permit applicant may find that the grouping of hazardous constituents is a useful simplification. The applicant may investigate health effects data developed for entire classes of compounds, such as polynuclear aromatic hydrocarbons (PAHs), halomethanes, or polychlorinated biphenyls (PCBs), as well as compound-specific data. Grouping of constituents should follow a two-step process. First, the applicant should perform a qualitative assessment of the constituents' physical, chemical, and toxicological properties. Second, a quantitative analysis should be performed to determine the most hazardous compound within each group identified in the first step. This step will be examined in more detail in the dose-response section of this chapter.

The qualitative assessment should include an initial screen of the structure activity relationships (SAR) of the constituents. Constituents with similar physical and chemical structures may be initially grouped together. These groupings should then be further evaluated on their toxicological effects. The predominant adverse biological effect for each constituent in each SAR group should be identified. The final grouping(s) should contain constituents with similar physical and chemical structures, and should result in the same toxic endpoints. This subgroup could form the basis for the exposure assumptions used in deriving the allowable concentrations for the ground-water contaminants. All of this information should be presented in tabular form to facilitate easy reference.

Dose-Response Assessment

This assessment attempts to quantitatively describe the expected human response to a given dose of a hazardous constituent, typically relying heavily on data from long-term animal studies. These animal studies are usually based on exposures at high dose levels, often orders of magnitude higher than doses encountered by humans. Therefore, mathematical models are used to estimate allowable dose levels from low-dose extrapolations. The mathematical models yield reference doses (RfDs) for toxic compounds and potency factors (PFs) for carcinogenic compounds. The RfD refers to the amount of the chemical to which humans can be exposed on a daily basis over long periods of time without suffering an adverse effect. A PF represents, in most cases, the largest possible linear slope at the 95% upper confidence limit of low extrapolated doses that is consistent with the dose- response data.

If Agency-compiled data on threshold (toxic) contaminants are not available, then the applicant can submit dose-response information reflecting the acute, subchronic, chronic, and "no-effect" levels for the threshold contaminants. Body surface area and weight, and absorption and excretion rates may be assumed to estimate equivalent oral doses based on data from inhalation or dermal exposure studies.

A conservative approach to risk assessment that includes groupings of compounds could reduce the amount of data needed to quantify potential human health effects. The quantitative step for grouping compounds consists of identifying the most potent compound in each group identified in the hazard identification step. For toxic compounds, the most potent compound would have the lowest RfD. For carcinogens, the compound with the lowest RSD, or highest PF, would be considered the most potent. This conservative number can then be applied to each compound within the group. It must be emphasized that this quantitative determination should only be performed after a qualitative assessment of the chemical, physical, and toxicological properties of each compound has been performed.

As a simplified example of the grouping process, assume that an applicant's contaminant plume contains PAHs. After analysis, the PAHs are found to be dibenzo(a,h)anthracene, benzo(j)fluoranthene, benzo(a)anthracene, benzo(b)-flouranthene, and benzo(a)pyrene. Since all of these are suspected carcinogens and their chemical structures are similar, these five could be qualitatively grouped. A literature search would reveal that benzo(a)pyrene is the most potent carcinogen, and a RSD could then be obtained from EPA for this compound. The RSD could then be applied to the other four PAHs to calculate allowable exposure levels. To be acceptable to the Agency, this example would require much more supportive information and a number of references.

Risk Characterization

Allowable exposure concentrations can be derived by using MCLs or applying appropriate exposure assumptions to established RfDs or PFs, or alternate dose levels derived from the literature if established dose levels are not available.

When deriving an ACL for those ground waters that are current or potential sources of drinking water, MCLs set under the Safe Drinking Water Act should be examined for use in setting the allowable concentration level at the point of exposure (POE). In those cases where a MCL does exist for the particular contaminant, and the potential exposure route is human drinking water, the MCL should normally be used as the allowable POE concentration. If a MCL does not exist for a hazardous constituent, then either RfDs or RSDs should be used to set the allowable exposure levels.

There are other circumstances where it may be necessary to apply an allowable exposure level other than the MCL at the POE. The circumstances depend on the site-specific factors involved and include the following scenarios:

- Where there are multiple contaminants in the ground water at a site, individual contaminant levels may have to be set below the MCL in order to achieve an overall carcinogenic risk level in the range of 10^{-4} and 10^{-7}.

- Where drinking water is but one of the possible exposure routes.

In the first case, the permit applicant should examine the RSD or RfD value and consider using some form of additivity to derive the appropriate POE concentration. In the latter case, the MCL should be compared to the allowable exposure levels for the other potential receptors. The level at the POE should be set at the lowest allowable exposure level in order to protect all potential receptors.

