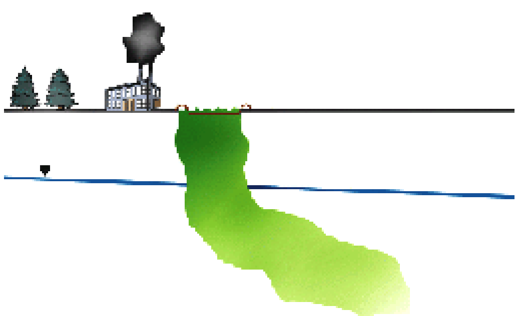
United States Environmental Protection Agency

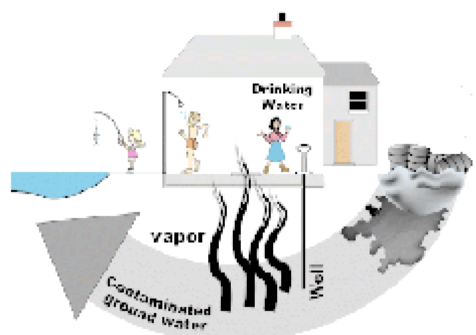
Solid Waste and Emergency Response (5303W)

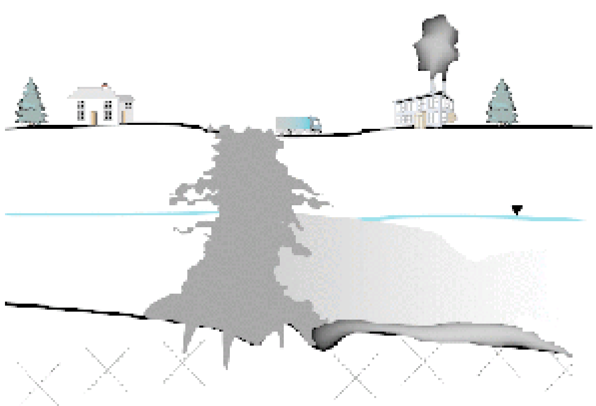
EPA530-R-04-030
April 2004*
http://www.epa.gov/correctiveaction

Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action

for Facilities Subject to Corrective Action Under
Subtitle C of the Resource Conservation and Recovery Act







* As described on page x of the Introduction, EPA intends to keep this Handbook current. This document is an update to the original version dated September 2001. This most recent revision provides (1) an update to section 15.0 - Completing Groundwater Remedies - in order to ensure that this Handbook is consistent with new guidance on completing corrective action at RCRA facilities (available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gen_ca/compfedr.pdf), and (2) updated internal navigational and external Internet links to ensure that resources and cited references are available to the reader. While this most recent version of the Handbook is dated April 2004, the date provided at the beginning of each policy section reflects the last time EPA made any substantive changes (i.e., beyond updating web links).

Acknowledgments

This Handbook was produced by EPA's Office of Solid Waste, Permits and State Program Division in conjunction with EPA Region III. Contributing authors include Guy Tomassoni from the Corrective Action Programs Branch, and Deborah Goldblum and Joel Hennessy from EPA Region III's Waste and Chemicals Management Division. We express a special thanks to Joel and Deborah for their expertise, time and dedication to this effort. We also thank Region III management, who supported their involvement. We also acknowledge and thank the individuals and organizations that provided comments and suggested improvements on previous draft versions.

Links to State Cleanup Programs

If you are viewing an electronic version,
you can click a button to take you to a topic of interest.

Links to EPA Regions

Handbook Overview

What does this Handbook do?
Who should use this Handbook?
Applicability to State Cleanup Programs
Roles and Responsibilities

Short Term Protection Goals including Environmental Indicators

Intermediate Performance Goals

Final Cleanup Goals including Remedy Selection

Future Policy (place holder)

Groundwater Cleanup Levels

Completing Groundwater Remedies

Groundwater Protection and Cleanup Strategy for RCRA Corrective Action

Point of Compliance

Performance Monitoring

Cleanup Timeframe

Reinjection of Contaminated Groundwater

Source Control

Technical Impracticability

Monitored Natural Attenuation

Institutional Controls

Groundwater Use Designations

References

Links to Internet Resources

Glossary

This page intentionally left blank.

Table of Contents

Overview

(September 2001)

What does this Handbook do?

This Handbook is designed to help you as a regulator, member of the regulated community, or member of the public find and understand EPA policies on protecting and cleaning up groundwater at Resource Conservation and Recovery Act (RCRA) corrective action facilities[1]. EPA developed this Handbook as part of the RCRA Cleanup Reforms (refer to Cleanup Reforms) that EPA announced in July 1999 and January 2001 (EPA, 2001d and EPA, 1999c). EPA's goal for this Handbook is to help meet the objectives of these reforms by reducing time-consuming uncertainties and confusion about EPA's policies concerning groundwater protection and cleanup at RCRA facilities. We believe clarifying EPA's groundwater policies will help promote faster, focused, and more flexible cleanups, and foster creative solutions.

This Handbook recommends that groundwater cleanups[2] generally be implemented in terms of short-term protection goals, intermediate performance goals, and final cleanup goals. EPA recommends that facilities, regulators, and members

Why is groundwater important?

Beneath the surface of the earth, a huge supply of fresh water is available to support the health and economic well-being of our country. More specifically,

- Groundwater supplies drinking water to half of the nation and virtually all people living in rural areas.
- Groundwater supplies the majority of water in streams and rivers in large areas of the country and provides much of the water in lakes and wetlands; these surface water bodies provide the balance of drinking water to those areas that do not rely on groundwater as their primary source for drinking water.
- Groundwater supports many billions of dollars worth of food production and industrial activity.

---

1 This Handbook primarily addresses corrective action as required by the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA. For additional background regarding RCRA in general, refer to the RCRA Orientation Manual (EPA, 1998a) available at http://www.epa.gov/epawaste/inforesources/pubs/orientat/. For more information about RCRA corrective action, refer to the corrective action Web site at http://www.epa.gov/correctiveaction. Additionally, an on-line introductory training on RCRA corrective action is available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/training.htm.

2 The terms cleanup or cleaning up, when used in this Handbook, refer to the range of activities that could occur in the context of addressing environmental contamination at RCRA facilities. For example, cleanup activities could include removing waste or contaminated media (e.g., excavation and pumping groundwater), in-place treatment of the waste or contaminated media (e.g., bioremediation), containment of the waste or contaminated media (e.g., barrier walls, low-permeable covers, and liners), or various combinations of these approaches. The term "cleanup" is often interchanged with the term "remediate" or "remediation."

of the public use these goals to focus discussions as well as resources, and to ultimately improve the quality of groundwater at and near corrective action facilities. EPA is issuing this Handbook to communicate what we believe should generally occur at RCRA corrective action facilities to protect human health and the environment.

What is the difference between statements in this Handbook and EPA statutory or regulatory requirements?

This Handbook provides guidance to EPA regional and State RCRA Corrective Action Program implementers, as well as to owners and operators of facilities subject to RCRA corrective action requirements, and to the general public. More specifically, this Handbook conveys how EPA generally expects to exercise its discretion in implementing RCRA statutory and regulatory provisions that concern RCRA corrective action. EPA designed this guidance to explain and clarify national policy on issues related to the protection and cleanup of groundwater at RCRA corrective action facilities.

The statutory provisions and EPA regulations discussed in this Handbook contain legally binding requirements. This Handbook itself does not substitute for those provisions or regulations, nor is it regulation itself. Thus, this Handbook does not impose legally binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the specific circumstances of the corrective action facility. EPA and State regulators retain their discretion to use approaches on a case-by-case basis that differ from this Handbook where appropriate. EPA and State regulators base their corrective action decisions on the statute and regulations as applied to the specific facts of the corrective action facility. Interested parties are free to raise questions and concerns about the substance of this Handbook and appropriateness of the application of recommendations in this Handbook to a particular situation. Whether or not the recommendations in this Handbook are appropriate in a given situation will depend on facility-specific circumstances.

Who should use this Handbook?

This Handbook is designed to help anyone who wants to develop a better understanding of EPA's groundwater cleanup policies for RCRA corrective action facilities. We wrote this Handbook for State and EPA regulators, owners and operators of facilities subject to RCRA corrective action, and members of the public. Throughout the rest of this Handbook we will refer to these three groups as "regulators," "facilities," and the "public," respectively. Sometimes, we will refer to all three groups collectively as "stakeholders."

How will this Handbook help me?

If you are a regulator, the Handbook can help clarify key groundwater-related policies that you should consider, where appropriate, to guide investigations and cleanups at your assigned facilities (via permits, orders, or voluntary actions). EPA designed this Handbook to help you do your part in promoting a technically sound, reasonable, and consistent approach to protecting and cleaning up our Nation's groundwater.

If you represent a facility, the Handbook can help you reduce your uncertainties about the actions a regulator may require of you. Reducing uncertainties can help you in your financial planning and project management. Clarity in EPA's expectations will allow you to phase your investigation and cleanup strategy in a manner consistent with the RCRA Corrective Action Program priorities. These policies can help if you are currently undergoing RCRA corrective action under some form of regulatory oversight, or if you intend to begin cleanup in advance of oversight by an EPA or State regulator.

If you are a member of the public, this Handbook can help you understand what EPA generally expects[3] regulators and facilities to do during an investigation and cleanup of contaminated groundwater at a RCRA corrective action facility. EPA encourages you to use this Handbook as a tool in your interaction with regulators or facilities. In essence, EPA wrote this Handbook, in part, to help you influence decisions related to groundwater protection and cleanup at RCRA corrective action facilities.

What does the RCRA Corrective Action Program do?

Accidents or other activities at RCRA facilities have sometimes resulted in releases[4] of hazardous waste or hazardous constituents into soil, groundwater, surface water, sediments, or air. The Corrective Action Program requires such facilities to conduct investigations and cleanup actions as necessary to protect human health and the environment. Currently, EPA believes that there are over 5,000 facilities subject to RCRA corrective action statutory authorities. Of these, approximately 3,700 facilities have corrective action already underway or will need to implement any necessary corrective action as part of the process to obtain a permit to treat, store, or dispose of hazardous waste. To help prioritize resources, EPA established specific goals for 1,714 facilities[5] that generally warrant attention in the next several years.

EPA's authority to require facility-wide corrective action comes from the Resource Conservation and Recovery Act (RCRA). The following specific sections of the RCRA statute that regulators use to require corrective action (or aspects of corrective action) include: §§3004(u)&(v), 3005(c)(3), 3008(h), 3013, and 7003. EPA's regulatory provisions for corrective action at permitted facilities are found primarily in 40 CFR Part 264 Subpart F. EPA provides additional direction on corrective action through guidance, policy directives, and related regulations. The most recent and comprehensive guidance issued for RCRA corrective action is in Section III (pages 19440 – 19455) of the May 1, 1996 Advance Notice of Proposed Rulemaking (ANPR; EPA, 1996a; see also EPA, 1997a).

---

[3] See glossary to definition of "remedy expectations" used in the context of the RCRA Corrective Program.

[4] See glossary definition of "releases."

[5] For additional information about the list of 1,714 facilities we call the "RCRA Cleanup Baseline," refer to http://www.epa.gov/epawaste/hazard/correctiveaction/pdfs/base_sta.pdf.

If you are relatively new to RCRA corrective action, you can learn more about the program by referring to the background information at http://www.epa.gov/epawaste/hazard/correctiveaction/programs

What are the general roles and responsibilities of various stakeholders involved with RCRA corrective action?

EPA Headquarters

EPA Headquarters oversees the national Corrective Action Program through its Office of Solid Waste and its Office of Site Remediation Enforcement. In general, major responsibilities of these offices for corrective action include: developing goals for the regional Corrective Action Programs and monitoring progress toward those goals; developing regulations, policies, and guidance on implementing corrective action; providing technical and policy assistance; acting as a liaison to other EPA programs (e.g., Superfund) and Federal Agencies (e.g., Departments of Defense and Energy) involved in cleanup issues; providing information and testimony to Congress; and, seeking input from outside stakeholders (e.g., regulated community, public interest groups, and environmental groups) to consider various and diverse interests.

Lead Regulators

Typically, there will be a "lead regulator" who is the first-line staff person for the government authority that is responsible for ensuring that a facility implements corrective action as necessary to meet facility-specific corrective action goals. The lead regulator could either be a Federal employee working in an EPA regional office or an employee of a particular State or Territory. The lead regulator is typically responsible for a variety of activities, including, for example:

- drafting permits, orders, or voluntary agreements;
- reviewing documents developed by the facility;
- recommending facility-specific approaches and, where appropriate, making decisions pertaining to a variety of corrective action issues; and
- ensuring the public has opportunities to provide input on corrective action issues.

EPA Regional Offices

Staff within EPA's 10 regional offices (http://www.epa.gov/epawaste/hazard/correctiveaction/facility/index.htm#Contacts) be the lead regulator for facilities located in States that have not yet been authorized (see discussion below regarding States and Territories) to implement corrective action. Sometimes, EPA may continue carrying out lead regulator responsibilities during early stages of a newly authorized State cleanup program. EPA staff may also be the lead regulators on specific corrective action enforcement issues (e.g., issuing administrative orders) in both authorized and unauthorized States.

EPA's regional offices are also responsible for overseeing State programs in situations where the State has the lead role for implementing corrective action. Responsibilities of that oversight role include, for example: establishing goals, tracking progress, and reporting progress to EPA Headquarters; developing and distributing guidance; contributing to EPA Headquarters initiatives (e.g., supplying comments on guidance and regulations); conducting training; and providing facility-specific assistance on technical, policy, and public participation issues.

States and Territories

Staff within State or territorial cleanup programs are typically the lead regulators for overseeing corrective action at particular facility when: (1) EPA has authorized the State Corrective Action Program, or (2) an EPA regional office has entered into a "worksharing agreement" with either an unauthorized or authorized State program. EPA Headquarters supports the variety of creative approaches EPA regions and States/Territories use to work together toward achieving corrective action goals.

As of September 2001, EPA has authorized 38 States and Territories for facility-wide corrective action under RCRA §3004(u). EPA's authorization of a State Corrective Action Program is based on a determination that the State is capable of implementing corrective action equivalently to EPA, and in a manner consistent with applicable Federal statutes, regulations, and guidance. These authorized States have the primary responsibility for corrective action at hazardous waste treatment, storage, and disposal facilities (TSDFs). This responsibility includes making decisions dealing with the policies addressed in this Handbook.

Federally Recognized Indian Tribes

In keeping with the EPA Policy for the Administration of Environmental Programs on Indian Reservations (EPA, 2001a), EPA is committed to ensuring that Tribes play an active role in RCRA corrective action when Tribal rights and interests are at stake. This commitment is clearly present when EPA personnel serve as lead regulators for a given facility – especially when the facility is located on Tribal or Federal lands. However, the commitment is also present when Tribes are potentially affected by facilities regulated by authorized non-Federal regulators. While Tribal members are able to participate as part of the established RCRA public involvement activities, Tribal governments have a unique status and can play a more significant role. Although EPA cannot authorize a Tribe to be a lead regulator, the Agency can enter into cooperative agreements with the Tribe, ensure the Tribe has full access for meaningful participation in corrective action activities, and give the Tribe's concerns special consideration throughout the regulatory process.

Facilities

Facilities subject to RCRA corrective action are responsible for conducting investigations and cleanups as necessary to protect human health and the environment. Facilities subject to a permit, order, or sometimes even a voluntary agreement typically present their recommendations for investigation and cleanup activities to the lead regulator for review and approval. However, many facilities are also proactively conducting investigations and cleanup actions in advance of oversight[6] by a State or EPA regulator. Additionally, many facilities are also assuming greater responsibility to involve the public throughout corrective action.

> **Who is the public?**
>
> The "public" in the context of RCRA refers not only to private citizens, but also representatives of consumer, environmental, and minority associations; trade, industrial, agricultural, and labor organizations; public health, scientific, and professional societies; civic associations; public officials; and government and educational institutions.

