



# Ground-Water Monitoring Under RCRA

- BACKGROUND:** In developing a regulatory strategy for the disposal of hazardous waste under the Resource Conservation and Recovery Act (RCRA), protection of ground-water resources was the primary goal of the Environmental Protection Agency (EPA). EPA's ground-water protection strategy seeks to minimize the potential for hazardous wastes and hazardous constituents in waste placed in land disposal units to migrate into the environment. This is achieved through liquids management (limiting the placement of liquid wastes in or on the land, requiring the use of liners beneath waste, installing leachate collection systems and run-on and run-off controls, and covering wastes at closure). Ground-water monitoring serves to detect any failure in EPA's liquids management strategy so that ground-water contamination can be detected and addressed as soon as possible.
- STATUTE:** The Resource Conservation and Recovery Act (RCRA), Sections 3004 and 3005.
- REGULATIONS:** 40 CFR Part 264, Subpart F; 40 CFR Part 265, Subpart F; 40 CFR Part 270.
- REFERENCES:**
1. *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*, U.S. Environmental Protection Agency, PB 87-107751, September 1986.
  2. *Model RCRA Permit for Hazardous Waste Management Facilities*, U.S. Environmental Protection Agency, PB 90-210998, September 1988.
  3. "Statistical Methods for Evaluating Ground-Water Monitoring from Hazardous Waste Facilities," (53 FR 39723; October 11, 1988).
  4. *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Office of Solid Waste, Waste Management Division, U.S. Environmental Protection Agency, April 1989.
  5. *Alternate Concentration Limit Guidance, Part I – Policy and Information Requirements*, U.S. Environmental Protection Agency, 1987, (NTIS # PB87-206165).
  6. *Alternate Concentration Limit Guidance: Case Studies*, U.S. Environmental Protection Agency, 1988 (NTIS # PB88-214267).
  7. "RCRA Corrective Action Permit Requirements and Modifications Under Subpart F Regulations," EH-231 Information Brief, EH-231-022/0693, DOE Office of Environmental Guidance, RCRA/CERCLA Division, June 1993.
  8. "RCRA Corrective Action Variances from Subpart F Requirements," EH-231 Information Brief, EH-231-025/0793, DOE Office of Environmental Guidance, RCRA/CERCLA Division, July 1993.

## At what types of facilities must ground-water monitoring be performed?

Ground-water monitoring must be performed at RCRA-regulated hazardous and radioactive mixed waste management units/ facilities where hazardous waste is stored or disposed of in or on the land. Such units include interim status and permitted surface impoundments, landfills, and land treatment units (40 CFR 264.90, 265.90). Owners/operators of permitted waste piles are also required to perform ground-water monitoring unless they are granted an exemption (see below) [40 CFR 264.90(b)(5)].

Ground-water monitoring must be performed at miscellaneous units [40 CFR 264.90(d)] if necessary to meet the environmental performance standards specified in 40 CFR 264.601. Miscellaneous units can include, for example, geologic repositories or chemical, physical, or biological treatment units that are not tanks, surface impoundments, or land treatment units [52 FR 46953; December 10, 1987].

During the post-closure care period, ground-water monitoring must also be performed at hazardous waste management units such as tank systems or drip pads, where waste residues or contaminated soils remain after closure. Such units must close as land disposal units [40 CFR 264.110, 265.110, 270.14(b)(13)].

## Is it possible to obtain a waiver from ground-water monitoring requirements?

Owners/operators of interim status facilities may obtain a waiver from all or part of the ground-water monitoring requirements by demonstrating that there is a low potential for migration of hazardous waste or hazardous constituents from the facility via the uppermost aquifer to water supply wells or to surface water. This demonstration must be in writing, kept at the facility, and certified by a qualified geologist or geotechnical engineer. The demonstration must establish that there is a low potential for hazardous waste or hazardous constituents:

- to migrate from the facility to the uppermost aquifer and enter the uppermost aquifer and
- migrate to a water supply well or surface water [40 CFR 265.90(c)(1) & (2)].