The permit applicant should use generally accepted standard factors in the exposure assessment, some of which are listed in Appendix E. The allowable exposure level can be calculated for toxic compounds using the RfD and the exposure assumptions of a 70 kg adult consuming two liters of water per day. The following formula should be used to calculate the allowable exposure concentration:

$$\text{RfD Exposure level (mg/l)} = \frac{\text{RfD} \times 70}{2}$$

A potency factor (PF) is used to estimate a risk specific dose for a hazardous constituent concentration that corresponds to a particular statistical lifetime cancer risk value. For example, a contaminant concentration corresponding to a lifetime cancer risk of 10^{-6}, assuming that a 70 kg adult consumes two liters of water per day, is estimated by the following formula:

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

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^{-7}. In setting ACLs, the following factors should be considered in choosing a risk level within the 10^{-4} to 10^{-7} range:

1. Other environmental health factors borne by the affected population, and
2. Level of uncertainty in the data base and models used in the risk analysis.

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^{-7} range for a particular facility. Justification should then be provided for using a different level of risk.

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 affected ground water or surface water should be performed. This data is necessary to determine the total concentration of the ACL constituents in the affected water resource, the health effects associated with the concentrations, and the relative exposure contribution of the ACL constituents emanating from the site to the total exposure concentration. At a minimum, an additive approach based on contaminants that produce the same adverse effects by similar mechanisms should be used to estimate health effects from exposure to mixtures of contaminants.

The applicant should submit an allowable health effects exposure level for each ACL constituent. The health-risk assessment should be based on conservative health based numbers. Table I lists the compounds for which RfDs and RSDs have been derived by the U.S. EPA at the time of publication of this document (their derivation is an ongoing process). The RfD summary sheets and the RSDs can be obtained by contacting the Health Assessment Section, in the Office of Solid Waste at the U.S. EPA in Washington D.C. (Phone number: 202-382-5219). 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 allowable 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 compound has not been submitted, and the compound cannot be grouped, the concentration limit will be set at the background level or at the maximum concentration listed in Table 1 of Section 264.94(a) of the regulations.

TABLE 1

A. CHEMICALS WITH POTENCY FACTORS

Acrylonitrile
Aldrin
Aniline
Arsenic
Benzene
Benzidene
Benz[a]anthracene
Benzo[a]pyrene
Bis(2-chloroethyl)ether
Cadmium
Carbon tetrachloride
Chlordane
Chlorinated ethanes
1,2-Dichloroethane
1,1,2,2-Tetrachloroethane
Chloroform
Chromium VI
DDT
Dibenzo(a,h)anthracene
3,3'-Dichlorobenzidine
1,1-Dichloroethylene
(Vinylidene chloride)
Dichloromethane
(Methylene chloride)
Dieldrin
2,4-Dinitrotoluene
1,4-Dioxane
Ethylene oxide
Hexachlorobenzene
Hexachlorobutadiene
3-Methylcholanthrene
4,4-Methylene-bis-2-chloroaniline
N-nitrosopyrolidine
Pentachloronitrobenzene
Pronamide
2,4,6-Trichlorophenol
Tetrachloroethylene
Trichloroethylene
Vinyl chloride

TABLE 1 (continued)

B. CHEMICALS WITH VERIFIED REFERENCE DOSES

Acetone
Aldrin
Allyl alcohol
Antimony
Barium
Beryllium
Bis(2-ethylhexy1)phthalate
Bromodichloromethane
Bromomethane
n-Butane
Carbon Disulfide
Carbon Tetrachloride
Chlordane
Chlorobenzene
Chlorodibromomethane
Chloroform
Crotonaldehyde
Cyanide (free)
2,4-D
DDT
D-n-butylphthalate
1,2-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethylene
2,4-Dichlorophenol
Diethylphthalate
2,4-Dinitrophenol
Disulfoton
Diphenylamine
Ethylacetate
Ethylbenzene
Ethyl Ether
Famphur
Fluoride
Heptachlor epoxide
Hexachlorobutadiene
Hexachlorocyclopentadiene
Isobutyl alcohol
Isophorone
Mercury (inorganic)
Methylene Chloride
Methanol
Methyl ethyl ketone
Methyl isobutyl ketone
Nitrobenzene
Pentachlorobenzene
Pentachloronitrobenzene (PCNB)
Pentachlorophenol
Phenol
Pyridine
Silver
Styrene
1,2,4,5-Tetrachlorobenzene
Tetrachloroethylene
2,3,4,6-Tetrachlorophenol
2,4,5-Trichlorophenol

CHAPTER X

POTENTIAL DAMAGE TO WILDLIFE, VEGETATION, AGRICULTURE, AND PHYSICAL STRUCTURES (40 CFR 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 the point of exposure at the point of compliance, and the nearest likely receptor is human, 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. 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 terrestial environments; agricultural crops, products, and lands; and physical structures. The exposure assessment involves examining the extent of the hazardous contaminant plume, 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 VI and VII before proceeding with this chapter. The data 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 subject 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 the 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. ACL applicants probably will not need to address terrestrial environmental impacts in detail when there are no direct exposure routes between terrestrial systems and ground water. In these cases, or when the POE is set at the POC, the 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 if exposure is likely. 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 and their degradation products. 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 analysis 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, he/she should consult U.S. EPA (1984d) 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 infrared 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 of macrofloral plants, 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 along with the data collected and a complete discussion of results should be submitted by the applicant.