Public

EPA strongly encourages the public to be involved with corrective action to help ensure protection of human health and their environment. The RCRA statute and EPA's regulations and detailed guidance describe a variety of public involvement opportunities and activities. The following are just some of the actions you (see highlight box) can take to help influence corrective action decisions:

- Find out if a particular facility of interest is on the list of facilities EPA believes warrant attention in the next several years (http://www.epa.gov/epawaste/hazard/correctiveaction/pdfs/base_sta.pdf).

- Contact the State or EPA region to identify the lead regulator and ask for your name to be placed on mailing lists for notices, fact sheets, and other documents distributed by EPA, the State, or the facility; and

- Actively participate in public hearings and other meetings.

For a more complete list of activities as well as other detailed guidance pertaining to public participation, you should refer to EPA's 1996 RCRA Public Participation Manual (EPA, 1996d) available at http://www.epa.gov/epawaste/hazard/tsd/permit/pubpart/manual.htm. You can also contact EPA regional and State offices to determine whether they have additional guidance concerning public

---

[6] To avoid duplicating efforts and to ensure compliance with applicable laws and regulations, EPA strongly recommends that facilities conducting cleanup actions without oversight by an EPA or State regulator do so with a clear understanding of applicable State and EPA requirements and implementation guidance. In particular, facilities should be fully aware of requirements associated with managing remediation waste. For more information about Federal requirements and implementation guidance associated with remediation waste, you should refer to http://www.epa.gov/epawaste/hazard/correctiveaction/facility/index.htm#Feds

involvement at corrective action facilities.

How do the policies in this Handbook apply to State cleanup programs?

EPA expects States to consider this guidance carefully when they have a lead role in implementing cleanups at RCRA corrective action facilities. However, as mentioned previously, this document reflects Agency guidance and is not a binding statute or regulation. Therefore, States have considerable latitude in making decisions that would lead to equivalent levels of protection EPA would achieve if the Federal Government were implementing the program. Also, it is extremely important that Handbook users consult with the appropriate State cleanup program prior to conducting corrective action to ensure that State requirements and guidance are addressed. Some specific examples you should be aware of with regard to State cleanup programs include:

- Some States have their own specific requirements regarding administrative procedures and cleanup criteria (e.g., primary and secondary drinking water standards, risk levels, and exposure scenarios for closing waste management units); such States may not be able to take advantage of some of the approaches described in this Handbook.

- Regulators (both State and Federal) typically make investigation and cleanup decisions on a case-by-case basis; therefore, a particular approach used at one facility may be inappropriate at another facility.

How is this Handbook organized?

EPA organized this Handbook to address its overall implementation strategy for contaminated groundwater and to summarize and clarify policies that are often the subject of questions and confusion. While some topics deal with broader issues, the primary focus of this Handbook is on groundwater. Furthermore, the topics addressed in this Handbook predominantly were designed to address facilities undergoing facility-wide corrective action under §3004(u) and (v), and §3008(h), which were enacted as part of the Hazardous and Solid Waste Amendments (HSWA) to RCRA. However, the policies on groundwater cleanup levels and point of compliance address some questions

TOPICS PRESENTED*

- Groundwater Protection and Cleanup Strategy
- Short-Term Protection Goals
- Intermediate Performance Goals
- Final Cleanup Goals
- Groundwater Cleanup Levels
- Point of Compliance
- Cleanup Timeframe
- Source Control
- Groundwater Use Designations
- Institutional Controls
- Monitored Natural Attenuation
- Technical Impracticability
- Reinjection of Contaminated Groundwater
- Performance Monitoring
- Completing Groundwater Remedies

* See discussion on page x of this overview section (or click here) to see how EPA intends to keep this Handbook current.

unique to corrective action at RCRA regulated units[7]. You should be aware that 40 CFR Part 264, Subpart F includes specific groundwater monitoring and corrective action requirements for RCRA regulated units[8].

Note that key topics mentioned within the text are often underlined and "hyperlinked." This feature allows you to recognize and quickly go to topics that are expanded elsewhere in the Handbook.

Where do the policies in this Handbook come from?

Most of the topics in this Handbook are already addressed in an existing EPA guidance document, directive, or memorandum. We do not intend for this Handbook to replace previous guidance, but it does reflect EPA's latest thinking on groundwater policies for RCRA corrective action.

You will notice that many of the policies come from Section III of the May 1, 1996 Advance Notice of Proposed Rulemaking (ANPR; EPA, 1996a). EPA issued the ANPR, in part, to seek public comment on how to address the proposed regulations for corrective action (55 FR 30798, July 27, 1990; EPA, 1990c). After considering comments on the ANPR, EPA opted against finalizing these regulations because, among other things, the Agency decided it was not necessary for successful implementation of the program. In fact, since a majority of the States and Territories were already authorized to implement facility-wide corrective action in lieu of EPA, and several others were seeking authorization, EPA decided that issuing corrective action regulations would be unnecessarily disruptive. In an October 7, 1999 Federal Register Notice (64 FR 54604; EPA, 1999a), EPA announced its withdrawal of most of the provisions of the 1990 proposed corrective action regulations. In this notice, EPA stated that rather than issuing a rule to achieve consistency at all facilities, it would be more appropriate to develop guidance and training to promote consistency, where appropriate. This Handbook is an example of such guidance.

The October 7, 1999 notice also stated that Section III of the ANPR should serve as the primary corrective action implementation guidance. For that reason, the ANPR is a key reference for many of the topics in this Handbook. Section V of the ANPR requested comments on a number of topics addressed in this Handbook, such as the point of compliance. This Handbook does not foreclose

---

[7] Regulated Units are defined in 40 CFR 264.90 (available through http://www.gpoaccess.gov/cfr/retrieve.html) as surface impoundments, waste piles, land treatment units, and landfills that received hazardous wastes after July 26, 1982.

[8] The Post-Closure Regulations (EPA, 1998d), 63 FR 56710, October 22, 1999 (available at http://www.epa.gov/fedrgstr/EPA-WASTE/1998/October/Day-22/f28221.pdf) provides flexibility for regulators to replace requirements, associated with regulated units, for groundwater monitoring and corrective action for releases to groundwater in certain circumstances (see 264.90(f)). EPA encourages States to adopt and seek authorization for this provision, either separately or as part of the full post-closure rule; but, some States might choose not to adopt all or parts of this rule. Pending authorization or adoption for this portion of the post-closure rule, States authorized for corrective action would be able to implement the provision if they could do so as a matter of State law, and they implemented it in a way that was no less stringent than Federal requirements. For more detail on authorization for the post-closure rule see the preamble to the rule.

further discussion of issues raised for comment in the ANPR, or any other issue discussed in this Handbook, and EPA intends to update this Handbook as the Corrective Action Program continues to evolve.

EPA recognizes that some elements in this Handbook may appear new because of the names used to describe them. For example, "Intermediate Performance Goals" is a term introduced in this Handbook; however, it is consistent with the phased approach to corrective action that EPA emphasized in the ANPR and other guidance going back to the early 1990s (EPA, 1991a and EPA, 1990a).

You may also notice that the choice of words to describe a policy in this Handbook may differ from the words in the ANPR or another original source of the policy; however, the substance of the policy remains the same. There are two primary reasons for this difference. First, we wrote this document in "plain language" and second, the terminology in RCRA is evolving.

"Plain language" uses everyday words, active voice, and shorter sentences. EPA has used this style to help make documents easier to read and more understandable. While it may appear at times that EPA has changed its position on a particular topic because we are using different words in this Handbook, the policy is actually still the same. For example, the Handbook recommends several factors for assessing use, value, and vulnerability of groundwater. These factors are the same factors as those listed in the Comprehensive State Groundwater Protection Program ("CSGWPP") Guidance (EPA, 1992a) except we modified the words to meet the goals of plain language.

Another source of perceived change stems from the maturing of RCRA corrective action terminology[9]. As the program has evolved, so have RCRA definitions. For example RCRA's early guidance, Subpart S (EPA, 1990c) and the ANPR, refer to point of compliance only in the context of final cleanup. We now formally recognize that the concept of "point of compliance" can be used in the context of short-term, intermediate, and final cleanup goals. We made this change because we recognized that the general definition of point of compliance for groundwater applies to a variety of situations where regulators require facilities to achieve certain concentrations of chemicals in groundwater.

Are the policies contained in this Handbook consistent with EPA's other cleanup programs?

The basic approaches described in this Handbook are consistent with EPA's Superfund, Underground Storage Tank, and Brownfields cleanup programs. Much of the Handbook is derived from guidance developed jointly by EPA's cleanup programs (e.g., Use of Monitored Natural Attenuation at Superfund, RCRA and Underground Storage Tank Sites (EPA, 1999d)). This Handbook, therefore, is consistent with EPA's long-standing goal for EPA's cleanup programs to yield similar remedies in similar circumstances. To learn more about RCRA-CERCLA coordination issues, you should refer to "Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities" (EPA,

[9] Some States may have their own terms to describe similar concepts addressed in this Handbook.

1996b) available at www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gen_ca/coordmem.pdf and the RCRA-CERCLA deferral policy found in 54 FR 41004-41006 (October 4, 1989b). For more detailed information about EPA's Superfund, Underground Storage Tank, and Brownfields cleanup programs, you can link to their respective Internet Web sites found in Appendix 2.

How will I know that the policies in this Handbook are current?

As necessary, EPA intends to maintain this Handbook as a living document by adding new topics, new policies, or by changing or clarifying existing policies. Since this Handbook is guidance, EPA may make such revisions without public notice. Therefore, if you are reading a printed copy of this Handbook, we urge you to access the electronic version available via the Internet at http://www.epa.gov/correctiveaction/. The front page of the Internet version will indicate the most recent date EPA revised the Handbook. Additionally, the top of each policy section includes the date of the most recent revision. You should compare this date to the Internet version to ensure that you are reading the Agency's most current guidance.

How can I get further information about the policies in this Handbook?

You can get further information on policies in this Handbook in several ways. You can refer to the references at the end of each policy or to the complete list of references at the end of the Handbook in Appendix 1. Note that most references provide an Internet Web address and a "hotlink" that allows you to directly access the document of interest. You can also get more information by contacting individuals in EPA regional or State cleanup programs. If you are viewing this document electronically and have access to the Internet, you can press the link to State or EPA program buttons on the interactive button page at the beginning of the Handbook to guide you to contacts in EPA or State offices. Internet Web links are also provided in Appendix 2 to help you find more information. Lastly, if you are uncertain of a meaning of a term, you can refer to the glossary provided in Appendix 3.

What if I have comments on this Handbook?

EPA welcomes public comments on this Handbook at any time and will consider those comments in any future revisions. You can submit your comments to:

Corrective Action Programs Branch (mail code 5303W)
Permits and State Programs Division
Office of Solid Waste
US Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue
Washington, DC 20460

References:

EPA, 2001a. EPA Indian Policy (July 11). Available at http://www.epa.gov/indian/pdfs/reaffirmindpol01.pdf.

EPA, 2001d. RCRA Cleanup Reforms Round II - Fostering Creative Solutions (EPA/530/F-01/001, January). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/reforms/index.htm.

EPA, 1999a. Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities (64 FR 54604, October 7).

EPA, 1999b. Safe Drinking Water Act, Section 1429 Groundwater Report to Congress. EPA-816-R-99-016; October, 1999. Available at http://www.epa.gov/ogwdw000/gwr/finalgw.pdf.

EPA, 1999c. RCRA Cleanup Reforms (EPA/530/F-99/018). For more information, refer to http://www.epa.gov/epawaste/hazard/downloads/factsheet1.pdf.

EPA, 1999d. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites (April 21). OSWER Policy Directive 9200.4-17P. Available at http://www.epa.gov/swerust1/directiv/d9200417.htm. Other helpful links regarding MNA available at http://www.epa.gov/swerust1/cat/mna.htm and http://www.epa.gov/swerust1/oswermna/mnalinks.htm

EPA, 1998a. RCRA Orientation Manual (EPA/530/R-98/004). Available at http://www.epa.gov/epawaste/inforesrources/pubs/orientat/index.htm.

EPA, 1998d. Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities: Post-Closure Permit Requirement and Closure Process; Final Rule (63 FR 56710). Available at http://www.epa.gov/fedrgstr/EPA-WASTE/1998/October/Day-22/f28221.pdf.

EPA, 1997a. Memorandum from Elliott P. Laws and Steven A. Herman to RCRA/CERCLA Senior Policy Managers titled, "Use of the Corrective Action Advance Notice of Proposed Rulemaking as Guidance" (January 17). Available at http://yosemite.epa.gov/osw/rcra.nsf/documents/8BF009F9B3672563852566110072DA71.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages: 19440-55.

EPA, 1996b. Memorandum from Steven A. Herman and Elliott P. Laws to RCRA/CERCLA Senior Policy Managers titled, "Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities" (September 24). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gen_ca/coordmem.pdf.

EPA, 1996d. RCRA Public Participation Manual (EPA/530/R-96/007). Available at http://www.epa.gov/epawaste/hazard/tsd/permit/pubpart/manual.htm. Particularly relevant pages: 2.5-2.7.

EPA, 1992a. Final Comprehensive State Groundwater Protection Program Guidance (EPA/100/R-93/001). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/csgwpp.htm.

EPA, 1991a. Managing the Corrective Action Program for Environmental Results: The RCRA Stabilization Effort (October 25). Available at http://yosemite.epa.gov/osw/rcra.nsf/d8382df2d09b646685256528005197452/7d1baa5c1dbb8f38525670f006be76d?OpenDocument.

EPA, 1990a. The Nation's Hazardous Waste Management Program at a Crossroads: The RCRA Implementation Study (EPA/530/SW-90/069).

EPA, 1990c. Corrective Action for Solid Waste Management Units at Hazardous Waste management Facilities; Proposed Rule (55 FR 30798, July 27).

EPA, 1989b. National Priorities List for Uncontrolled Hazardous Waste Sites – Final Rule Covering Sites Subject to the Subtitle C Corrective Action Authorities of the Resource Conservation and Recovery Act (commonly referred to as the RCRA Deferral Policy). Available in Section V which appears on 54 FR 41004-41006. Available at http://www.epa.gov/superfund/sites/npl/f891004.htm#41000.

1. Groundwater Protection and Cleanup Strategy
(September 2001)

What is EPA's groundwater protection and cleanup strategy for RCRA corrective action?

EPA's groundwater strategy generally is to:

- focus resources at facilities that warrant attention in the near term;
- control short-term threats;
- prioritize actions within facilities to address the greatest risks first; and
- make progress toward the ultimate goal of returning contaminated groundwater to its maximum beneficial use[1].

This strategy guides regulators and facilities toward achieving environmental results rather than following any particular administrative process, and emphasizes clear communication among all stakeholders. This strategy is consistent with the phased approaches recommended in past Agency guidance (EPA, 1990a; EPA, 1991a; EPA, 1994b, EPA, 1996a; EPA, 1996c, and others), and is also consistent with EPA's overall groundwater protection and cleanup goals described below.

How does this strategy benefit the public, regulators, and facilities?

This strategy benefits the public because it promotes early actions and continued progress toward our overall groundwater protection and cleanup goals. Regulators benefit because it helps them focus their oversight resources on defining, tracking, and, if necessary, enforcing measurable milestones. Facilities benefit because the strategy helps them plan for investigation and cleanup actions.

Rationale for Groundwater Protection and Cleanup Strategy

Based on EPA's experience with environmental cleanups over the past 20 years, it is clear that addressing contaminated groundwater is challenging from both a resource and technology perspective. Therefore, EPA believes its strategy involving short-term, intermediate, and final goals provides a realistic approach that focuses resources on the greatest threats first and emphasizes results rather than a particular process. This strategy emphasizes protection and cleanup of groundwater by using meaningful and measurable milestones, as well as clear and effective communication.