In addition, ground-water monitoring requirements may be waived for interim status surface impoundments where the owner/operator can demonstrate that there is no potential for migration of hazardous wastes if the impoundments:

- are only used to neutralize wastes that are hazardous because they exhibit the characteristic of corrosivity or were listed for exhibiting this characteristic and
- contain no other hazardous wastes [40 CFR 265.90(e)].

A regulator may waive ground-water monitoring requirements for the following types of permitted units:

- engineered structures that do not receive liquid wastes and have inner and outer containment layers with a liquid detection system in each containment layer [40 CFR 264.90(b)(2)];
- units in which the regulator finds no potential for migration of liquids to the uppermost aquifer [40 CFR 264.90(b)(4)]; and
- during the post closure care period only, land treatment units with unsaturated (vadose) zone monitoring programs meeting the requirements of 40 CFR 264.90(b)(3).

(Reference 7 provides more detailed information about waivers of ground-water monitoring requirements at permitted units.)

### **What does a ground-water monitoring program at an interim status facility consist of?**

The ground-water monitoring program at an interim status facility must be capable of determining the facility's impact on the quality of the ground water in the uppermost aquifer underlying the facility [40 CFR 265.90(a)]. It may be divided into four phases. The following sections discuss these phases.

#### ***Development and Installation of a Monitoring System (40 CFR 265.91)***

The monitoring system must consist of *at least* four wells: one upgradient from the unit and three downgradient [40 CFR 265.91(a)]. The upgradient well(s) collect(s) ground-water samples that are representative of background ground-water quality in the uppermost aquifer near the facility and that are not affected by the facility. The downgradient wells collect ground-water samples that are tested for the presence of any statistically significant amounts of hazardous waste or hazardous constituents that migrate from the waste management area to the uppermost aquifer. A determination that the ground water is contaminated is based on a comparison of the data from upgradient and downgradient wells.

Separate monitoring systems for each waste management component of a facility are not required if the ground-water monitoring system is capable of detecting any discharge from the waste management area. At a facility with only one surface impoundment, landfill, or land treatment area, the waste management area is delineated by the waste boundary. The waste management area at a facility consisting of more than one surface impoundment, landfill, or land treatment area is described by an imaginary boundary line circumscribing the waste management components [40 CFR 265.91(b)]. (Detailed information with respect to the characterization of site hydrogeology and the placement of monitoring wells is available in Chapters 1 and 2 of reference 1.)

Monitoring wells must be cased to maintain the integrity of the monitoring well bore hole. Casings must be constructed to enable sample collection at depths where aquifer flow zones exist. The space between the bore hole and the well casing (annular space) must be sealed to prevent the contamination of samples and ground water [40 CFR 265.91(c)]. (The proper design and construction of monitoring wells is discussed in Chapter 3 of reference 1.)

The facility owner/operator must develop a ground-water monitoring, sampling, and analysis plan to be kept at the facility. The sampling and analysis plan must include procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, and chain of custody control. (Chapter 4 of reference 1 describes the preparation of ground-water monitoring sampling and analysis plans.)

#### ***Establishment of Background Ground-Water Quality (40 CFR 265.92)***

Monitoring at the upgradient well(s) must take place quarterly for a full year to establish background parameters indicating the suitability of the ground water as a source of drinking water [Appendix III to 40 CFR 265], establish the quality of the ground water [40 CFR 265.92(b)(2)], and establish the extent of ground-water contamination [40 CFR 265.92(b)(3)].

#### ***Detection Monitoring (40 CFR 265.92)***

After establishing background levels, detection monitoring examines ground water for elevated levels of indicator parameters that suggest that contamination may be occurring. After the first year all monitoring wells must be sampled and the samples analyzed with the following frequencies:

- Samples collected to establish ground-water quality must be obtained and analyzed at least annually.
- Samples collected to detect ground-water contamination must be collected at least semi-annually [40 CFR 265.92(d)].

Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained [40 CFR 265.92(e)]. (Continuous collection of information about ground-water elevation is necessary to determine if horizontal and vertical flow gradients have changed since the initial site characterization.)