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. 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 factors. The exposure assessment for surface waters was discussed in Chapters VI and VII. 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. The Office of Water, U.S. EPA, has published a document that the applicant and reviewer should find useful in evaluating aquatic impacts (U.S. EPA, 1985a). 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.

ACLs may be established based on contaminant discharge into a surface water body. This is allowable only where the contaminant plume has already reached the surface water body and the constituents do not cause a statistically significant increase in contaminant levels over background in the surface water concentrations. That is, after accounting for the inherent variation in the sampling and analysis data, the release of a constituent into a surface water body should not cause an increase in the background surface water concentration of that constituent.

In order to make this determination of statistical significance, samples of surface water should be taken during a period in which the flow (for rivers and streams) or standing volume (for ponds and lakes) of the water body is near average conditions for the specific season. It may also be necessary to collect sediment samples to make this determination. The permit applicant should determine the flow of the surface water at or near the time of sampling and supply this determination, the actual monitoring data, and historical information that demonstrates that the flow at the time of sampling was near the seasonal average.

Surface water samples should be collected within the discharge zone of the ground- water contaminant plume. The discharge zone will have to be determined on a site-specific basis, and is dependent on the local hydrogeology. Since ground-water movement near surface water bodies can be quite complex, some of the initial samples may have to be collected adjacent to the facility as well as some distance downstream in order to identify the discharge zone. If, upon sampling in the discharge zone, the levels of the constituent of concern are not detectable, a statistical comparison of sampling data does not need to be performed. However, if the discharge levels are detectable, an appropriate statistical procedure should be used to compare the constituent concentration in the discharge zone to the constituent concentration upstream in the surface water body. The Agency expects to develop further guidance on appropriate statistical techniques for making these comparisons. The background concentration should be determined by sampling the surface water body in an area that is not expected to be affected by the RCRA facility, and is also not near other sources of contamination.

If a RCRA facility receives an ACL based upon the release of a contaminant into a surface water body, the facility's permit should contain a requirement for periodic surface water sampling. The sampling frequency should be determined on a site-specific basis to assure that the constituent concentration does not surpass a statistically significant level over background in that surface water body.

If it is found that the ground-water contamination discharge is not causing a statistically significant increase over background in the surface water body, then an ACL for an operating unit may be set at the contaminant levels currently at the point of compliance. However, if the ground-water contaminant plume contains much higher levels of contamination (i.e., hot spots) than have already reached the surface water, these hot spots may have to undergo some form of corrective action, so as to not violate the standard of statistical significance. To meet this standard, appropriate ground-water contaminant plume management techniques will have to be selected on a site-specific basis.

Agricultural Impact Assessment

The potential impacts of ground-water contamination on agriculture should be examined when the POE is not set at the POC. 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 an appropriately scaled 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 attentuation 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 map employing the appropriate scale. Chapter VII 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 VI). 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 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 concentration limit may be set at background levels.

Physical Structure Impact Assessment

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

Determining the potential exposure of the physical structures to waste contaminants requires identification of 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 if they are likely to be reached by contaminants. 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 that 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 XI

PERSISTENCE AND PERMANENCE OF POTENTIAL ADVERSE EFFECTS (40 CFR 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 a potential exists for exposure to the ACL constituents to result in adverse effects, the adverse effects will be considered permanent unless they are generally accepted to be not permanent or information is submitted by the permit applicant to justify that they are 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 if the demonstration is attenuation-based. The processes should be discussed from a ground-water perspective, a surface water perspective, or any other environments or combination of environments 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, photolysis, oxidation, reduction, adsorption, dispersion, or precipitation, all of which were discussed in Chapter II. The various degradation products, if known, should also be discussed.

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 or are provided in the literature. 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 based on attenuation mechanisms. This information should be included in the demonstration's health risk assessment (Chapter IX) and the environmental risk assessment (Chapter X). 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 individual organisms 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 attenuation considerations. The effects should be classified as either reversible or irreversible.