What is EPA's overall goal for groundwater protection and cleanup?

[1] EPA recognizes that groundwater serves a variety of uses and purposes, including for example, drinking water, agricultural irrigation, and discharge to adjacent groundwater and surface water bodies. As such, EPA also recognizes that there could be a variety of ways humans as well as ecological receptors (including aquatic fauna residing in groundwater) can be exposed to contaminated groundwater. Within the range of reasonably expected uses and exposures, the maximum beneficial groundwater use is the one that warrants the most stringent groundwater cleanup levels and approaches.

EPA's overall goal with respect to groundwater is to prevent adverse affects to human health and the environment, which includes protecting the integrity of the nation's groundwater resources, both now and in the future (EPA, 1991b). EPA believes that short-term prevention and long-term cleanup goals are both essential elements of a strategy designed to achieve this overall goal.

With respect to prevention, we should protect groundwater to: (1) ensure that the nation's public and private drinking water supplies, including those currently used as well as those reasonably expected to be used, do not cause adverse health effects both in the short term as well as for future generations; and, (2) avoid negative impacts to ecosystems such as those caused by contaminated groundwater flowing into surface water (EPA, 1991b).

With respect to cleanup of contaminated groundwater, facilities as well as regulators should generally: (1) prioritize cleanup activities to limit the risk to human health first; and then, (2) restore[2] currently used and reasonably expected sources of drinking water and groundwater closely hydraulically connected to surface waters, whenever such restorations are practicable and attainable (EPA, 1991b).

Stakeholders evaluating appropriate prevention and cleanup strategies should consider use, value and vulnerability of the groundwater resources, as well as social and economic values. For more information regarding this overall goal, refer to "Protecting the Nation's Groundwater: EPA's Strategy for the 1990's" (EPA, 1991b). The groundwater protection and cleanup strategy presented in this Handbook supports EPA's overall groundwater goals.

How should facilities and regulators implement this groundwater protection and cleanup strategy for RCRA corrective action?

EPA recommends that regulators and facilities implement this strategy in terms of short-term protection goals, intermediate performance goals, and final cleanup goals. You can find more detailed descriptions of these goals later in this Handbook.

How do short-term, intermediate and final cleanup goals work together to achieve EPA's overall groundwater goals?

EPA believes its strategy (see Figure 1) to implement corrective action in terms of short-term, intermediate, and final cleanup goals is an efficient and effective way to satisfy RCRA's statutory mandate to protect human health and the environment both now and in the future. EPA does not view these three goals as discrete elements; rather, EPA designed them to support each other toward achieving EPA's overall groundwater protection and cleanup goals.

---

[2] The term "restore" or "restoration" used in this context refers to achieving a certain cleanup level(s) developed to ensure protection based on maximum beneficial use of the groundwater at a particular facility. Restoring contaminated groundwater does not necessarily imply cleanup to pristine conditions.

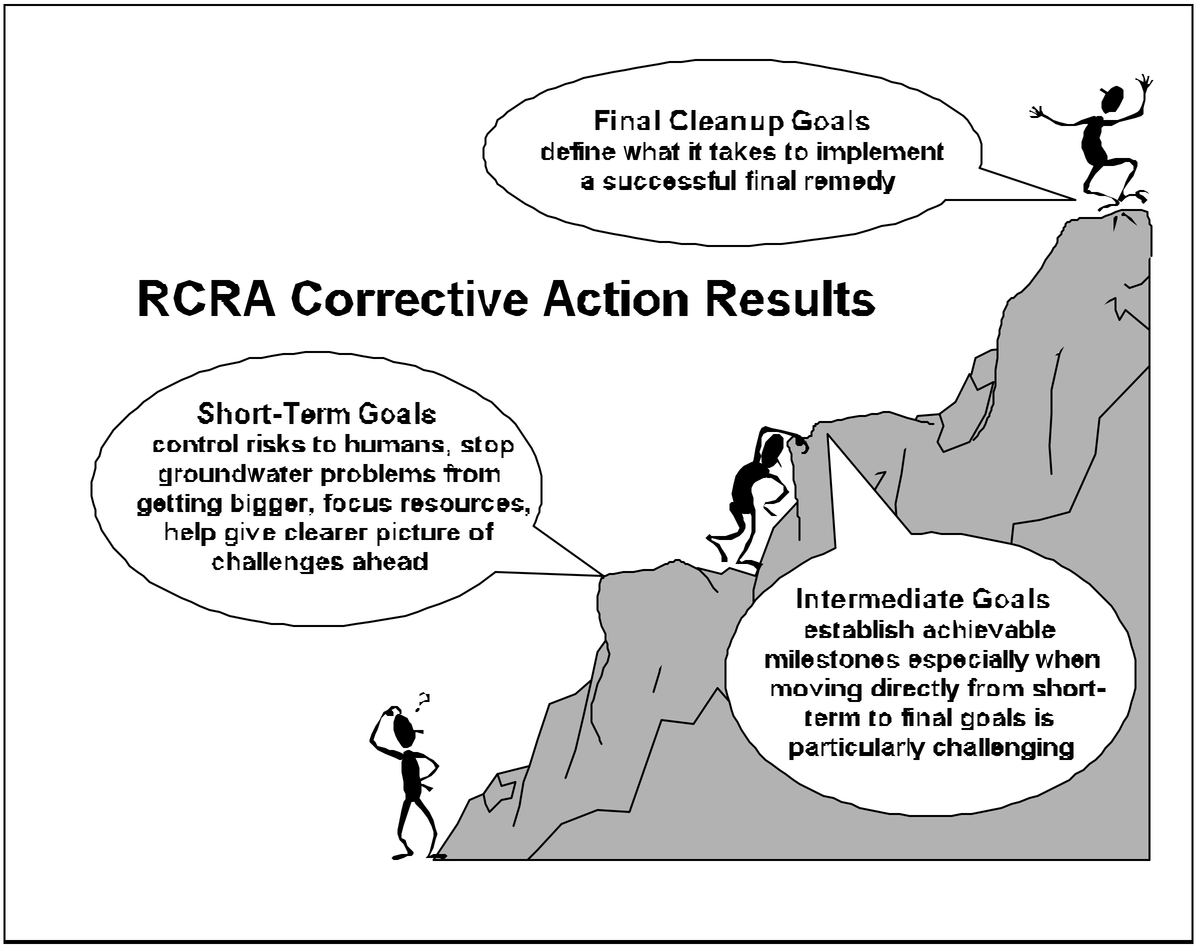


Figure 1: Relationship between short-term, intermediate, and final corrective action cleanup goals.

In the short-term[3], EPA believes it is important that facilities take actions as soon as possible to ensure that (1) humans are not being exposed to unacceptable levels of contamination, and (2) contaminated groundwater is not continuing to migrate beyond its current extent[4]. EPA measures these short-term protection goals with two environmental indicators[5] called "Current Human Exposures Under Control" and "Migration of Contaminated Groundwater Under Control" (EPA, 1999e). EPA has found that these environmental indicators are proving to have benefits beyond just demonstrating facilities are meeting these two important goals. For example, clear, achievable, and meaningful milestones associated with environmental indicators help promote effective working relationships between

[3] Short-term in this context refers to the Corrective Action Program's Year 2005 goals EPA established in response to the Government Performance and Results Act. Refer to the Short-Term Protection Goals section of this Handbook for specific information pertaining to these short-term goals.

[4] Cleaning up contaminated groundwater can be very challenging; therefore, this element of the overall strategy is designed to prevent existing problems associated with contaminated groundwater from getting worse.

[5] You can learn more about these two indicators at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/index.htm.

stakeholders. These relationships often foster creative, results-based approaches that are increasing the overall pace, efficiency and effectiveness of subsequent actions leading to final cleanup goals. Furthermore, the actions facilities take to achieve these goals should often help them achieve the final goals. For example, stopping a plume of contaminated groundwater from getting bigger in the short term limits the extent of the problem the facility will have to address to achieve final cleanup goals.

With respect to final cleanup goals for contaminated groundwater, EPA expects[6] to return usable groundwater to its maximum beneficial use wherever practicable within a timeframe that is reasonable given the particular circumstances of the facility. EPA recognizes, however, that some States determine that certain groundwater is either not usable and/or they have no intention to use it in the foreseeable future[7]. For such situations, EPA acknowledges that final cleanup goals such as source control and long-term plume containment may provide an appropriate level of protection to human health and the environment (EPA, 1996c and 1997b). However, prior to selecting such alternatives, regulators should ensure that other exposures to contaminants in or from groundwater do not exist and the groundwater is not used for purposes not recognized in, for example, a "non-use" State designation. Regardless of the approach, clear final cleanup goals are important because they provide the target to which regulators and facilities should focus their activities. Establishing clear final cleanup goals should also help facilities determine what they will have to do to implement a successful final remedy.

Intermediate performance goals can often serve as helpful milestones between short-term and final cleanup goals. EPA recognizes, as does the general scientific community (NRC, 1994), that achieving cleanup goals for contaminated groundwater can be very challenging. For some facilities, these challenges can appear to be so insurmountable that moving directly to, for example, returning all of the contaminated groundwater to its maximum beneficial use diminishes the ability of regulators and facilities to identify a realistic path forward. Therefore, for such facilities, EPA recommends that facilities and regulators consider developing a series of facility-specific intermediate performance goals designed to promote continuous progress toward the final cleanup goals.

How should facilities and regulators implement these goals?

EPA recommends that facilities implement short-term protection, intermediate performance, and final cleanup goals in terms of clearly defined, facility-specific media cleanup objectives. These objectives typically include elements that clearly define "what, where, and when." The first element defines what action the facility should conduct. The second element defines where the specific action should take

---

[6] See glossary for definition of "remedy expectations" used in the context of the RCRA Corrective Action Program.

[7] EPA recognizes that most States classify the majority of their groundwater as potential sources of drinking water. Refer to the Final Remedy, Point of Compliance and Groundwater Use Designation sections of this Handbook for further discussion on final cleanup goals, the role of groundwater use in the RCRA Corrective Action Program, and additional guidance concerning groundwater use decisions and exposures associated with various uses/purposes of groundwater.

place. The third element defines when the facility should implement and complete an action.

Along with defining “what, where, and when,” EPA also recommends that facilities and regulators describe actions in terms of “who, why, and how.” Describing “who” performs an action helps communicate to the public the different roles and responsibilities of the facility and the regulator. Describing “why” provides the opportunity to explain the relationship between particular actions and how they help achieve short-term, intermediate, or final goals. And lastly, describing “how” ensures that stakeholders understand the techniques and approaches that a facility will use to implement an activity.

Implementing goals in terms of “what, where, and when” is not a new approach to corrective action but rather a clarification of “cleanup objectives” as described in the May 1, 1996 Advance Notice of Proposed Rulemaking (ANPR - EPA, 1996a; page 19449). For example, to measure achievement of final groundwater cleanup goals, the ANPR described final cleanup objectives in terms of (1) groundwater cleanup levels, (2) the point of compliance, and (3) cleanup timeframes[8] (see EPA, 1996a - page 19449). For such final groundwater remedies, groundwater cleanup levels represent the “what,” point of compliance represents the “where,” and cleanup timeframes represent the “when” associated with implementing a groundwater remedy and estimates on how long it would take to achieve the final cleanup goals.

EPA encourages facilities and regulators to describe short-term, intermediate, and final cleanup goals in terms of “what, where, when, who, why, and how” to enhance and clarify communication among all stakeholders.

References:

EPA, 1999e. Interim Final Guidance for RCRA Corrective Action Environmental Indicators (February 5). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/ei_guida.pdf.

EPA, 1997b. Rules of Thumb for Superfund Remedy Selection (EPA/540/R-97/013). Available at http://www.epa.gov/superfund/resources/rules/rulesthm.pdf. Particularly relevant page: 17.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages: 19440-55.

EPA, 1996c. Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites (EPA/540/R-96/023, October). Available at http://www.epa.gov/superfund/resources/gwguide/index.htm. Particularly relevant pages: 15-17.

[8] Previous guidance (EPA, 1996a) referred to “Cleanup timeframes” as compliance timeframes.

EPA, 1994b. The RCRA Corrective Action Plan (EPA/520/R-94/004, May). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gen_ca/rcracap.pdf.

EPA, 1991a. Managing the Corrective Action Program for Environmental Results: The RCRA Stabilization Effort (October 25). Available at http://yosemite.epa.gov/osw/rcra.nsf/d8382df2d09b6466852565280051974527d1baa5c1dbb8f38525670f006be76d?OpenDocument.

EPA, 1991b. Protecting the Nation's Groundwater: EPA's Strategy for the 1990's. Office of the Administrator. Washington, D.C. Available at http://www.epa.gov/superfund/resources/remedy/pdf/21z-1020-s.pdf.

EPA, 1990a. The Nation's Hazardous Waste Management Program at a Crossroads: The RCRA Implementation Study (EPA/530/SW-90/069).

NRC, 1994. *Alternatives for Ground Water Cleanup* / Committee on Ground Water Cleanup Alternatives, Water Science and Technology Board, Board on Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, National Research Council. National Academy Press, 1994. Available at http://www.nap.edu/books/0309049946/html/.

2. Short-Term Protection (Environmental Indicator) Goals
(September 2001)

What are EPA's short-term protection goals for groundwater?

EPA's short-term goals associated with groundwater[1] are to ensure that (1) humans are not being exposed to unacceptable levels of contamination, and (2) contaminated groundwater is not migrating above levels of concern[2] beyond its current extent (EPA, 1999e).

How does EPA monitor progress toward these goals?

EPA developed two facility-wide "environmental indicators" to help monitor progress in achieving short-term protection goals on a national basis. The two environmental indicators (EIs) are called **"Current Human Exposures Under Control"** and **"Migration of Contaminated Groundwater Under Control."** EPA commonly refers to these two environmental indicators as the Human EI and Groundwater EI, respectively. In general terms, these measures indicate current "environmental conditions"-- whether people are currently being exposed to environmental contamination at unacceptable levels -- and whether any existing plumes of contaminated groundwater are getting larger or adversely affecting surface water bodies. EPA is specifically tracking progress in meeting these environmental indicator goals at 1,714 facilities that EPA considers to warrant attention in the near term; you can see this list of facilities at http://www.epa.gov/epawaste/hazard/correctiveaction/facility/index.htm.

> **Rationale for**
> **Short-Term Protection Goals**
>
> The highest short-term priorities of the RCRA Corrective Action Program are to make sure that people are not being exposed to unacceptable levels of contaminants and to prevent further contamination of our Nation's groundwater resources. While final remedies remain the RCRA Corrective Action Program's long-term objective, EPA developed two environmental indicators to focus efforts on early risk reduction, risk communication, and resource protection. This focus on short-term protection goals enables the Agency to achieve an increased overall level of protection by implementing a greater number of actions across many facilities.

EPA is using these two environmental indicators to monitor progress in response to the Government Performance and Results Act (GPRA - see http://www.epa.gov/ocfo/planning/gpra.htm). EPA's specific GPRA goals for these indicators are as follows: By 2005, the States and EPA will verify and

---

[1] EPA's short-term goals apply to all contaminated media, not just groundwater. For example, our short-term goals associated with protecting humans include ensuring that humans are not being exposed to unacceptable levels of contaminants in soils. However, we focus here on short-term goals associated with groundwater contamination because the focus of this Handbook is on groundwater.

[2] Levels of concern are concentrations of each contaminant in groundwater appropriate for the protection of the groundwater resource typically based on its maximum beneficial use.

document that 95 percent of the GPRA baseline facilities will have "Current Human Exposures Under Control" and 70 percent will have "Migration of Contaminated Groundwater Under Control." You can see the progress toward achieving these goals at http://www.epa.gov/epawaste/hazard/correctiveaction/facility/index.htm.

Who evaluates and determines whether a facility meets environmental indicator goals?