During the detection monitoring phase, facility owners/operators must develop an assessment program outline to facilitate the timely implementation of an assessment monitoring program, if assessment monitoring becomes necessary (see below). The facility owner/operator must develop this outline within one year of becoming subject to the ground-water monitoring requirements. The assessment program described in the outline must be able to determine for hazardous waste or hazardous constituents :

- whether they have entered the ground water,
- their concentrations in the ground water, and
- their rate and migration in the ground water [40 CFR 265.93(a)].

#### ***Assessment Program (40 CFR 265.93)***

If the results of detection monitoring suggest that ground-water contamination has occurred, the facility owner/operator must institute an assessment monitoring program to determine the nature, extent, and rate of the ground-water contamination. Assessment monitoring must continue on a quarterly basis until the facility undergoes final closure or monitoring requirements are established in conjunction with obtaining a permit and/or performing corrective action. If no contamination has occurred, the owner/operator continues detection monitoring.

A facility must implement an assessment monitoring program if a comparison of background and detection monitoring results show a statistically significant increase for any indicator parameters (or decrease in the case of pH) in downgradient wells. (Sampling, analysis, and computation methods for determining whether increases or decreases are statistically significant are described in 40 CFR 265.93(b) - (d), Appendix IV to 40 CFR 265, and Chapter 5 of reference 1.)

Owners/operators must provide written notice to the regulator that the facility may be affecting ground-water quality within seven days of receiving results confirming a statistically significant increase for any indicator parameter (or decrease in the case of pH). Within 15 days of informing the regulator that the facility may be affecting ground-water quality, owners/operators must submit an assessment monitoring plan specifying:

- the number, location, and depth of wells;
- sampling and analytical methods for those hazardous wastes or hazardous constituents in the facility;
- evaluation procedures, including any use of previously gathered ground-water quality information; and
- a schedule for implementation [40 CFR 265.93(d)(1) - (3)].

An assessment of ground-water quality must begin as soon as technically feasible. A written report containing an assessment of the ground-water quality must be submitted to the regulator within 15 days of determining the concentration, fate, and extent of migration of hazardous waste or hazardous constituents in the ground water. Annually, until final closure of the facility, owners/operators must submit a ground-water quality assessment report that summarizes the results of the facility's ground-water assessment monitoring program [40 CFR 265.94 (b)(2)]. (Chapter 6 of reference 1 provides additional information about how to conduct assessment monitoring).

Before planning and implementing an assessment program, owners/operators who assume or know that ground-water monitoring, performed in accordance with 40 CFR 265.91 and 265.92, would show statistically significant increases (or decreases in the case of pH) for indicator parameters may install, operate, and maintain an alternate ground-water monitoring system provided that they comply with the provisions of 40 CFR 265.90(d)(1) - (5).

#### **What is the relationship of assessment monitoring to corrective action?**

Information developed in an assessment monitoring program is used by regulators to evaluate the need for corrective action at an interim status facility. The data may either be used to establish corrective action requirements in a facility's permit or to form the basis of an enforcement order under Section 3008(h) of RCRA, compelling corrective action prior to the issuance of a permit.

#### **What ground-water monitoring information must be submitted with RCRA Part B permit applications?**

Owners/operators of regulated units must submit the following information with RCRA Part B permit applications regarding protection of ground water:

- a summary of the ground-water monitoring data obtained during the interim status period;
- 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;
- delineation on a topographic map of the waste management area, property boundary, and proposed location of ground-water monitoring wells;
- a description of any plume of contamination that has entered the ground water from a regulated unit;
- detailed plans and an engineering report describing the proposed ground-water monitoring program; and
- sufficient information, data, and analyses to implement a detection, compliance, or corrective action monitoring program, whichever is applicable [40 CFR 270.14(c)].

Regulated units are defined as surface impoundments, waste piles, and land treatment units that received hazardous waste after July 26, 1982 (40 CFR 264.90).

A RCRA permit may mandate that detection, compliance, or corrective action monitoring, or any combination of these three types of monitoring be performed at a facility. If more than one type of monitoring program is included in the permit, the permit writer must specify the circumstances or conditions under which each program will be required [40 CFR 264.91(b); reference 2].