CHAPTER XII

SUMMARY AND CONCLUSIONS

The factors involved in preparing and supporting an ACL demonstration were discussed in the previous chapters. Chapter I outlined the Agency's policy quidelines for implementation of the ACL process. Information on each of the criteria discussed in this guidance document is not required in every ACL demonstration because every RCRA facility is unique with different environmental properties and waste characteristics. Therefore, each ACL demonstration based on attenuation mechanisms must reflect site-specific conditions. 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 B 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 B also contains a summary outline of the information that can be used 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.

Once the data have been submitted by the permit applicant, the permit writer must assess the quality of the submitted information and determine the allowable concentrations of contaminants at the point of exposure, and 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 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 I of Section 264.94(a) (if EPA rejects the ACL demonstration), or it will contain ACLs. 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 or she cannot postpone corrective action in order to argue for ACL changes.

CHAPTER XIII

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ACL POLICY AND INFORMATION REQUIREMENTS

APPENDICES

APPENDICES

A. Outline of Information That May Be Cross Referenced From the Permit Application

B. Summary of Tables, Figures, and Information Required to Support an ACL Demonstration

C. Summary Sheet of Hazardous Constituent Properties

D. Summary Sheet on Health Effects Factors

E. Standard Factors Used in Exposure Assessments

APPENDIX A

Outline of Information That May Be Cross Referenced from the Permit Application

The following information, required in the Part B permit, may be cross-referenced in the ACL application:

§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; and

(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 additional sections of the Part B permit application may also 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 USC 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 that meets the requirements of §264.100, if applicable to the ACL demonstration, or a compliance monitoring program that meets the requirements of §§264.99 and 270.14(c)(6).

APPENDIX B

Summary of Figures, Tables, and Information Required in ACL Demonstrations

1. Figures
2. Tables
3. Information

This appendix can be used as a quick reference to determine what types of information are needed for various types of ACL demonstrations. As was discussed in earlier chapters, not all the information discussed in this document is necessary in all applications. The applicant is responsible for deciding what information is necessary for the site, though the appropriate permitting authority may provide some help in making this determination. Most notably, a simplified ACL demonstration may be based strictly on an EPA reviewed dose level (with no mechanisms of attenuation considered). In some cases, as was discussed in the first chapter, this may be the only type of ACL demonstration acceptable to EPA.

However, all ACL applications are required to provide certain information. If this information is not provided or is supplied in an unacceptable form, then the ground-water protection standard will be set at background or one of the MCLs listed in the regulations (40 CFR §264.94(a)). This appendix points out what information is usually required in all demonstrations, and what additional information may be required in some cases.

This appendix is only a summary; it is not comprehensive. The applicant or reviewer should refer to the main body of the guidance for a more thorough discussion of the types of information needed in an ACL application.

FIGURES

A. Figures That Should Be Included in All ACL Demonstrations

1. Plume map(s) of each hazardous constituent
2. A site map showing:
   - all structures
   - all waste management areas
   - all monitoring wells and surface water sampling locations (if applicable)
   - all ground-water withdrawal and injection wells
   - all surface water bodies
3. Horizontal and vertical ground-water flow map(s)

B. Figures That Should Be Included in All Detailed Demonstrations

1. Areal soil map
2. Vertical soil map
3. Facility subsurface stratigraphy map(s)
4. Regional subsurface stratigraphy map(s)
5. 100 year floodplain map
6. Ground-water recharge and discharge map
7. Agricultural land uses map

C. Additional Figures That May Be Necessary in a Demonstration

1. Withdrawal well cones of depression
2. Map showing locations of other potential sources of pollution
3. Map showing locations of stressed terrestrial environments
4. Map showing locations of stressed aquatic environments

TABLES

A. Tables That Should Be Included in All ACL Demonstrations

1. Background concentration of each hazardous constituent in both ground water and each surface water body (if applicable)
2. Uppermost aquifer characteristics
3. Ground-water well location and use information
4. Health effects information of each constituent (including EPA-reviewed allowable dose levels if available)

B. Tables That Should Be included in All Detailed Demonstrations

1. Location information of surface water bodies
2. Soil characteristics
3. Subsurface geology characteristics
4. Horizontal flow net data
5. Vertical flow net data
6. Ground-water withdrawal data (if applicable)
7. Annual and monthly precipitation data
8. Endangered and threatened species information (if applicable)
9. Degradation and attenuation properties of hazardous constituents
10. Soil attenuation properties
11. Mathematical model(s) assumptions (if applicable)
12. Ground-water use

C. Additional Tables That May Be Necessary in a Demonstration

1. Physical characteristics data of each water body
2. Designated uses of each surface water body
3. Point source information
4. Population characteristics
5. Toxicity information on terrestrial impacts
6. Terrestrial environment diversity information

TABLES (CONT'D)

7. Aquatic toxicity information
8. Aquatic diversity
9. Agricultural crop impacts data
10. Animal husbandry impacts data
11. Agricultural land use information
12. Physical structural impacts data