The lead regulator makes the actual environmental indicator determination. However, EPA, States, or the facility (or the facility's consultant) can conduct an environmental indicator evaluation. EPA developed environmental indicator forms to guide regulators and facilities through this evaluation. In some cases, facilities have voluntarily filled out environmental indicator forms to "self-assess" their status and have even initiated activities on their own to meet the environmental indicators. You can obtain these environmental indicator forms at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/index.htm.

How should regulators and facilities evaluate environmental indicators?

EPA issued detailed guidance (EPA, 1999e) to help those conducting environmental indicator evaluations; you can access that guidance at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/index.htm. The guidance includes a series of questions and a flow chart to help arrive at one of the following three possible outcomes: **YES**, the facility has achieved an environmental indicator goal; **NO**, the facility has not achieved an environmental indicator goal; or, **IN,** there is insufficient information available to determine whether or not a facility has achieved an environmental indicator goal.

How does a facility get to YES?

For the Current Human Exposures Under Control environmental indicator, a facility should be able to demonstrate that there are no unacceptable human exposures to contamination[3] that can be reasonably expected under current land and groundwater use conditions. For the Migration of Contaminated Groundwater Under Control environmental indicator, a facility should be able to demonstrate that contaminant plumes throughout the facility are not continuing to get larger[4] or continuing to negatively impact adjacent surface water bodies, and that the facility will monitor groundwater to verify whether the environmental indicator determination remains valid.

Facilities typically meet these goals either by: (1) demonstrating that no cleanup actions are warranted; (2) taking short-term cleanup actions sometimes referred to as interim remedial measures, interim

---

[3] Contamination in this context describes media containing contaminants in any form (e.g., non-aqueous phase liquids, dissolved in water, vapors, and solids) that are subject to RCRA corrective action and present in concentrations in excess of appropriately protective levels of concern.

[4] A plume getting larger typically refers to groundwater contamination above levels of concern moving beyond a previously defined furthest three-dimensional extent of the contaminant plume.

measures, interim actions, or stabilization[5] measures; or (3) implementing a final remedy that also meets short-term cleanup goals.

How should facilities and regulators develop facility-specific short-term protection goals?

Facilities and regulators should work together, with the input from the public as appropriate, to develop clearly defined objectives focused on meeting short-term protection goals. As described in the Groundwater Protection and Cleanup Strategy in this Handbook, EPA recommends these objectives be expressed in terms of what actions the facility will take, and where and when the facility will take the action.

If some form of cleanup action is needed to achieve the Current Human Exposures Under Control indicator, stakeholders should understand:

- **What** action the facility will take to ensure that there are no current or near-term future unacceptable exposures to contaminated groundwater. For example, the facility might provide for alternative water supplies to eliminate exposure due to contaminated groundwater in residential wells.

- **Where** the facility will implement an action to eliminate unacceptable human exposures to contamination from groundwater.

- **When** the facility will eliminate all unacceptable human exposures to contaminants from groundwater.

To achieve the Migration of Contaminated Groundwater Under Control indicator when contaminants are present in groundwater above levels of concern, stakeholders should understand:

- **What** the levels of concern are for defining the current limit of the groundwater contaminant plume.

- **Where** the current three-dimensional limit of the groundwater contaminant plume is, as defined by the levels of concern, and **where** the facility will monitor groundwater to demonstrate that they achieved and will continue to achieve the prevention of further migration of contaminated groundwater above levels of concern.

- **When** the facility will be able to demonstrate that the groundwater contaminant plume is not migrating above levels of concern.

---

[5] The term stabilization used in this context refers to "stabilizing" a situation so that, for example, the contamination does not represent unacceptable threats or does not continue to spread. Stabilization used in this context does not refer to engineered treatment used to "solidify" wastes although such technologies could be used as a stabilization action. For more information on the RCRA Corrective Action Program's stabilization initiative, refer to EPA, 1991a and EPA, 1996a.

If a cleanup action is needed to achieve a particular goal, EPA believes all interested stakeholders, particularly the public, will benefit from a clear understanding of **who** is taking the action(s), **why** they are taking the action(s), and **how** they will implement the action. For example, all interested members of the public might not realize that the facility, rather than the government, is responsible for implementing a particular cleanup. Furthermore, communicating "why" can help the public understand the reasoning behind selecting, for example, a particular treatment technology such as a subsurface treatment wall as compared with a pump-and-treat approach to clean up contaminated groundwater. Communicating "how" can help educate stakeholders about the particular steps involved with implementing a remedy. For example, during installation of a subsurface treatment wall, stakeholders may be interested in how contaminated soils and other contaminated media will be managed.

How should facilities and regulators consider groundwater use when evaluating "Current Human Exposures Under Control?"

The individual conducting the environmental indicator evaluation should first consider whether there is any current human exposure to contaminated groundwater. This determination relies on actual current conditions rather than on a groundwater use designation or its potential uses. In making this environmental indicator determination, the regulator should consider all direct and indirect ways humans could currently be exposed to contaminated groundwater. Some examples of direct routes of exposure include drinking contaminated groundwater or having skin come into contact with contaminated groundwater from bathing. Examples of indirect exposure include breathing contaminated vapors entering buildings from underlying contaminated groundwater, and ingesting sediments, surface water, or fish that are contaminated from groundwater discharging to surface water.

How should facilities and regulators evaluate the "Migration of Contaminated Groundwater Under Control" indicator?

The individual conducting the evaluation should first be reasonably confident that the furthest three-dimensional boundary of the groundwater contaminant plume(s) is defined using an appropriate number and location of groundwater monitoring wells (or some other devices approved by the regulator to assess groundwater quality)[6]. To achieve a **YES** determination, the evaluator should be able to demonstrate that the plume is not continuing to expand above contaminant-specific levels of concern. The evaluator should base this determination on whether the contaminant concentrations found in the groundwater near the outer perimeter of the plume remain below the levels of concern over time. Levels of concern used for this indicator would commonly be the groundwater clean-up levels developed to be consistent with the groundwater use designation and considering other current routes of exposure from contaminated groundwater. However, early in corrective action, regulators could be

[6] Facilities and regulators typically define a plume boundary based on estimating a division between where groundwater is contaminated above and below levels of concern. They commonly make this estimate based on professional interpretation (often with the aid of computer software) of chemical analyses of groundwater samples collected from properly located monitoring wells or other monitoring devices.

evaluating environmental indicators prior to designating groundwater use or developing final cleanup levels. In such situations, regulators often use readily available screening levels (e.g., drinking water standards) to define a plume boundary. Generally, drinking water standards will be acceptable to define the boundary of a plume when evaluating this environmental indicator unless more stringent levels are needed based on other actual exposures to contaminated groundwater.

Can a facility achieve the "Migration of Contaminated Groundwater Under Control" indicator when the plume extends beyond the facility boundary?

EPA typically does not differentiate on-site contaminated groundwater from off-site contaminated groundwater as a factor in determining whether a facility achieves the groundwater environmental indicator (EPA, 1999e). The primary intent of this indicator is to demonstrate that groundwater problem is not expanding, regardless of whether the contamination is on-site or off-site. However, cleanup of the off-site plume will often be a high priority and may be an appropriate intermediate performance goal because facilities typically have less ability to control exposures outside the boundary of their property.

Can a facility achieve the "Migration of Contaminated Groundwater Under Control" indicator when contaminated groundwater discharges to surface water?

According to EPA guidance (EPA, 1999e), a facility could potentially achieve this indicator if the regulator determines that the discharge of contaminated groundwater into surface water is currently acceptable. "Currently acceptable" in this context means that the current discharge of contaminated groundwater into surface water does not cause unacceptable impacts to surface water, sediments, or ecosystems in ways that should not be allowed to continue until the facility implements a remedy selected to achieve final cleanup goals.

Appropriate levels for surface water protection should generally be based on the designated uses of the impacted surface waters and available Federal water quality criteria or State water quality standards for any of the contaminants found in the discharging ground water. Regulators and facilities should also evaluate possible adverse effects of the groundwater discharge for actual pathways of exposure to humans or aquatic life. Based on these evaluations, facilities and regulators should verify whether available generic cleanup values will protect the surface water and its sediments. If generic cleanup values are not available, facilities should propose facility-specific groundwater cleanup levels designed to prevent appropriate water quality standards in the surface water body from being exceeded, and to prevent unacceptable risks to human health or the environment.

For additional information concerning groundwater/surface water interaction, contact the State cleanup program because many States have specific groundwater cleanup levels based on protecting surface water bodies. Links to State cleanup programs are available at http://www.epa.gov/epawaste/hazard/correctiveaction/baseline.htm. Additional resources you may find helpful include the Proceedings of the Groundwater/Surface Water Interaction Workshop (EPA, 2000c) available at http://www.epa.gov/tio/tsp/download/gwsw/gwsw_part1.pdf and information regarding sediments available at http://www.epa.gov/OST/cs/. Facilities or regulators evaluating environmental indicators for situations where contaminated groundwater is entering surface water should also consider Total Maximum Daily Loads (TMDLs[7]) for the receiving surface water; additional information concerning TMDLs is available at http://www.epa.gov/owow/tmdl/.

Will an environmental indicator evaluation require additional investigation?

The act of evaluating environmental indicators should not result in additional investigations beyond those that would typically be conducted to support facility-wide corrective action. However, pursuing environmental indicators may result in collecting information earlier than when a facility was planning to conduct a more comprehensive, site-wide investigation needed to support, for example, final cleanup goals.

Do facilities need to perform additional investigation or cleanup, once they achieve the environmental indicator goals?

Achieving the environmental indicator goals is an important milestone but does not relieve a facility from meeting other investigation objectives or from meeting any facility-specific intermediate performance goals and final cleanup goals. The facility will often need to conduct further investigation to support evaluation and selection of final remedies. Furthermore, the facility may need to conduct remedial actions that might be outside the scope of these two environmental indicators to achieve other short-term, intermediate, and final goals for groundwater (e.g., returning contaminated groundwater to its maximum beneficial use).

Do facilities need to control sources to meet the environmental indicator goals?

Source control may not always be necessary to meet the environmental indicator goals. For example, a facility could meet the Migration of Contaminated Groundwater Under Control indicator, without controlling an original source, by installing a pump-and-treat system designed to stop the further migration of the outer fringes of a plume of contaminants dissolved in groundwater. However, there are many instances where source control would be essential to meeting these goals. For example, source control of some kind would typically be necessary to achieve the Human Exposures Under Control indicator if there were direct human exposures to the source material, such as an old disposal area with no covering and unrestricted access. Two examples of situations that would typically warrant source control to achieve the Migration of Contaminated Groundwater Under Control indicator would be if a

[7] A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. For more information on TMDLs, refer to http://www.epa.gov/owow/tmdl/intro.html.

non-aqueous phase liquid[8] (NAPL) was directly discharging to a stream, or where a mobile NAPL plume was migrating faster (and farther) than the dissolved contaminants moving with groundwater. Source control is often still desirable in many circumstances because minimizing any further releases into the environment is often easier to manage than trying to clean up contaminants after they have spread. Furthermore, to meet final cleanup goals, EPA expects that facilities will need to control or eliminate surface and subsurface sources of groundwater contamination as necessary to protect human health and the environment.

Are these two environmental indicators the only short-term protection goals facilities should consider?

EPA chose these two indicators as significant short-term protection goals to track on a national basis. However, facilities may need to take other short-term actions to protect receptors when site conditions warrant. For example, a facility might need to take action to protect ecological receptors that are currently exposed to facility contaminants. Furthermore, EPA's focus on the two environmental indicators should not deter facilities from taking any other short-term actions to protect human health or the environment, or from taking early action to prevent environmental problems from getting worse.

References:

EPA, 2000c. Proceedings of the Ground-Water/Surface-Water Interactions Workshop (EPA/542/R-00/007, July). Available at http://www.epa.gov/tio/tsp/download/gwsw/gwsw_part1.pdf, http://www.epa.gov/tio/tsp/download/gwsw/gwsw_part2.pdf, and http://www.epa.gov/tio/tsp/download/gwsw/gwsw_part3.pdf.

EPA, 1999e. Interim Final Guidance for RCRA Corrective Action Environmental Indicators (February 5). Available at http://www.epa.gov/epaoswer/hazwaste/ca/eis/ei_guida.pdf.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages describing the stabilization initiative and environmental indicators on 19436-37, and discussion of interim measures on page 19446-47.

EPA, 1995b. Groundwater Issue: Light Non-Aqueous Phase Liquids (EPA/540/S-95/500). Available at http://www.epa.gov/ada/download/issue/lnapl.pdf.

EPA, 1994c. DNAPL Site Characterization (EPA/540/F-94/049). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/dnapl.pdf.

[8] Additional information and reports concerning NAPL contamination is available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/non_aqu.htm See also EPA, 1995b and 1994c.

EPA, 1991a. Managing the Corrective Action Program for Environmental Results: The RCRA Stabilization Effort (October 25). Available at http://yosemite.epa.gov/osw/rcra.nsf/d8382df2d09b64668525652800519745/27d1baa5c1dbb8f38525670f006be76d?OpenDocument.

3. Intermediate Performance Goals

(September 2001)

What are intermediate performance goals for groundwater?

Intermediate performance goals are facility-specific environmental conditions or measures that demonstrate progress towards achieving the final cleanup goals. EPA refers to these goals as "intermediate" because actions taken to meet these goals will typically occur after a facility achieves its short-term protection goals, but before they achieve all final cleanup goals. EPA encourages regulators and facilities to establish intermediate goals when they can use such goals to demonstrate progress toward the ultimate final cleanup goals and:

- help focus resources,
- improve environmental conditions, or
- enhance performance of a cleanup action.

Achieving intermediate performance goals does not relieve a facility from meeting any facility-specific investigation or cleanup actions necessary to achieve final cleanup goals.

> **Rationale for Intermediate Performance Goals**
>
> EPA's approach for intermediate performance goals recognizes that for many sites, using a "phased-approach" is often appropriate for complex groundwater cleanups. Establishing site-specific intermediate performance goals provides a mechanism to prioritize work and measure progress toward achieving long-term goals.

How can intermediate performance goals help me?

Intermediate performance goals help facilities, regulators, and the public see and document progress towards meeting final cleanup goals.

Intermediate performance goals also help to prioritize work necessary to meet the final cleanup goals. Facilities may use intermediate performance goals to outline a phased approach toward the cleanup. A phased approach allows a facility to use information obtained from previous phases to plan and refine subsequent work (EPA, 1996a and EPA, 1996c). Facilities can also direct response actions to achieve intermediate performance goals at high-priority areas of the facility first, and address lower priority areas at a later time.

Intermediate performance goals may also serve to bridge differences in opinion between regulators, facilities, and the public on the scope of environmental response at a facility. There may be consensus on intermediate actions that facilities can take that provide significant environmental benefit while stakeholders continue to negotiate issues associated with final cleanup goals.

Are intermediate performance goals appropriate for all facilities?

No. For example, intermediate performance goals may not be appropriate for those situations where facilities can achieve final cleanup goals in a relatively short period of time (e.g., months to several years).

When should facilities and regulators establish intermediate performance goals?

Regulators and facilities should establish intermediate performance goals as part of a final remedy to create milestones of environmental progress. However, where significant uncertainties exist as to what a final remedy should involve and could achieve, EPA believes it may be appropriate to establish and strive to achieve intermediate performance goals prior to a formal evaluation and selection of a final remedy. In this latter situation, stakeholders could use the information gained from implementing actions to achieve the intermediate performance goals to help improve the effectiveness and efficiency of the final remedy.

How should facilities and regulators develop facility-specific intermediate performance goals?

Facilities and regulators should work together, with the input from the public as appropriate, to develop clearly defined objectives focused on meeting intermediate performance goals. As described in the Groundwater Protection and Cleanup Strategy in this Handbook, EPA recommends these objectives be expressed in terms of what actions the facility will take, and where and when the facility will take the action.