(Reference 7 provides information about the relationship between ground-water monitoring requirements and RCRA permits.)

#### **What is a detection monitoring program at a permitted facility?**

Detection monitoring is designed to detect a change in ground-water quality in wells surrounding a unit subject to the ground-water monitoring regulations. The ground water at the downgradient edge of the unit must be monitored for indicator parameters or constituents specified in the facility permit [40 CFR 264.98(a)]. These parameters and constituents are established by the permit writer based on information in the facility's waste analysis plan, waste characterization, site hydrogeologic characterization, and proposed plan for ground-water monitoring of waste parameters and constituents (reference 2).

Background levels must be established for each of the indicator parameters and constituents monitored in the detection program (40 CFR 264.97). The number and kinds of samples collected to establish background levels must be appropriate for the form of statistical tests used to determine if a contaminant release to ground water has occurred. The procedure must involve at least four samples, taken at an interval that assures that an independent sample is obtained each time [40 CFR 264.97(g)]. During detection monitoring, the background samples are then compared with downgradient samples using one of the statistical methods described in 40 CFR 264.97(h) to determine if ground-water contamination has occurred (40 CFR 264.97).

Detection monitoring continues during the active life of the unit and during the post-closure care period, unless compliance monitoring is triggered (see below) (40 CFR 264.98; reference 2).

#### **What is a compliance monitoring program at a permitted facility?**

A ground-water protection standard (GWPS) is established and included in a facility's permit when a statistically significant release is detected at the waste management unit boundary under a detection monitoring program (40 CFR 264.92). A compliance monitoring program determines whether a GWPS has been exceeded [40 CFR 264.99(a)].

The GWPS included in a permit consists of a list of hazardous constituents and concentration limits for which ground-water monitoring must be conducted, the point of compliance, and the compliance period (40 CFR 264.92). The list is composed of hazardous constituents that have been detected in the uppermost aquifer underlying the regulated unit that are reasonably expected to be in or derived from the waste from the unit [40 CFR 264.93(a)]. The concentration limits of the GWPS are set at background levels, maximum contaminant levels (MCLs), or alternate concentration limits (ACLs) [40 CFR 264.94(a)]. The constituent levels detected during compliance monitoring must be compared against the GWPS at least semi-annually using one of the statistical methods described in 40 CFR 264.97(h) [40 CFR 264.99(f)].

During compliance monitoring, the facility owner/operator is also required to perform additional investigations to characterize the nature and extent of contamination. Samples from all monitoring wells at the compliance point must be tested for all constituents contained in Appendix IX to Part 264 at least annually to determine whether additional hazardous constituents are present in the uppermost aquifer. If analyses confirm the presence of Appendix IX constituents that are not already identified in the permit as monitoring constituents, they must be reported to the regulator and added to the monitoring list [40 CFR 264.99(g) & (h)].

## What are MCLs and ACLs?

MCLs are the maximum permissible concentrations of 14 specific constituents in drinking water supplies as promulgated by EPA under the Safe Drinking Water Act. The constituents and their MCLs are listed in 40 CFR 264.94.

ACLs are site-specific alternative limits approved by the regulator and incorporated into the facility's permit. In approving an ACL, the regulator must find that the presence of the constituent in the ground water at a level below the ACL will not pose a substantial hazard to human health or the environment. In setting an ACL, the regulator must also consider potential adverse effects on ground-water quality and on the quality of hydraulically-connected surface water [40 CFR 264.94(b)]. EPA has issued guidance to assist regulators and owners/operators in determining when it may be appropriate to set ACLs (see references 5 and 6).

## How are Appendix VIII to 40 CFR 261 and Appendix IX to 40 CFR 264 different?

EPA developed the list of hazardous constituents in Appendix VIII to 40 CFR 261 to identify the universe of chemicals of concern under RCRA. The list is primarily used to determine if a waste should be considered for listing under 40 CFR 261.11. EPA's original ground-water monitoring regulations required owners/operators in a compliance monitoring program to analyze ground water for all constituents in the 40 CFR 261, Appendix VIII list. This led to a variety of problems because Appendix VIII includes listings that cover broad categories (e.g., chlorinated naphthalene, not otherwise specified), listings of compounds that decompose in water, and listings for which no analytical standard existed.