INFORMATION

Hazardous Constituent Characteristics (Chapter II)

1. Extent of Ground-Water Contamination (§270.14(c))

   A. Information Required for All Demonstrations
      - i. Appendix VIII (under revision to Appendix IX of Part 264) analysis results
      - ii. plume definition of each hazardous constituent

2. Waste Characteristics (§264.13)

   A. Information Required in All Demonstrations
      - i. quantity of waste in regulated unit
      - iii. characteristics of waste in regulated unit

3. Characteristics of ACL Constituents

   A. Information Required for a Detailed Demonstration
      - i. density
      - ii. solubility
      - iii. vapor pressure
      - iv. viscosity
      - v. octanol-water partitioning coefficient (if applicable)

   B. Additional Information That May Be Required Depending on Fate-Related Arguments
      - i. chemical degradation data
         - a. oxidation
         - b. reduction
         - c. hydrolysis
      - ii. biological degradation data
         - a. biodegradation
         - b. biotransformation

iii. physical attenuation data
   a. ion exchange
   b. precipitation
   c. complexation

Hydrogeological Characteristics (Chapter III)

1. Identification of Uppermost Aquifer (§270.14(c))

    A. Information Required in all Demonstrations
        i. horizontal extent
        ii. vertical extent

2. Characteristics of Each Soil Type

    A. Information Required for a Detailed Demonstration
        i. thickness
        ii. areal extent
        iii. hydraulic properties

    B. Additional Information That May be Required Depending on Attenuation Arguments
        i. dispersion properties
        ii. retardation and sorptive properties
            a. organic and mineral content
            b. cation and ion exchange
            c. grain size

3. Characteristics of Each Subsurface Stratigraphic Unit

    A. Information Required in a Detailed Demonstration
        i. horizontal and vertical extent
        ii. hydrologic properties
            a. hydraulic conductivity
            b. specific yield or storage
            c. effective porosity

    B. Additional Information Required if Aquitard is Present
        i. hydraulic conductivity
        ii. pump test results

Ground-Water Flow Direction and Quantity (Chapter IV)

1. Ground-Water Flow Characteristics (§270.14(c))

   A. Information Required in All Demonstrations
      i. horizontal flow in saturated zone
         a. ground-water elevation data
         b. storage or specific yield data
      ii. vertical flow in saturated zone
         a. nested piezometer data
         b. storage data

   B. Additional Information That May Be Required Depending on Site Conditions
      i. temporal variability in ground-water flow
         a. seasonal recharge patterns
         b. surface water elevation changes
            1. tidal effects
            2. riverine or lake
      ii. ground-water withdrawal effects on ground-water flow
         a. drawdown effects

Rainfall (Chapter V)

1. Precipitation Characteristics

   A. Information Required in a Detailed Demonstration
      i. monthly rainfall and/or snowfall
      ii. effects of rainfall on seasonal recharge

   B. Additional Information Required if Surface Waters are Nearby (see Chapter VII)
      i. storm frequency patterns (1, 10, 25, 100 years)
      ii. effects of storms on infiltration
      iii. effects of storms or flooding
         a. 100-year floodplain (§270.14(b))
      iv. site-specific characteristics affecting flooding and infiltration
      v. ground-water discharge pathways

Proximity of Surface Water and Ground-Water Users (Chapter VI)

1. Surface Water Information

   A. Information Required in a Detailed Demonstration
      i. location of each water body within 5 km downgradient of facility
         a. distance from facility
         b. travel time of ACL constituents from facility to the water body

   B. Additional Information is Required if Ground-Water Discharge of ACL Constituents is Likely to Reach Surface Waters
      i. physical characteristics of each water body
         a. dimensions
         b. hydraulic residence time, flow rate, or tidal periodicity
      ii. discharge zone size

2. Ground-Water User Information

   A. Information Required in All Demonstrations
      i. location and distance from facility of ground water users
      ii. types of users
         a. potable
         b. domestic
         c. industrial
         d. agricultural
         e. recharge

   B. Additional Information That May Be Required
      i. demography of surrounding area
      ii. zoning patterns
      iii. projected population growth
      iv. projected ground-water use

Uses of Ground Water and Surface Water (Chapter VII)

1. Ground-Water Uses

   A. Information Required in a Detailed Demonstration

      i. use or potential use of local ground water

      ii. State certification of groundwater's beneficial use

2. Surface Water Uses

   A. Additional Information is Required if Surface Waters are Nearby and Contaminated Ground Water Discharge is Likely

      i. designated use of each water body

         a. drinking water source
         b. fish and wildlife propagation
         c. industrial or agricultural use
         d. area of ecological concern
         e. recreational area