If some form of cleanup action is needed to achieve an intermediate performance goal, stakeholders should understand:

- **What** the specific goals are and what actions the facility will take to achieve those goals.

- **Where** the facility will implement an action and/or **where** the facility will measure to determine if the action has been successful.

- **When** the facility can implement a remedy and achieve facility-specific intermediate goals (cleanup timeframe).

In addition to these three elements, EPA believes stakeholders should also clearly understand who is taking the responsibility for implementing an action designed to achieve a particular intermediate performance goal, why they are taking the action, and how they are going to implement the action.

What are some examples of intermediate performance goals?

Some examples of intermediate performance goals include: source control (e.g., various combinations of removal, treatment, and containment), plume size reduction, cleaning up off-site plumes, prioritizing work, and remedy performance enhancements. For example:

Source control: A facility is pumping and treating groundwater to prevent a contaminant plume from migrating off-site. The site investigation identifies an area of soil contaminated with chlorinated solvents that appears to be contributing to the groundwater contamination. The facility estimates if they clean up the contaminated soil (using soil vapor extraction) to a particular level as an intermediate performance goal, monitored natural attenuation[1] will have a greater likelihood of being able to address the remaining groundwater contamination.

Cleaning up off-site plumes: A facility has an off-site plume and had to install vapor recovery systems under individual homes to eliminate exposures to indoor air impacted by contaminated groundwater. By focusing on achieving cleanup levels in groundwater off site as an intermediate performance goal, the facility is able to reduce its long-term liabilities associated with relying solely on the in-home vapor recovery systems to ensure protection.

Prioritizing work: A large industrial facility identifies several areas that need to be addressed, but has limited resources available for cleanup. The regulator and facility work together to establish a sequence of intermediate goals directed toward achieving the final cleanup goal. In establishing the sequence of work to be conducted, the regulator and facility consider the relative risk and/or potential environmental harm associated with the current contamination in the different areas. They then can establish a series of intermediate goals with different cleanup timeframes for the different areas based on the relative risk. The result is that the most environmentally significant areas are cleaned up first, and the facility is able to budget resources efficiently.

Why is it important to establish intermediate performance goals on a facility-specific basis?

Intermediate performance goals should be specific to the environmental problem(s) that need to be solved at a facility. The environmental benefit of a particular intermediate performance goal will vary for different facilities based on the type of contaminants, environmental receptors, anticipated timing of groundwater use, and the current extent of contamination, among other factors. Therefore, EPA cautions stakeholders against automatically applying an intermediate performance goal that makes sense at one facility to another facility since no two facilities are exactly alike. For example, controlling a source of contamination at one facility as an intermediate performance goal may be appropriate, while at another facility, controlling a source might be more appropriately addressed as part of a short-term or final cleanup action.

References:

---

[1] For more information, refer to the Monitored Natural Attenuation section of this Handbook and EPA, 1999d.

EPA, 1999d. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites (April 21). OSWER Policy Directive 9200.4-17P. Available at http://www.epa.gov/swerust1/directiv/d9200417.htm. Other helpful links regarding MNA available at http://www.epa.gov/swerust1/cat/mna.htm and http://www.epa.gov/swerust1/oswermna/mnalinks.htm.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant page (pertaining to phasing remedies): 19441.

EPA, 1996c. Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites (EPA/540/R-96/023, October). Available at http://www.epa.gov/superfund/resources/gwguide/index.htm.

4. Final Cleanup Goals

(September 2001)

What are EPA's final cleanup goals for corrective action?

EPA recommends that regulators and facilities use the following three threshold criteria[1] as general goals for final cleanup and as screening tools for potential remedies, including final groundwater remedies:

1. Protect human health and the environment[2];

2. Achieve media cleanup objectives[3]; and

3. Control the source(s) of release so as to reduce or eliminate, to the extent practicable, further releases of hazardous waste or hazardous constituents that may pose a threat to human health and the environment[4].

Rationale for Final Cleanup Goals

This policy on final cleanup goals for contaminated groundwater is important to protect human health and the environment by ensuring the short- and long-term availability of our Nation's groundwater resources and by preserving and protecting hydraulically connected surface waters and their ecosystems. EPA's policy on final cleanup goals states that the situations where long-term containment remedies are acceptable should generally be limited to when cleaning up contaminated groundwater is technically impracticable, or to where EPA or the State designates the groundwater as having no use or value.

---

[1] The 1996 ANPR lists four remedy threshold criteria. EPA believes that the fourth criterion "complying with applicable standards for waste management" is not necessary since complying with applicable waste management standards is automatically required under existing RCRA Subtitle C and D regulations. For more information about Federal requirements and implementation guidance associated with remediation waste, refer tohttp://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/index.htm.

[2] Protecting the environment means, among other things, considering the ecological setting at and around a facility in evaluating and selecting final remedies. This is especially important for groundwater remedies where contaminated groundwater discharges into surface water.

[3] Media cleanup objectives for final remedies typically includes the more specific concepts of media cleanup levels, points of compliance, and cleanup timeframes. In previous guidance (EPA, 1996a - page 19449), EPA referred to media cleanup objectives as media cleanup standards; we now use media cleanup objectives to avoid confusion over the term "standard" that is often associated just with numeric values.

[4] EPA expects (see glossary for a definition of "remedy expectations") facilities to control or eliminate surface and subsurface sources of groundwater contamination as necessary to protect human health and the environment. In controlling sources, EPA prefers approaches that lead to permanent reductions in toxicity, mobility, or volume. Additionally, EPA expects that treatment will be used to address source materials considered to be "principal threats," i.e., materials that are highly toxic or highly mobile that generally cannot be reliably contained or

(continued...)

Protecting human health and the environment is the mandate from the RCRA statute and regulations; therefore, it is appropriate to include this goal as the first and overarching threshold criterion for final RCRA corrective action remedies. Use of this threshold criterion also serves to ensure that remedies include protective activities (e.g., providing an alternative drinking water supply) that would not necessarily be needed to achieve the other recommended criteria. However, EPA also recommends that remedies meet the second (achieving media cleanup objectives) and third (controlling sources) criteria as a means to demonstrate progress toward achieving the overall mandate to protect human health and the environment.

What are EPA's final cleanup goals for groundwater?

EPA expects final remedies to return "usable" groundwaters to their maximum beneficial use[5], wherever practicable, within a timeframe that is reasonable given the particular circumstances of the facility (EPA, 1996a). Facilities and regulators should establish specific media cleanup objectives that will meet this expectation. EPA also expects final remedies to control or eliminate surface and subsurface sources of groundwater contamination. In determining appropriate and protective media cleanup objectives for groundwater remedies, stakeholders should consider the use, value, and vulnerability of the groundwater resource, and all potential pathways that could result in human or ecological exposure to contaminants in or from groundwater.

When does EPA consider groundwater "usable" for selecting final cleanup goals?

EPA recognizes that "usable" groundwater may serve a variety of purposes. Common purposes of groundwater include, for example, drinking water, agricultural irrigation, car washes, and manufacturing. Groundwater also has less formally acknowledged purposes such as replenishing adjacent aquifers or surface water bodies. Regulators should consider purposes such as these to acknowledge whether groundwater is "usable" and to determine appropriate cleanup goals. For more guidance regarding groundwater use, see the groundwater use designation policy in this Handbook.

What if groundwater is not usable?

For groundwater formally designated by EPA or a State[6] as having no use or value, final cleanup goals such as source control and/or long-term containment, rather than meeting a particular cleanup level

---

[4](...continued)
would present a significant risk to human health or the environment should exposure occur. A complete list of EPA's general expectations for final remedies is available in EPA, 1996a (page 19448).

[5] Within the range of reasonably expected uses and exposures, the maximum beneficial groundwater use is the one which that warrants the most stringent groundwater cleanup levels and approaches.

[6] EPA recognizes that most States classify the majority of their groundwater as potential sources of drinking water.

throughout the groundwater, may be acceptable as long as the remedy protects human health and the environment[7]. However, stakeholders should consider all potential pathways[8] that could result in human or ecological exposure before deciding that not cleaning up the entire groundwater plume is acceptable.

Even in those instances when groundwater is not usable, final remedies should still achieve the three threshold criteria described above. In addition, EPA recommends that regulators ensure that: (1) the non-use designation is appropriate; (2) humans or ecological receptors would not be exposed to contaminants in or from groundwater[9]; (3) the approaches used to achieve the final cleanup goals would be effective in the long term; (4) they consider the potential impacts to human health or the environment if the remedy were to fail; and (5) the facility has the financial ability to maintain the remedy for as long as necessary to ensure protection of human health and the environment[10].

When significant uncertainties exist regarding the reliability of a containment system, regulators should strongly consider establishing the goal of cleaning up the groundwater so that relying on long-term containment is not be needed to ensure protection.

What if returning contaminated groundwater to its maximum beneficial use is not technically practicable?

Where returning contaminated groundwater to its maximum beneficial use is not technically practicable, EPA generally expects facilities to prevent or minimize the further migration of a plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. For more information on what to do if returning contaminated groundwater to its maximum beneficial use is technically impracticable, see the policy on technically impracticability in this Handbook.

How should facilities and regulators evaluate final remedies that meet the threshold criteria?

---

[7] In the Superfund Program, final cleanup goals or objectives that are not associated with returning contaminated groundwater to its beneficial use are often referred to as "non-restoration" goals or objectives (EPA, 1997b).

[8] Refer to the Groundwater Cleanup Levels Section of the Handbook for guidance concerning potential ways humans or ecologic receptors could be exposed to contaminated groundwater.

[9] For example, humans could be exposed to indoor air contamination resulting from contaminants that volatilize from underlying groundwater. Further, aquatic organisms living within the groundwater or within surface water to which groundwater discharges, could be exposed to unacceptable levels of contamination.

[10] RCRA §3004(u) and 40 CFR 264.101(b) require that RCRA permits contain assurances of financial responsibility for completing RCRA corrective action.

EPA recommends (EPA, 1996a) that facilities consider the following seven balancing criteria[11] when evaluating a single cleanup alternative or choosing among several alternatives anticipated to meet the final remedy threshold criteria:

(1) Long-term reliability and effectiveness, along with the degree of certainty that remedies will remain protective of human health and the environment, considering, as appropriate: the magnitude of risks that will remain at a site from untreated hazardous wastes and hazardous constituents and treatment residuals, and the reliability of any containment systems and institutional controls;

(2) Reduction of toxicity, mobility, or volume through treatment of hazardous wastes and hazardous constituents, including how treatment is used to address principal threats posed by the facility, and the degree to which remedies employ treatment that reduces the toxicity, mobility, or volume of hazardous waste and hazardous constituents, considering, as appropriate: the treatment processes to be used and the amount of hazardous waste and hazardous constituents that will be treated; the degree to which treatment is irreversible; and the types of treatment residuals that will be produced;

(3) Short-term effectiveness and short-term risks remedies pose, along with the amount of time it will take for remedy design, construction, and implementation;

(4) Ease or difficulty of remedy implementation, considering, as appropriate: the technical feasibility of constructing, operating, and monitoring the remedy; the administrative feasibility of coordinating with and obtaining necessary approvals and permits from other agencies; and the availability of services and materials, including capacity and location of needed treatment, storage and disposal services;

(5) Capital as well as operation and maintenance costs, and the net present value of these costs.

(6) The degree to which remedies are acceptable to the surrounding community; and

(7) The degree to which remedies are acceptable to the State in which the facility is located[12].

How thorough of an assessment should facilities conduct when evaluating one or more remedial options?

[11] These balancing criteria are not ranked in terms of importance.

[12] The last two recommended balancing criteria (State and community acceptance) were not explicitly stated in the May 1, 1996 ANPR (EPA, 1996a). EPA believes these criteria are important considerations to ensure that both regulators and facilities consider public views and opinions, as well as State requirements, guidance and policies. Considering State input is especially important for those situations where EPA, not the State, selects the final remedy. Including these last two balancing criteria has the added benefit of improving consistency between the RCRA Corrective Action Program and EPA's Superfund Program.

EPA encourages facilities to focus their evaluations on realistic remedies and tailor the scope and substance of studies to the complexity of contamination and hydrogeologic conditions at a given facility. EPA emphasizes that it does not expect facilities to undertake studies simply for the purpose of completing procedural steps. Furthermore, there are a number of opportunities to significantly streamline remedy evaluation. For example, where there are straightforward solutions (e.g., when standard engineering solutions have proven effective in similar situations) or where presumptive remedies[13] are appropriate and can be applied, it may not be necessary to evaluate more than one alternative. However, when facilities only evaluate one alternative, they should still justify their proposal based on EPA's recommended threshold and balancing criteria.

How should facilities and regulators develop facility-specific final groundwater cleanup goals?

Facilities and regulators should work together, with input from the public as appropriate, to develop clearly defined media cleanup objectives to implement final cleanup goals. As described in the Groundwater Protection and Cleanup Strategy, EPA recommends that these objectives be expressed in terms of what actions the facility will take, and where and when the facility will take the action.

If some form of cleanup action is needed to achieve a final cleanup goal, stakeholders should understand:

- **What** the groundwater cleanup level is for contaminants in groundwater.

- **Where** the facility will demonstrate it has achieved groundwater cleanup levels (i.e., the groundwater point of compliance).

- **When** the facility anticipates it can implement a remedy and can achieve a groundwater cleanup (cleanup timeframe).

In addition to these three elements, EPA believes stakeholders should also clearly understand who is implementing the final remedy, why they are taking the action, and how they are going to implement the action.

What are the media cleanup objectives if containment is the final goal rather than meeting cleanup levels throughout contaminated groundwater?

When containment is part of the final remedy, facilities and regulators should develop systems to

---

[13] Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of how well technologies perform (EPA, 1996c). You can access EPA's guidance on presumptive remedies at http://www.epa.gov/superfund/resources/presump.

monitor the effectiveness of the containment. For example, the **what** could include the cleanup levels the facility needs to meet outside the containment area. The **where** could include locations outside the containment area at which the facility will be monitoring groundwater conditions to verify the containment system is working. The **when** could include how often and for how long the monitoring will continue. In addition, the facility and regulator should identify the specific measures or conditions that will indicate whether the containment is effective, and what actions the facility will take if the containment fails.

Key References:

EPA, 1997b. Rules of Thumb for Superfund Remedy Selection (EPA 540-R-97-013). Available at http://www.epa.gov/superfund/resources/rules/rulesthm.pdf .

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages: 19448-52.

EPA, 1996c. Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites (EPA/540/R-96/023, October). Available at http://www.epa.gov/superfund/resources/gwguide/index.htm.

5. Groundwater Cleanup Levels

(September 2001)

What are groundwater cleanup levels?

Groundwater cleanup levels are facility-specific chemical concentrations in groundwater that regulators generally establish when defining groundwater cleanup objectives for final remedies. EPA recommends that groundwater cleanup levels be based on the maximum beneficial use of the groundwater to ensure protection of human health and the environment. Additionally, groundwater cleanup levels often serve as the basis for identifying the "level of concern" used for the Migration of Contaminated Groundwater Under Control environmental indicator (i.e., short-term protection goals), and may be a component of a facility-specific intermediate performance goal.

Rationale for Groundwater Cleanup Levels

Groundwater cleanup levels provide clear numerical targets that stakeholders can use to measure the success of groundwater cleanup actions. EPA recommends that groundwater cleanup levels be based on the maximum beneficial use to ensure that groundwater is cleaned up to levels that protect human health and the environment both now and in the future. Identifying cleanup levels in this way helps to protect the environmental integrity of our nation's groundwater resources.

How should groundwater cleanup levels be developed?

Groundwater cleanup levels for human health should typically be developed by using existing cleanup standards (e.g., drinking water standards) when they are available and when using them is protective of current and reasonably expected exposures.