EPA promulgated Appendix IX to 40 CFR 264 to address the problems described above. Appendix IX includes both the compounds in Appendix VIII to 40 CFR 261 that are detectable in ground-water samples and compounds routinely monitored as part of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action. It lists the chemicals' common names, CAS numbers, SW-846 suggested test methods, and the practical quantitation limits (PQLs). PQLs are the lowest concentrations in ground water that reliably can be determined within specified precision and accuracy limits using the SW-846 suggested test method. Appendix IX to 40 CFR 264 lists the hazardous constituents that must be monitored on an annual basis by owners/operators of facilities in a compliance monitoring program.

## What is the point of compliance?

The point of compliance is the point in the ground water where the GWPS must be met. It is defined as the vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying regulated units (40 CFR 264.95). Owners/operators in a compliance monitoring program must install a ground-water monitoring system at the compliance point [40 CFR 264.99(b)]. An owner/operator must institute a corrective action program under 40 CFR 264.100 whenever hazardous constituents in ground water exceed concentration limits in the GWPS between the point of compliance and the downgradient facility property boundary (40 CFR 264.91).

## What is the compliance period?

The compliance period is the period during which the GWPS applies. It begins when the owner/operator initiates a compliance monitoring program and continues throughout the active life of the waste management area, including the closure period. If the owner/operator is engaged in a corrective action program at the end of the compliance period, the compliance period is extended until the owner/operator can demonstrate that the ground-water protection standard has not been exceeded for

three consecutive years (40 CFR 264.96). Thus, the compliance period can extend into and beyond the post-closure care period.

## What is a corrective action monitoring program at a permitted facility?

Corrective action is required when hazardous constituents exceed the GWPS at the point of compliance. The owner/operator is required to remedy the situation by removing hazardous constituents or treating them in place. The corrective action ground-water monitoring program must demonstrate the effectiveness of the corrective action program [40 CFR 264.100(d)].

## How do the ground-water protection programs for permitted and interim status facilities differ?

Requirements related to the development and installation of ground-water monitoring systems are similar at permitted and interim status facilities. At both interim status and permitted facilities, the ground-water monitoring system must consist of a sufficient number of properly located and constructed wells that are capable of ensuring that a release of hazardous wastes or hazardous constituents into ground water can be detected.

During detection monitoring, the primary difference between a ground-water monitoring program at a permitted facility and at an interim status facility is that at a permitted facility, the indicator parameters and constituents for which monitoring must be performed are specified in the facility's permit and based on a close examination of the wastes treated, stored, and disposed of at the facility. As a result, the list of parameters for which detection monitoring must be performed is generally much more extensive than the approximately 30 parameters for which detection monitoring must be performed at an interim status facility.

At permitted facilities, detection of a statistically significant change in the concentrations of monitored chemical parameters that could indicate a release leads to the implementation of a compliance monitoring program, and if necessary, a corrective action program. At interim status facilities, detection of statistically significant releases leads to the implementation of a ground-water quality assessment program and, if necessary, a corrective action program as specified in a RCRA Corrective Action Order [under Section 3008(h) of RCRA] or permitting of the facility (and a corrective action program as specified in the facility's permit).

Regulations applicable to the statistical methods used to evaluate ground-water monitoring data for hazardous constituents are more flexible and performance-oriented for permitted facilities than for interim status facilities [40 CFR 264.97(h) & (i), 265.93]. EPA has issued guidance to assist owners/operators in taking advantage of this flexibility (see reference 4). At the time these regulations were finalized for permitted facilities, EPA declined to revise them for interim status facilities because they believed that the majority of interim status land disposal facilities would be either permitted or closed by the time the new requirements became effective (53 FR 39723; October 11, 1988).

**Questions of policy or questions requiring policy decisions will not be dealt with in EH-231 Information Briefs unless that policy has already been established through appropriate documentation. Please refer any questions concerning the subject material covered in this Information Brief to Jerry Coalgate, RCRA/CERCLA Division, EH-231, 202-586-6075.**