Existing Quality of Ground Water and Surface Water and Other Sources of Contamination (Chapter VIII)

1. Ground-Water Background Quality (§264.99)

   A. Information Required in All Demonstrations
      i. ground-water assessment for Appendix VIII constituents
         a. hydrologic units in uppermost aquifer
         b. upgradient of facility

   B. Additional Useful Information
      i. historical regional ground-water quality information

2. Surface Water Quality

   A. Additional Information is Required if Ground-Water Discharge of ACL Constituents to Surface Waters is Likely
      i. surface water assessment for ACL constituents
         a. each surface water body that receives the contaminated ground water or that is downstream from a water body that does
      ii. historical regional ground-water quality information

3. Ground-Water Contamination Sources

   A. Information Required in All Detailed Demonstrations
      i. statement as to the presence or absence of other contamination sources

   B. Additional Information is Required if Background Ground Water is Contaminated
      i. location of other potential sources of contamination, including other RCRA facilities, Superfund sites, landfills, industrial areas, surface impoundments, etc.
      ii. available ground-water data from these sources

4. Surface Water Contamination Sources

   A. Additional Information is Required if Ground-Water Discharge of ACL Constituents to Surface Water is Likely

      i. statement as to the presence or absence of other surface water contamination sources

      ii. point source loading information including industrial facilities and publicly owned treatment works (POTWs)

         a. NPDES permit information

         b. waste load allocations

         c. mixing zone information

         d. monitoring data

      iii. Non-point source loading information including run-off and infiltration sources

Potential Health Risks (Chapter IX)

1. Exposure Assessment

   A. Information Required in All Demonstrations
      i. location of potential point of exposure (POE)
      ii. information or type of assumptions used for exposure

   B. Additional Information is Required Depending on Likelihood of Exposure (e.g., off-site plume, on-site ground-water use)
      i. description of likely exposure pathways
         a. drinking water (ground or surface water)
         b. ingestion of contaminated food (aquatic or agricultural products)
         c. dermal contact (bathing or recreation)
         d. inhalation of volatile organics
      ii. population information
         a. sensitive subgroups

2. Health Assessment

   A. Information Required in All Demonstrations
      i. allowable exposure levels for each ACL contaminant
         a. Reference Dose level (RfD)
         b. Potency Factor (PF)
      ii. basic toxicological data if EPA approved allowable exposure levels are not available
      iii. cumulative impacts if background is contaminated
      iv. if applicable and available, data on additive impacts for mixtures of contaminants

Potential Environmental Impacts (Chapter X)

1. Terrestrial Impacts

   A. Information Required in All Demonstrations

      i. statement as to the likelihood of any terrestrial environmental exposure

   B. *Additional Information is Required if Terrestrial* Environmental Exposure Can Occur

      i. toxicity and bioaccumulation values for ACL constituents

      ii. environmental effects for ACL constituents

         a. literature description

         b. stressed vegetation *analysis and diversity studies if exposure* has occurred

2. Endangered Species Impacts

   A. Information Required in All Demonstrations

      i. statement describing the presence of any endangered or threatened species near the facility

   B. Additional Information is Required if Endangered or Threatened Species are Found Near the Facility

      i. assessment of habitat impacts due to ACL constituents

      ii. assessment of species impacts

3. Aquatic Impact Assessment

   A. Information Required in All Demonstrations

      i. statement as to the likelihood of aquatic environmental exposures

B. Additional Information is Required if Aquatic Environmental Exposure Can Occur
   i. sampling protocol to show no statistical significance
      a. QA/QC
      b. sampling points and justification
   ii. data requirements
      a. water
      b. sediment

4. Agricultural Impacts

   A. Information Required in All Demonstrations
      i. statement as to the likelihood of agricultural operations exposures

   B. Additional Information is Required if Exposure is Likely
      i. data on agricultural land use near the facility
      ii. information on exposure pathways including shallow ground water and irrigation
      iii. assessment of crop impacts
      iv. assessment of livestock impacts

5. Physical Structure Impacts

   A. Information Required in All Demonstrations
      i. statement as to the likelihood of physical structure exposure

   B. Additional Information is Required if Exposure is Likely
      i. data on physical structures in area
      ii. information on exposure pathways
      iii. assessment of reactivity, ignitability, and migration potential of ACL constituents and their impact or physical structure

Persistence of Contamination and Permanence of Effects (Chapter XI)

1. Persistence

   A. Information Required in All Demonstrations
      i. statement on whether degradation of ACL constituent is used as a fate-related argument

   B. Additional Information is Required if Fate Arguments are Used
      i. assessment of degradation of ACL constituents (Chapter II information)
         a. biodegradation, bioconcentration, biotransformation
         b. oxidation/reduction
         c. hydrolysis
         d. precipitation, ion exchange, complexation
      ii. assessment of rates of degradation
         a. parameters
         b. coefficients
         c. assumptions