If a cleanup standard is not available for a constituent, a facility should first assess all actual and potential exposures to the contaminant(s). Then, a groundwater cleanup level should be developed based on the magnitude of exposure (i.e., dose[1]), and the toxicity of the contaminant resulting in an estimate of risk. Groundwater cleanup levels are then calculated to fall within generally acceptable levels of risk. EPA recommends that regulators choose risk-based cleanup levels as follows:

(1) For known or suspected carcinogens, regulators should establish groundwater cleanup levels at concentrations that represent an excess upper bound lifetime risk[2] to an individual of between 10^{-4}

---

[1] Dose is the amount of substance to which a person or other organism is exposed. Dose often takes body weight into account. Total dose is the sum of doses received by a person or organism from a contaminant in a given time interval resulting from interaction with all environmental media that contain the contaminant.

[2] EPA expresses cancer risk in terms of the likelihood that a person might develop cancer from exposure to contaminants from a facility. For example, a risk assessment might say that a receptor has an upper bound excess cancer risk of 10^{-4}. The numerical estimate means that for people receiving this level of exposure averaged over a 70-

(continued...)

and 10^{-6} (commonly referred to as EPA's cancer risk range[3]). Note that EPA prefers cleanup levels at the more protective end of the risk range. For facilities with multiple contaminants or exposure pathways, cleanup levels should generally be set so that cumulative (total) excess[4] upper bound lifetime risk from all contaminants still falls within the risk range.

(2) For toxic substances associated with adverse effects other than cancer, regulators should establish groundwater cleanup levels at concentrations to which human populations, including sensitive subgroups, could be exposed to on a daily basis without appreciable risk of negative effect during a lifetime. Such levels are generally interpreted as equal to or below a hazard quotient[5] of one. For facilities with multiple contaminants or exposure pathways, groundwater cleanup levels should generally be equal to or below a hazard index[6] of one.

Are there other factors regulators and facilities should consider when developing groundwater cleanup levels?

Yes. Groundwater cleanup levels that are higher or lower than the levels described above, might be appropriate in circumstances, such as those described below, provided the cleanup protects human health and the environment:

---

[2](...continued)
year lifetime, approximately one person out of every 10,000 would develop cancer as a result of the exposure. Note that the range of 10^{-6} to 10^{-4} translates to from one in one million to one in ten thousand. Values (i.e., screening values or "action levels") used as "triggers" for conducting additional corrective action activities are generally set at a cancer risk of 10^{-6}. For additional guidance concerning screening levels, refer to EPA, 1996e and http://www.epa.gov/oerrpage/superfund/resources/soil/.

[3] Refer also to State regulations and guidance on risk and risk ranges. For example, the State of Florida specifies 10^{-6} for risk assessments. Links to State hazardous waste programs are available at http://www.epa.gov/epawaste/hazard/correctiveaction/baseline.htm.

[4] The term "excess" in this context refers to the additional or extra risk of developing cancer due to exposure to a toxic substance incurred over the lifetime of an individual (source: Glossary of IRIS Terms available at http://www.epa.gov/iris/gloss8.htm).

[5] EPA expresses noncancer health risk as a ratio, known as the Hazard Quotient (HQ), which is defined as the calculated exposure from a single contaminant in a single medium divided by a reference dose. The reference dose is the level of exposure that EPA believes will not cause adverse affect in human populations, including sensitive individuals. Note that some chemicals may be associated with both carcinogenic as well as noncarcinogenic effects (such as liver or kidney disease); both should be considered when setting the cleanup level.

[6] The hazard index (HI) assesses potential for toxicity following exposure to multiple contaminants. It is equal to the sum of the hazard quotients. However, where information is available to identify the critical toxic effect for non-carcinogens, only hazard quotients associated with similar critical effects (target organs) are combined.

(1) Higher cleanup levels may be appropriate, for a given facility, for example, when:

(a) in addition to contamination originating from releases from the RCRA facility, groundwater is also contaminated by hazardous constituents that are naturally occurring[7] or have originated from a source not associated with the subject facility, and those hazardous constituents are present in concentrations such that remediation of the release would not provide significant reduction[8] in risks to actual or potential receptors; or,

(b) the groundwater designation is not a current or reasonably expected source of drinking water, and contaminants in groundwater would not result in unacceptable impacts to hydraulically connected surface water bodies.

(2) Lower groundwater cleanup levels may be necessary, for example, because of unacceptable risks to human receptors from combined effects of hazardous wastes or hazardous constituents, or to protect ecological receptors[9], or to protect potential receptors exposed through cross-media transfer.

For additional information, refer to numerous resources concerning human health and ecological risk issues including EPA, 2001b; EPA, 2001c; EPA, 1997f; EPA, 1989c; and, the following internet sites: http://www.epa.gov/superfund/programs/risk/tooltrad.htm#gp, and http://www.epa.gov/superfund/programs/risk/commeng.htm.

What is the role of groundwater use in setting cleanup levels?

Regulators and facilities should base groundwater cleanup levels on the maximum beneficial groundwater use. The maximum beneficial use, determined by EPA or State regulators, is the current or reasonably expected use that warrants the most stringent groundwater cleanup levels. Typically the groundwater use designation is the starting point for determining the appropriate reasonably expected uses and exposures to evaluate risks and identify groundwater cleanup levels. Facilities and regulators should consider groundwater use designations when evaluating the reasonably expected future uses of groundwater. The groundwater use designation may define whether the groundwater is a current or

[7] A naturally occurring substance is in its unaltered form, or is altered solely through naturally occurring processes or phenomena, in a location where it is naturally found (Superfund, Section 104(a)(3)(A)).

[8] What would or would not constitute "significant reductions in risk" should be defined on a case-by-case basis by the regulator. EPA's primary intent with this guidance is to convey that regulators have the flexibility to adjust cleanup levels to avoid, where appropriate, creating a groundwater "island of purity" in the midst of regional contamination from sources outside the facility in question.

[9] You should make sure to contact the cleanup program for the State in which a particular facility is located to determine applicability of any State-specific guidance or regulations concerning ecologic risk assessment procedures. Links to State hazardous waste programs are available at http://www.epa.gov/epawaste/hazard/correctiveaction/baseline.htm.

potential source of drinking water, or has value or uses other than drinking water.

What are the groundwater cleanup levels for a current or potential source of drinking water?

For groundwater that is currently used or designated as a current or reasonably expected source of drinking water, EPA recommends that regulators identify cleanup levels based on a residential drinking water exposure scenario. Even if no one is currently drinking the groundwater, the cleanup level should generally be based on drinking water use if the aquifer is considered by EPA or the State to be a reasonably expected future source of drinking water. For each constituent, regulators should determine whether a maximum contaminant level (MCL) has been established under the Safe Drinking Water Act (see http://www.epa.gov/safewater/sdwa/sdwa.html). They should also determine whether the State has adopted the Federal MCL for that constituent, or has promulgated a more stringent State MCL for drinking waters. Regulators should compare the Federal MCL and State MCL for each constituent and typically should use the more stringent as the cleanup level[10].

For chemicals that do not have Federal MCLs, you should contact the particular State program in which the facility is located to determine whether that State has a list of its own drinking water standards. Internet links to State hazardous waste programs are available at http://www.epa.gov/epawaste/hazard/correctiveaction/baseline.htm.

For constituents for which no Federal or State MCLs have been promulgated, regulators typically rely on other established drinking water standards and goals or a risk assessment incorporating residential exposure assumptions (for example, ingestion rate of 2 liters/day, and exposure frequency of 350 days/year) to estimate contaminant dose, derive risk estimates, and determine groundwater cleanup levels.

What is the cleanup level if the groundwater is designated as something other than a current or potential source of drinking water?

Regulators should develop cleanup levels that are consistent with the groundwater use designation. However, they should first verify that the groundwater use designation is valid. For example, even if a State-wide designation system defines (or would define) the aquifer as a non-drinking water resource, regulators and facilities should verify that no one is drinking the groundwater and that no other unacceptable exposure to contamination from groundwater is occurring.

Once verified, a non-drinking groundwater use designation could serve as a starting point for

---

[10] In the Superfund Program, non-zero maximum contaminant level goals (MCLGs) established under the Safe Drinking Water Act are also used as cleanup levels. At Superfund sites, regulators should compare the Federal MCL, Federal non-zero MCLG, and the State MCL for each constituent and use the most stringent of the these as the cleanup level. Relatively few chemicals have a non-zero MCLG, and for most of these the non-zero MCLG is equal to the MCL. For constituents that have an MCLG equal to zero, EPA's Superfund Program uses the MCL as the cleanup level (EPA, 1990b - 40 CFR §300.430(e)(2)(i)(B&C)). A table of MCLs and MCLGs established by EPA under the Safe Drinking Water Act is available at http://www.epa.gov/safewater/mcl.html.

establishing groundwater cleanup levels. Some States have established generic cleanup levels in regulations or guidance for groundwater in non-drinking water aquifers. In those States, facilities and regulators should consider these levels when appropriate. However, at a facility-specific level, there may be uses of groundwater or exposures to contaminants from groundwater that might not be considered in a State-wide groundwater use designation. Regulators should, therefore, verify that the generic values are protective of the known or reasonably expected groundwater uses and the potential exposures through cross-media transfer. For example, regulators should consider whether contaminants in groundwater could transfer (through volatilization) into soil gas that could migrate into overlying buildings[11] and negatively impact the quality of indoor air. Additionally, regulators should consider whether contaminants in groundwater could negatively impact adjacent aquifers or surface water bodies.

For example, a State designation may identify groundwater in a particular area as industrial and provide a generic value, but the groundwater discharges into an adjacent surface water body. In this case, regulators and facilities should determine the designated uses of the impacted surface water, and identify any Federal or State water quality criteria for those contaminants found in the discharging groundwater. Regulators and facilities should also evaluate possible adverse effects of the groundwater discharge for actual pathways of exposure to humans or aquatic life[12]. Based on these evaluations, facilities and regulators should verify whether available generic cleanup values are protective of the surface water and its sediments. If these generic levels are not protective, facilities should propose facility-specific groundwater cleanup levels designed to prevent exceeding appropriate water quality standards in the surface water body, and unacceptable risks to human health or the environment.

Additionally, in the absence of appropriate generic values for non-drinking water, facilities should identify the various actual and potential uses and exposures (i.e., pathways) to contaminants from groundwater to develop protective groundwater cleanup levels for the facility. To estimate dose, facilities or regulators should evaluate all current and potential routes of exposure within each pathway, such as inhalation, dermal (skin) contact, and inadvertent ingestion. Since EPA does not currently have standard exposure assumptions for nonresidential uses of groundwater, such as industrial or agricultural uses, facilities and regulators will generally need to quantify facility-specific exposure assumptions for all expected pathways by collecting facility-specific or other relevant data to develop an appropriate numerical value for those exposures. These exposure values along with toxicity values for each

---

[11] For information on a tool designed to assess impacts from contaminated groundwater to indoor air, refer to EPA's User's Guide for the Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings (EPA, 1991d) which is available at http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/guide.pdf. The model itself can be downloaded from http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm. See also EPA's Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance) available at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor.htm.

[12] Refer to EPA, 2001b for recent guidance concerning the use of screening level risk assessments and refining contaminants of concern for baseline ecological risk assessments.

contaminant can then be used to calculate contaminant-specific concentrations (groundwater cleanup levels) to achieve protective risk levels (i.e., generally an excess upper bound lifetime cancer risk of 10^{-4} to 10^{-6}, or equal to or below a hazard index of one).

Are there any situations where regulators might not establish specific groundwater cleanup levels?

Yes. In some cases, the groundwater will already be at acceptable levels for its designated use(s). In other situations, regulators might not establish specific groundwater cleanup levels if:

- the contaminated groundwater is within a designated non-drinking water aquifer;
- has no current or foreseeable beneficial use;
- does not discharge to surface water or to a drinking water aquifer at levels that could cause concern; and,
- does not cause other exposures through media transfer (e.g., indoor air).

However, the regulator may still require facilities to conduct monitoring or to provide containment to ensure continued protection of human health and the environment. If containment is warranted, then cleanup levels may be needed to help evaluate the effectiveness of the containment system. Other protective measures, such as source control, would still likely apply in this situation.

What are alternate concentration limits and do they apply to setting groundwater cleanup levels for facility-wide corrective action?

EPA's regulations pertaining to alternate concentration limits (ACLs) appear at 40 CFR 264.94(b) in the section of EPA's regulations that apply to corrective action for RCRA regulated units[13] for the purposes of detecting, characterizing and responding to releases to the uppermost aquifer. Alternate concentration limits are levels that the Regional Administrator may establish under certain defined circumstances as a component of the groundwater protection standard[14] for RCRA regulated units. The regulations refer to these levels as "alternate" because, if approved by the regulator, they are used instead of background concentrations or the values conveyed in Table 1 of 40 CFR 264.94(a)(2).

The ACL regulations (see 40 CFR 264.94(b)) take a risk-based approach that provides the Regional Administrator with the ability to establish an alternative level(s) that "will not pose a substantial present or potential hazard to human health and the environment." In establishing ACLs, the regulations also list factors the Regional Administrator will consider, such as "the physical and chemical characteristics of

---

[13] Regulated units are defined in 40 CFR 264.90 as surface impoundments, waste piles, land treatment units, and landfills that received hazardous waste after July 26, 1982.

[14] The groundwater protection standard (40 CFR 264.92) for RCRA regulated units consists of four elements including: hazardous constituents (40 CFR 264.93), concentration limits (40 CFR 264.94), the point of compliance (40 CFR 264.95), and the compliance period (40 CFR 264.96). These regulations are available through http://www.gpoaccess.gov/cfr/retrieve.html.

the waste in the regulated unit, including its potential for migration, and the potential adverse effects on hydraulically connected surface water." You can find further information setting ACLs, including on how to account for natural attenuation processes, in EPA Alternate Concentration Limit guidance (EPA, 1987).

Alternate concentration limits as described in 40 CFR 264.94(b) do not apply (see 40 CFR 264.90 regarding "applicability") to the facility-wide corrective action[15] of solid waste management units under 40 CFR 264.101. However, regulators and facilities could use many of the concepts of ACLs in developing cleanup levels and approaches for site-wide corrective action. For example, as described elsewhere in this Handbook, facilities and regulators should consider impacts of groundwater on hydraulically connected surface water, and cleanups can in certain circumstances rely on natural attenuation processes (see Handbook section on Monitored Natural Attenuation).

What are cleanup levels for groundwater if a facility is clean closing a RCRA regulated unit?

To achieve "clean closure," facilities should remove or decontaminate all hazardous waste, liners and environmental media contaminated by releases from the unit. However, hazardous constituents may remain at some level in environmental media, such as groundwater, after clean closure provided that the constituents are below levels that may pose a risk to human health or the environment.

In 1998, EPA issued a memorandum (EPA, 1998c) reaffirming risk-based clean closure standards. The memorandum interpreted EPA's regulations to permit some limited quantity of hazardous constituents to remain in environmental media after clean closure provided they are at concentrations below levels that may pose a risk to human health and the environment. This allows appropriate use of non-residential exposure assumptions[16] when identifying closure standards. Typically, regulators should not rely on nonresidential exposure assumptions for their clean-closure decisions unless they are reasonably confident that future land use will conform to those assumptions. Furthermore, regulators should make sure that the area covered by the nonresidential land use assumptions is clearly delineated. Facilities and regulators should also establish procedures (see Institutional Controls) to alert future users to the presence of contamination and risks presented, and to provide for periodic evaluations of actual

---

[15] Under limited circumstances specified in CERCLA 121(d)(2)(B)(ii), alternate concentration limits may also be used at Superfund sites. Additional guidance for using Superfund ACLs is found in the "Rules of Thumb for Superfund Remedy Selection" (EPA, 1997b). More specifically, the conditions under which ACLs may be considered in the Superfund Program include where: (1) contaminated groundwater discharges into surface water; (2) such groundwater discharge does not lead to "statistically significant" increases of contaminants in the surface water; and (3) enforceable measures can be implemented to prevent human consumption of the contaminated groundwater. In general, ACLs can be used in the Superfund Program when the preceding three conditions are satisfied and where restoration of the groundwater is found to be impracticable based on a balancing of Superfund's remedy selection criteria (EPA, 1990 - NCP preamble pages 8732 and 8754, and EPA, 1997b).

[16] Note that some State programs do not allow nonresidential scenarios to be used in determining criteria for clean closure.

land use. For more information on risk based closure, refer to the Risk-Based Clean Closure Memorandum (EPA, 1998c) and call your overseeing regulator.

References:

EPA, 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor.htm.

EPA, 2001b. ECO-UPDATE: The Role of Screening Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecologic Risk Assessments (EPA/540/F-01/014, June). Available at http://www.epa.gov/superfund/programs/risk/ecoup/slera0601.pdf.

EPA, 2001c. Risky Business (EPA/530/F-00/032, February). Available at http://www.epa.gov/epawaste/inforesources/pubs/riskfinal.pdf.

EPA, 1998c. Memorandum from Elizabeth Cotsworth to RCRA Senior Policy Advisors titled, Risk-Based Clean Closure (March 16). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/risk/cclosfnl.pdf

EPA, 1997b. Rules of Thumb for Superfund Remedy Selection (EPA/540/R-97/013). Available at http://www.epa.gov/superfund/resources/rules/rulesthm.pdf

EPA, 1997f. Exposure Factors Handbook (EPA/600/P-95/002F). Available at http://www.epa.gov/ncea/exposfac.htm.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages: 19448-52.

EPA, 1996e. Soil Screening Guidance Fact Sheet (EPA/540/F-95/041, July). Available at http://www.epa.gov/oerrpage/superfund/resources/soil/.

EPA, 1991d. USEPA's User's Guide for the Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings. Available at http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/guide.pdf. The model itself can be downloaded from http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm.

EPA, 1990b. National Oil and Hazardous Waste Contingency Plan (55 FR 8666 and 40 CFR 300). The preamble is available at http://www.epa.gov/superfund/action/guidance/remedy/pdfs/ncppreamble61.pdf. The CFR is available through http://www.access.gpo.gov/nara/cfr/waisidx_00/40cfrv20_00.html.

EPA, 1989c. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part A). Available at http://www.epa.gov/superfund/programs/risk/ragsa/index.htm.

EPA, 1987. Alternate Concentration Limit Guidance (EPA/530/SW-87/017). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/acl.htm.

6. Point of Compliance

(September 2001)

What is a point of compliance for groundwater?

As a general definition, the point of compliance for groundwater is where a facility should monitor groundwater quality and/or achieve specified cleanup levels to meet facility-specific goals[1]. For RCRA regulated units[2], EPA defines the location of the point of compliance in regulation (40 CFR 264.95). For groundwater contamination subject to facility-wide RCRA corrective action, EPA uses guidance to convey its recommendations for establishing the point of compliance.

Where is the point of compliance for RCRA regulated units?

For RCRA regulated units, Federal regulations define the point of compliance as the "vertical surface located at the hydraulically down gradient limit of the waste management area[3] that extends down to the uppermost aquifer underlying the regulated units"(40 CFR 264.95). The purpose of this point of compliance is to define where the facility must monitor groundwater and evaluate compliance with groundwater concentration limits (i.e., cleanup levels). Additionally, the regulations require facilities to take action, if necessary, to achieve cleanup levels within the volume of contaminated groundwater at and beyond the point of

> **Rationale for Point of Compliance**
>
> Defining where a facility should achieve specified levels of groundwater quality provides stakeholders a way to assess progress toward achieving cleanup goals. EPA recognizes that facilities often use a series of goals to address contaminated groundwater.
>
> EPA's policies in this Handbook reflect different approaches for points of compliance depending on whether the facility is pursuing a short-term, intermediate, or final cleanup goal.
> EPA believes the recommended throughout-the-plume/unit boundary point of compliance for final clean up goals is consistent with EPA's overarching goal of protecting human health and the environment by returning "usable" groundwater to its maximum beneficial use, where appropriate.
>
> This policy also helps ensure that operation and maintenance, including monitoring, continue as long as necessary to ensure protection of human health and the environment. Such monitoring is important because contamination represents a potential threat to human health and the environment as long as the contamination is present above levels of concern.

---

[1] Progress toward meeting a particular cleanup goal is typically measured at the point of compliance using groundwater monitoring wells. The locations of these monitoring wells may change during different stages of a groundwater cleanup action.

[2] Regulated Units are defined in 40 CFR 264.90 as surface impoundments, waste piles, land treatment units, and landfills that received hazardous wastes after July 26, 1982.

[3] If the facility contains more than one regulated unit [in close proximity to each other], the waste management area is described by an imaginary line circumscribing several regulated units (40 CFR 264.95(b)(2)).

compliance (40 CFR 264.100). For more information regarding the point of compliance for regulated units, refer to 40 CFR 264.90-100, which are available through http://www.gpoaccess.gov/cfr/retrieve.html. Also, see footnote number 8 in the Overview to read how EPA's Post Closure regulations (63 FR 56710, EPA 1998d) can provide additional flexibility for cleanup of regulated units. For additional guidance concerning groundwater monitoring of regulated units, refer to EPA, 1993b.

Where is the groundwater point of compliance for RCRA (facility-wide) corrective action?

EPA recognizes that the general definition of the point of compliance can apply to a variety of facility-specific goals, in particular short-term protection goals[4], intermediate performance goals, and final cleanup goals. Therefore, EPA recognizes the point of compliance may vary depending on the particular goal the facility and regulator are pursuing[5]. EPA recommends consideration of the following factors when developing a facility-specific groundwater point of compliance: proximity of sources of contamination; technical practicability of achieving particular cleanup levels; vulnerability of the groundwater and its possible uses; and exposure and likelihood of exposure and similar considerations (EPA, 1996a).

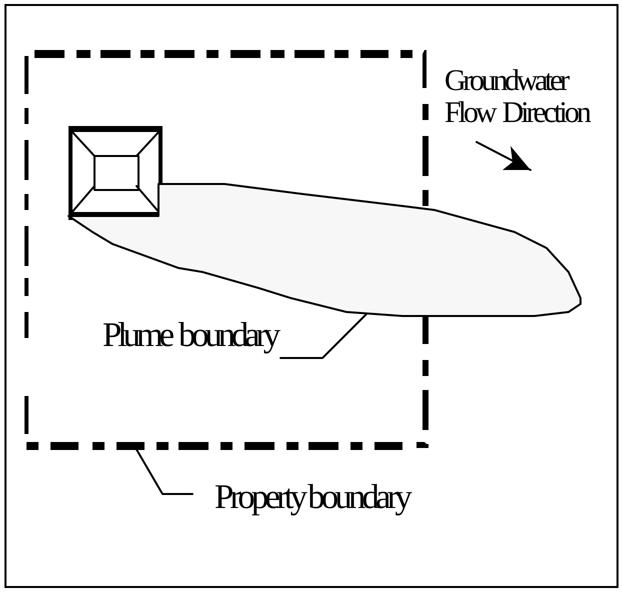


Figure 1: Example groundwater point of compliance for final cleanup goal involving returning contaminated groundwater to its maximum beneficial use. The shaded area represents a throughout the plume/unit boundary point of compliance corresponding to the volume of contaminated groundwater that needs to achieve specific groundwater cleanup levels.

Where is the groundwater point of compliance for final cleanup goals?

The location of the point of compliance should depend on whether the final cleanup is selected to (1) return usable groundwater to its maximum beneficial use; or (2) contain contamination within groundwater that EPA or a State has designated as not being usable (see Final

---

[4] The groundwater point of compliance in the context of short-term goals refers primarily to the Migration of Contaminated Groundwater Under Control Environmental Indicator, which is one of two environmental indicators used to track the progress of the RCRA Corrective Action Program (see Short-Term Protection Goals).

[5] EPA's intent in recognizing that there could be various locations for the groundwater point of compliance is to illustrate flexibility available to program implementers. EPA does not, however, want to create confusion over the names we attach to certain elements of corrective action. Regulators often have to define where facilities need to meet cleanup levels in order to achieve a particular goal. Whenever regulators define such locations, they are in essence establishing a point of compliance, but it is not necessary to refer to these locations as a point of compliance unless they find it beneficial to do so.

Cleanup Goals and Groundwater Use Designation) or in situations where the regulator determined that returning usable groundwater to its maximum beneficial use is technically impracticable.

For final cleanups selected to return groundwater to its maximum beneficial use, EPA recommends regulators set the point of compliance throughout the area of contaminated groundwater, or when waste is left in place[6], at and beyond the boundary of the waste management area encompassing the original source(s) of groundwater contamination (EPA, 1996a - page 19450). EPA typically refers to this area (more accurately described as a volume) as the "throughout-the-plume/unit boundary" point of compliance[7] (See Figure 1 on previous page).

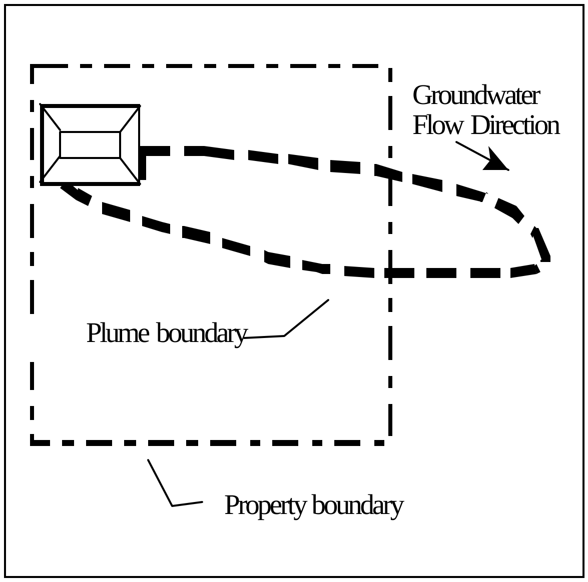


Figure 2: Plume boundary point of compliance for short-term protection goal associated with the Migration of Contaminated Groundwater Under Control environmental indicator. The heavy dashed line represents the point of compliance (i.e., boundary of the plume) defined by "contaminated" and "uncontaminated" monitoring wells.

If the final groundwater cleanup objective is to contain the plume rather than to return the groundwater to its maximum beneficial use, the point of compliance should generally be located at and, if appropriate, beyond the boundary of the containment zone. This point of compliance is similar to the approach regulators typically use to measure whether a facility achieves the Migration of Contaminated Groundwater Under Control environmental indicator (see answer to next question).

Where is the groundwater point of compliance for short-term protection goals?

Achieving the Migration of Contaminated Groundwater Under Control environmental indicator involves documenting that contaminated groundwater is expected to remain within an existing three-dimensional

---

[6] In the context of RCRA corrective action, "waste in place" typically refers to the waste management area encompassing the original source(s) of a release that the regulator determined is acceptable to leave in place as part of a final remedy. For example, a properly closed landfill represents a waste management area commonly allowed to stay in place as part of a final remedial action. EPA typically does not refer to contamination that has migrated from the original source(s) (e.g., non-aqueous phase liquid (NAPL)) as a waste management area or waste left in place (EPA, 1996c - page 17).

[7] This definition of a point of compliance for final remedies is consistent with the "area of attainment" (EPA, 1988) and "point of compliance" (EPA, 1997b) used in EPA's Superfund cleanup program. For more information concerning how the Superfund Program uses a point of compliance, refer to page 8753 of the NCP preamble (EPA, 1990b).

boundary(ies) of the plume[8] (EPA, 1999e). Using the general definition of a point of compliance described above, regulators and facilities could, in appropriate circumstances, recognize a plume boundary (see Figure 2) as a point of compliance for the Migration of Contaminated Groundwater Under Control environmental indicator. Evaluators should recognize that they need to account for all plumes of contaminated groundwater at a facility since EPA designed this indicator to reflect facility-wide conditions.

Where is the groundwater point of compliance for intermediate performance goals?

The need for, and location of, a point of compliance for an intermediate performance goal depends on facility-specific circumstances. Many intermediate performance goals for contaminated groundwater will not warrant establishing a point of compliance (e.g., source removal actions). In general, establishing a point of compliance as a component of an intermediate performance goal is only beneficial when a facility takes an action that includes assessment through groundwater monitoring. If the facility and the regulator wish to establish a point of compliance as a component of an intermediate performance goal, it should be located between the existing boundary of the plume and the original source of groundwater contamination. For example, establishing a facility boundary point of compliance may make sense when a groundwater contaminant plume extends off-site (see Figure 3). In this case, a facility boundary point of compliance establishes a way to measure when a facility achieves an intermediate goal of cleaning up the off-site groundwater.

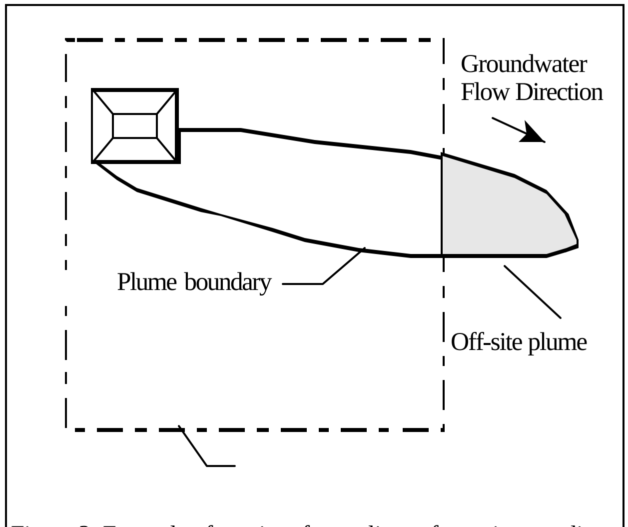


Figure 3: Example of a point of compliance for an intermediate performance goal. In this example, the point of compliance is considered to be throughout the portion of the contaminant plume that extends beyond the facility boundary.

In contrast, a facility boundary point of compliance would generally not be an appropriate component of an intermediate performance goal when a groundwater contaminant plume has not yet reached a property boundary because: (1) it would likely be inconsistent with EPA's general pollution prevention goals, and with the EPA's short-term protection goal of preventing the spread of contaminated groundwater; (2) monitoring uncontaminated wells at the facility boundary would not measure progress toward achieving the final cleanup goal; and, (3) as a practical matter, preventing groundwater contamination is usually much less costly than cleaning up the contamination after it has spread.

---

[8] Facilities and regulators typically define a plume boundary based on estimating a division between where groundwater is contaminated above and below levels of concern. They commonly make this estimate based on professional interpretation (often with the aid of computer software) of chemical analyses of groundwater samples collected from properly located monitoring wells or other monitoring devices.

References:

EPA, 1999e. Interim Final Guidance for RCRA Corrective Action Environmental Indicators (February 5). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/ei_guida.pdf.

EPA, 1997b. Rules of Thumb for Superfund Remedy Selection (EPA/540/R-97/013). Available at http://www.epa.gov/superfund/resources/rules/rulesthm.pdf.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant page: 19450.

EPA, 1996c. Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites (EPA/540/R-96/023, October). Available at http://www.epa.gov/superfund/resources/gwguide/gwfinal.pdf.

EPA, 1993b. Waste Management Area and Supplemental Well Guidance (June). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/wma_sup.htm.

EPA, 1990b. National Oil and Hazardous Waste Contingency Plan (55 FR 8666 and 40 CFR 300). The preamble is available at http://www.epa.gov/tio/osc/documents/mar1990.pdf. The CFR is available through http://www.access.gpo.gov/nara/cfr/waisidx_00/40cfrv20_00.html.

EPA, 1988. OSWER Directive 9283.1-2, "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites," (December 1).

7. Cleanup Timeframe
(September 2001)

What is the cleanup timeframe?