2. Permanence

   A. Information Required in All Demonstrations
      i. statement on whether acceptable risk arguments are used

   B. Additional Information is Required if Exposures Do Occur
      i. long-term effects associated with exposure to ACL contaminants
         a. chronic effect levels
         b. reversibility of effect

APPENDIX C

Summary Sheet of Hazardous Constituent Properties

PHYSICAL AND CHEMICAL PROPERTIES OF EACH HAZARDOUS CONSTITUENT

1. Name of Constituent: ____________________
2. CAS #: ____________________
3. Molecular Weight: ____________________
4. Physical state of product/chemical and quantity during storage or disposal.

	Storage	Disposal
Solid		
Gas		
Liquid		

5. Melting Point: ____________
6. Boiling Point: ____________
7. Solubilities in:
   a. Water: ____________
   b. Nonaqueous Solvent (specify): ____________
8. Dissociation Constant (specify): ____________
9. Partition Coefficient (Kow): ____________
10. Density: ____________
11. Reactivity (specify)
    a. Photochemical Degradation: ____________
    b. Hydrolysis: ____________
    c. Chemical Oxidation: ____________
    d. Chemical Reduction: ____________
12. Vapor Pressure: ____________
13. Henry's Law Constant: ____________
14. Viscosity of Liquids: ____________
15. Biodegradation Characteristics: ____________
16. Adsorption/Desorption Characteristics: ____________
17. Chemical Incompatibility: ____________
18. pH: ____________
19. Decomposition Temperature: ____________
20. Decomposition Products: ____________

APPENDIX D

Summary Sheet on Health Effects Factors

SUMMARY SHEET ON HEALTH EFFECTS

Name of Constituent: ______________________________ CAS #: ____________

AGENCY-REVIEWED ALLOWABLE HEALTH LEVELS

MCL	Reference Dose	Risk Specific Dose	Other (water quality criteria, etc.)
________	Dose ______ ____________ Assumptions ____________ ____________ Concentration ____________	Potency Factor ____________________ Assumptions ____________________ ____________________ Concentration at 10^{-6} risk ______________	____________________ ____________________ ____________________

HEALTH EFFECTS TESTING, IF AGENCY-REVIEWED LEVELS ARE UNAVAILABLE

1. a. Has the chemical been evaluated for the following:

Effects	Test Performed		Effects Observed	
	Yes	No	Yes	No
Oncogenicity				
Carcinogenicity				
Mutagenicity/Genotoxicity				
Teratogenicity/Fetotoxicity				
Chronic Toxicity				
Subacute Toxicity				
Other				

b. What organization performed the toxicology testing?

____

c. Is a protocol for the testing available? _____ Yes _____ No

d. Are copies of the testing reports available? _____ Yes _____ No

If yes, attach copies and check here: _____

2. If a positive response was given in any part of Question 1.a, then summarize test(s) below. Make copies of the table and complete one table for each test performed on the subject chemical.

a. Test Subjects	Sex: ________ Species: ____________
b. Dose and Duration	Dose: ____________ Frequency of administration: ____________ Duration of exposure: ____________
c. Route of Exposure	☐ Oral ☐ Dermal ☐ Eyes ☐ Inhalation ☐ Subcutaneous ☐ Intramuscular ☐ Interperitoneal ☐ Intravenous ☐ Other
d. Effects Observed 1/	____________
e. Protocol Followed	☐ Yes ☐ No If yes, cite protocol: ________
f. Comments 2/	
g. Reference or Source	

1/ Include non-tumorigenic and all other effects observed, dose levels at which the effects were observed, statistical evaluations of data, and latency periods observed.
2/ Report any variables which may have affected the results obtained.

APPENDIX E

Standard Factors Used in Exposure Assessments

Standard Factors Used in Exposure Assessments

A. BIOLOGICAL PARAMETERS

Mass of Standard Humans[1]

male adult: 70 kg
female adult: 60 kg

Skin Surface Area[2]

1.8 m^2	-	totally exposed (man 180 cm high)
0.3 m^2	-	assuming short-sleeved, open-necked shirts, pants, shoes, with no gloves or hats
0.09 m^2	-	assuming long sleeved shirts, gloves, pants, shoes.

Effective Pore Size of Skin and Other External Membranes[3]

4 Angstroms (0.4 nm)

Amount of Food Consumption[4]

1500 gm/day (excluding beverages)

Drinking Water Consumption[5]

1.9 liters per day average with a range of 1 to 2.4 liters per day (2 liters per day is frequently used).

Respiratory Rate[5]

	Adult man	Adult woman	Child (10 yr)
minute volume (liters/min)			
resting	7.5	6.0	4.8
light activity	20.0	19.0	13.0
Liters of air breathed			
8 hr working "Light activity"	9,600	9,100	6,240
8 hr nonoccupational activity	9,600	9,100	6,240
8 hr resting	3,600	2,900	2,300

Size of Respirable Particulates (aerodynamic diameter)[3]

<1 µm : 100% reach the alveoli; 0% retention in nasal passage
2 µm : 80% reach the alveoli; 20% retention in nasal passage
5 µm : 50% reach the alveoli; 50% retention in nasal passage
>10 µm : almost complete retention in nasal passage
- mouth breathers can inhale particles up to 15 µm aerodynamic diameter

1980 U.S. Population by Age and Sex (in thousands)[6]

	Male	Female	Total
Total, all years	110,032	116,473	226,505
under 5 years	8,360	7,984	16,344
5-9 years	8,538	8,159	16,697
10-14 years	9,315	8,926	18,241
15-19 years	10,752	10,410	21,162
20-24 years	10,660	10,652	21,313
25-29 years	9,703	9,814	19,518
30-34 years	8,676	8,882	17,558
35-39 years	6,860	7,103	13,963
40-44 years	5,708	5,961	11,668
45-49 years	5,388	5,701	11,088
50-54 years	5,620	6,089	11,709
55-59 years	5,481	6,133	11,614
60-64 years	4,669	5,419	10,086
65 years and older	10,303	15,242	25,544
median age (yrs.)	28.8	31.3	30.0

Time Spent in Various Activities[7]

activity budget for 8 hr workday:	6 hr light work 2 hr heavy work
activity budget for 24 hr day:	12 hr rest 10 hr light work 2 hr heavy work

Birth Rate[5]

1980: 16.2 per 1,000 population

Death Rate[6]

1980: 8.9 per 1,000 population

Average Life Expectancy[6] (1980)

Male - 69.9 years

Female - 77.8 years

Employment by Industry (1980)[6]

	Total ($x 10^3$)	Percent Female
Agriculture, forestry, fisheries	3,470	19.5
Mining	940	13.5
Construction	6,065	8.0
Manufacturing	21,593	31.4
Transportation, communications, and other public utilities	6,393	25.2
Wholesale and retail trade	19,727	46.4
Wholesale trade	3,827	25.8
Retail trade	15,900	51.4
Finance, insurance, and real estate	5,860	58.2
Banking and other finances	2,504	65.7
Insurance and real estate	3,355	52.6
Services[a]	27,983	61.3
Business Services	2,308	45.1
Automobile services	924	12.6
Personal services[a]	3,738	73.2
Private households	1,229	88.3
Hotels and lodging places	1,106	65.2
Entertainment and recreation	1,017	39.1
Professional and related services	19,472	65.7
Hospitals	3,947	77.2
Health services except hospitals	3,281	74.3
Elementary, secondary schools	5,467	71.0
Colleges and Universities	2,066	48.8
Welfare and religious agencies	1,560	58.6
Public administration[b]	5,240	35.8

[a] Includes industries not shown separately

[b] Includes workers involved in uniquely governmental activities, e.g., judicial and legislative

Farms[5] (1980)

number of farms in the U.S. - 2.4×10^6
total farm acreage in the U.S. - 1×10^9 acres
average farm size in the U.S. - 430 acres

Total Land in U.S.[6]

2.3×10^9 acres

Home Gardens[8]

average size - 750 ft^2
annual value of home grown produce - $14 billion
percentage of U.S. household with gardens - 44%
total amount of land used as gardens - 6 million acres

House Size[9]

142 - 425 m^3

Building Size for Typical Endosed Production Facility[10]

7,000 - 26,000 m^3 (250,000 - 925,000 ft^3)

C. CHEMICAL PARAMETERS

pH Ranges for Various Water Quality Categories[11]

Category	Range
Recreation and Aesthetics	5.0 - 9.0
Public Water Supplies	6.0 - 8.5
Fish, Aquatic, and Wildlife	6.0 - 9.0
Marine and estaurine organisms	6.7 - 8.5
Wildlife	7.0 - 9.2
Fresh water organisms	6.0 - 9.0
Agricultural Use	5.5 - 9.0
Irrigation Water Supplies	4.5 - 9.0

D. PHYSICAL PARAMETERS

Air Change Rate (Home Dwelling)[9]

0.25 - 5 per hour

Characterization of Production Emissions[10]

Emission Route	% of Total Emissions of Air
Process Vents	66 - 70%
Fugitive Emissions	15 - 20%
Storage and Transportation	8 - 10%
Solid and Liquid Waste Stream Emissions	2 - 5%

Average Wind Speed[12]

5.5 m/sec

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