The cleanup timeframe is an estimate of when groundwater quality will achieve a certain level at a specified location and/or the schedule developed to take an action or construct a remedy designed to achieve a particular short-term protection, intermediate performance, or final cleanup goal.

EPA believes that cleanup timeframes should be reasonable, linked to specific goals, and based on facility-specific conditions. Examples of factors regulators and facilities should, where appropriate, take into account when developing cleanup timeframe(s) for a given facility include (EPA, 1996a):

- potential risks from exposures to contamination;
- current and reasonably expected future land and water use(s);
- type, source(s), and extent of contamination;
- hydrogeologic characteristics;
- reliability of exposure controls;
- design and capabilities of cleanup technologies;
- availability of treatment and/or disposal options;
- community preferences; and
- financial resources of the facility.

Rationale for Cleanup Timeframe

Establishing reasonable timeframes based on specific goals offers facilities realistic objectives, provides flexibility, helps prioritize resources efficiently, and maintains protection.

EPA's short-term goals are directed toward eliminating unacceptable exposures to contamination and preventing plumes from spreading as soon as possible. After achieving the short-term goals, facilities can move toward final cleanup goals in a timeframe commensurate with the technical difficulties and potential risks. Considering these factors to determine acceptable cleanup timeframes allows the RCRA Corrective Action Program to direct its resources toward reducing potential threats at more facilities, while maintaining its long term environmental cleanup goals.

What is the cleanup timeframe for EPA's short-term goals?

As described previously in this Handbook, the Corrective Action Program's short-term goals that EPA is currently using to monitor progress in response to the Government Performance and Results Act include: documenting that current human exposures to unacceptable levels of contamination are under control, and preventing plumes of contaminated groundwater from getting larger or adversely affecting surface water bodies. To help focus the program, EPA established nationwide goals which are as follows:

By 2005, EPA's goal is to verify and document that 95 precent of a baseline of 1,714 RCRA corrective action facilities (see http://www.epa.gov/epawaste/hazard/correctiveaction/baseline.htm) have human exposures under control and 70 precent have the migration of contaminated groundwater under control. EPA encourages regulators and facilities to work together to establish appropriate cleanup timeframes, based on the particular circumstances of each facility, that will help meet these near-term objectives. If people are currently using or being exposed to contaminated groundwater or contaminants transferred from groundwater (e.g., indoor air), facilities and regulators should take action as soon as possible to prevent these exposures and to achieve short-term protection goals.

How should regulators establish cleanup timeframes for intermediate performance goals?

If an intermediate performance goal is warranted, the timeframe to achieve that goal should be reasonable and based on facility-specific factors. In situations where facilities and regulators anticipate the time to achieve final cleanup goals will be long, establishing cleanup timeframes for intermediate goals can help provide meaningful measures to assess and communicate progress among interested stakeholders. Timeframes for intermediate goals should generally help to prioritize actions at a facility. For example, at a complex site with many areas of contamination, the regulator and facility may want to consider a sequence of intermediate goals for the purpose of demonstrating progress toward the final cleanup goals. A key consideration in prioritizing actions should be the relative risk and/or potential environmental harm associated with the current contamination.

How should regulators establish cleanup timeframes for achieving final cleanup goals?

EPA recognizes that uncertainties associated with the cleanup may make it impossible to specify with a high level of confidence when a remedy will achieve final cleanup goals. Regulators and facilities can't always accurately predict how long it will take to return groundwater to its maximum beneficial use because of the following kinds of complexities: type of contaminants; hydrogeologic characteristics; contaminant interactions; and, technology limitations among other factors. In these circumstances, facilities should generally still attempt to predict the time needed to achieve final cleanup goals, but stakeholders should recognize that such predictions are best considered in a relative sense for comparing one cleanup option to another. Where such predictions are difficult, EPA recommends that cleanup timeframes primarily focus on the schedules associated with implementing the remedy and perhaps anticipated timeframes associated with achieving certain other facility-specific milestones.

In general, a regulator is more likely to accept a longer timeframe for final cleanup goals when adequate monitoring and reliable controls are in place to prevent exposure (e.g., drinking water wells are prohibited). For example, a regulator might allow a facility to have an extended timeframe to clean up groundwater when the facility overlies groundwater designated as a future source of drinking water but where no one is currently using or anticipated to use the water in the foreseeable future.

Reference:

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant page: 19450.

8. Source Control
(September 2001)

What does source control mean?

Source control refers to a range of actions (e.g., removal, treatment in place, and containment) designed to protect human health and the environment by eliminating or minimizing migration of, or exposure to, significant contamination.

> **Rationale for Source Control**
>
> Source control, where necessary, will be a critical component of a facility's cleanup strategy aimed at returning contaminated groundwater to its maximum beneficial use in a reasonable timeframe. Controlling sources of contamination is also consistent with the Agency's long-standing pollution prevention goals; it is generally easier to deal with the contamination at the source than to clean up wide-spread contamination.

What are sources of contamination?

EPA typically describes sources[1] as contaminated material that acts as a reservoir for the continued migration of contamination to surrounding environmental media (i.e., soil, groundwater, surface water, sediment, or air), or provides a direct threat to a receptor. Sources are not always stationary, but can migrate from a location, such as a landfill or surface impoundment, where the contamination was originally released. For example, dense non-aqueous phase liquids (DNAPLs[2]) may be present as a "mobile" phase that continues to migrate deeper into the subsurface, migrate along a subsurface feature, or accumulate in a subsurface feature, such as a depression in a low permeable layer of clay.

What are EPA's expectations for source control regarding groundwater?

As conveyed in the 1996 Advance Notice of Proposed Rulemaking (ANPR), EPA expects[3] facilities to control or eliminate surface and subsurface sources of groundwater contamination (EPA, 1996a). EPA believes most facilities will need to control sources of contamination to achieve facility-specific cleanup goals. Sometimes facilities may need to implement source controls to achieve short-term protection goals. For example, controlling a source of contamination may be important for a facility that wants to rely on monitored natural attenuation to achieve the Migration of Contaminated Groundwater Under Control environmental indicator. Source control at many facilities will be an important component of

[1] See glossary definition of "source materials."

[2] Additional information and reports concerning DNAPL contamination is available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/non_aqu.htm

[3] See glossary for a definition of "remedy expectations."

intermediate performance goals used, for example, to demonstrate progress toward achieving final cleanup goals. Furthermore, as addressed in the Final Cleanup Goal section of this Handbook, EPA identifies source control as a recommended threshold criterion for final corrective action remedies. More specifically, facilities should propose final remedies that control the source(s) of releases so as to reduce or eliminate, to the extent practicable[4], further releases of hazardous wastes or hazardous constituents that may pose a threat to human health or the environment. EPA expects facilities to control the sources of contamination regardless of the current groundwater use or the groundwater use designation.

When should facilities and regulators consider source control measures?

You should consider source control measures as early as possible in corrective action. For example, you should consider whether source controls will be necessary to achieve short-term protection goals, or whether they would be more appropriate to implement as part of an intermediate performance goal or a final remedy. Furthermore, early consideration of potential source control technologies can help facilities focus their data collection to ensure they have adequate evaluation and design information.

When can facilities contain the sources rather than treat them?

EPA expects facilities to use treatment to address wastes and contaminated media that EPA considers principal threats (EPA, 1996a and EPA, 1990b). EPA considers sources or "source materials" to be principal threats when they are highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur (EPA, 1997b; EPA, 1996a; and EPA, 1991c). EPA expects to use engineering controls, such as containment, for wastes and contaminated media that can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable. The exact balance between treating, removing, and containing the source is best determined on a case-by-case basis during remedy evaluation and selection, and may depend on whether the facility is trying to achieve short-term, intermediate, or final cleanup goals. Along with identifying principal threats, you should also generally consider other factors such as long-term reliability, short-term risks, and community acceptance when evaluating the right balance between containment and treatment.

In some situations, it may be appropriate to contain rather than treat even principal threat wastes due to difficulties in treating the wastes. For example, the following situations could, depending on facility-specific circumstances, justifiably lead a regulator to decide that containment rather than treatment would be acceptable for principal threat wastes (EPA, 1997b):

[4] EPA recognizes that finding subsurface sources of contamination can be very challenging. Therefore, in this context, "practicable" refers to both finding as well as cleaning up sources of contamination. Decisions pertaining to the practicability of source control actions are best determined on a facility-specific basis.

- Treatment technologies are not technically feasible or are not available within a reasonable timeframe.

- The extraordinary volume of materials or complexity of the site may make implementation of treatment technologies impracticable (e.g., large landfills).

- Implementation of a treatment-based remedy would result in greater overall risk to human health and the environment due to risks posed to workers, the surrounding community, or impacted ecosystems during implementation (to the degree that these risks cannot otherwise be controlled during implementation).

- Implementation of the treatment technology would have severe effects across environmental media.

Why should facilities control sources when they have already achieved environmental indicators goals?

Environmental Indicators are only milestones on the way to meeting final cleanup goals and completing corrective action. For example, EPA believes that source control will often be necessary to achieve the final cleanup goal of returning groundwater to its maximum beneficial use within a reasonable timeframe.

References:

EPA, 1997b. Rules of Thumb for Superfund Remedy Selection, OSWER Directive No. 9355.0-69 (EPA/540/R-97/013, August). Available at http://www.epa.gov/oerrpage/superfund/resources/rules/index.htm. Particularly relevant text pertaining to applicability to RCRA corrective action found on page 1, and on Treatment of Principal Threat Wastes on pages 11 and 12.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant page: 19448.

EPA, 1991c. A Guide to Principal Threats and Low Level Threat Wastes. Superfund Publication 9380.3-06FS (November). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/threat.pdf.

EPA, 1990b. National Oil and Hazardous Waste Contingency Plan (55 FR 8666 and 40 CFR 300). The preamble is available at http://www.epa.gov/superfund/action/guidance/remedy/pdfs/ncppreamble61.pdf. The CFR is available through http://www.access.gpo.gov/nara/cfr/waisidx_00/40cfrv20_00.html.

9. Groundwater Use Designations

(September 2001)

What is a groundwater use designation?

A groundwater use designation is a determination of the reasonably expected use(s)[1], resource value (e.g., priority), and/or vulnerability of groundwater in a particular area. A system used to make protective groundwater use designations should account for these factors and be:

- based on an overall goal that is no less protective than EPA's groundwater protection goal[2];
- applied consistently to all groundwaters of a State; and
- developed with thorough opportunity for public participation.

EPA and States can use the designation as a factor in determining the maximum[3] (highest) beneficial use of the groundwater in order to establish facility-specific corrective action goals.

> **Rationale for Groundwater Use Designations**
>
> States should have the primary responsibility for managing and protecting their groundwater resources. Therefore, EPA prefers, where appropriate, to rely on State groundwater use designations when developing groundwater cleanup objectives.
>
> EPA supports State groundwater use designation systems that promote a consistent and comprehensive approach to groundwater protection based on varying groundwater characteristics. EPA's primary objectives are to advocate approaches for groundwater use designations that protect both the current as well as reasonably expected uses of groundwater. In particular, EPA wants to avoid inappropriate groundwater use designations and associated cleanup decisions that would rely on the lack of current drinking water use at or around an individual facility as the only justification for a non-drinking water use designation.

How does EPA define use, value, and vulnerability?

The term "use" refers to the current use and reasonably expected use of the groundwater. When

[1] Further guidance on defining "reasonably expected uses of groundwater" is available in Appendix B of the EPA guidance titled, Final Comprehensive State Groundwater Protection Program Guidance (EPA, 1992a).

[2] EPA's overall groundwater protection goal is to prevent adverse effects to human health and the environment and to protect the environment by, among other things, protecting that integrity of the Nation's groundwater resources (EPA, 1991b).

[3] Within the range of reasonably expected uses and exposures, maximum beneficial groundwater use warrants the most stringent groundwater cleanup levels.

people think about groundwater use, they often consider only drinking water use; however, there are many other groundwater uses besides drinking water. These uses include, for example, sanitary water, cooling water, car washes, livestock watering, and agricultural irrigation.

"Value" depends on the current and reasonably expected use, but it also considers groundwater's potential impact on other media; exposures to contaminants from groundwater can occur even when there is no direct use of the groundwater. For example, groundwater may recharge adjacent or underlying aquifers that are used for drinking water, or discharge to surface water to support aquatic life, recreation, and drinking water. In addition, exposure to contaminated indoor air can result from underlying groundwater contaminated with volatile chemicals. Value also refers to the irreplaceability of groundwater either as a source of drinking water (e.g., sole source aquifer) or to support vital ecological systems.

Groundwater "vulnerability" is the relative ease with which a contaminant introduced into the environment can migrate to an aquifer under a given set of management practices, contaminant properties, and aquifer hydrogeologic characteristics.

For additional information regarding how EPA defines the use, value, and vulnerability of groundwater, refer to Appendix B of EPA, 1992a.

Factors to Assess Use, Value, and Vulnerability of Groundwater Resources

- Vulnerability to contamination
- Hydrogeologic regimes (recharge and discharge areas)
- Flow patterns
- Quantity and potential yield
- Ambient and/or background quality
- Wide-spread contamination
- Current use and exposures (including public water supply systems and private drinking water supply wells)
- Reasonably expected future uses (based on demographics, remoteness, and availability of alternative water supplies)
- Connections to surface waters
- Impacts to ecological receptors
- Value attributed to a groundwater resource, including public opinion
- Governmental and legal boundary considerations (e.g., groundwater migrating across State boundaries)

(based on EPA, 1992a)

What factors should States consider when making groundwater use designations?

To promote consistency, where appropriate, EPA issued guidance to States (EPA, 1992a) that includes a list of factors (see adjacent box) they should generally consider in assessing use, value, and vulnerability of their groundwater resources.

How does EPA's policy on groundwater use designations affect States that consider all of their groundwater to be a potential drinking water supply?

EPA recognizes that some States have statutes, regulations, or policies designating all groundwater to be a potential drinking water supply, and requiring that all contaminated groundwater be cleaned up to drinking water standards. States may take a more stringent approach than what EPA would otherwise use for making groundwater use and cleanup decisions. However, EPA still encourages such States to develop methods for prioritizing groundwater resources to focus cleanup actions on facilities in more sensitive areas first. Examples of factors or criteria that States might use to distinguish among potential drinking waters on a facility-specific basis are:

- expected timeframe of future use;
- likelihood of use within a certain time period (e.g., 30 years);
- relative priority or value;
- relative vulnerability;
- proximity to existing public and private water supplies;
- presence of elevated concentrations of naturally occurring contaminants; and,
- likelihood of impacting sensitive areas (e.g., wetlands) or environmental receptors[4]

States are already acquiring this kind of information for other EPA programs. For example, Section 1453 of the Safe Drinking Water Act (SDWA) as amended in 1996 requires States to develop and implement Source Water Assessment Programs (SWAPs). These programs must assess source waters within the State that support public drinking water systems. A source water assessment program will consist of: (1) a delineation of the source water area; (2) an inventory of potential sources of contaminants; (3) a susceptibility analysis of public drinking water systems; and (4) making the results of the assessments available to the public.

States were required to submit their Source Water Assessment Programs for approval by February 1999, and have 3 ½ years to complete the assessment following program approval. Most States will have completed their assessments by May 2003. EPA will not consider assessments to be complete until the results have been made available to the public. EPA believes that these assessments will prove to be helpful in identifying areas needing greater protection of groundwater resources. For more information on Source Water Assessment Programs, refer to State Source Water Assessment and Protection Programs Guidance (EPA, 1997d). Electronic information is available at http://www.epa.gov/OGWDW/swp/swappg.html.

Who makes groundwater use designations?

The regulator makes the groundwater use designation for the purposes of facility-specific RCRA corrective action, since regulators are responsible for ensuring that corrective action is protective of human health and the environment. However, a facility can provide the information the regulator needs

---

[4] Risks to ecological receptors may in some situations be the primary reasons for cleanups, especially for groundwater that is not designated as a source of drinking water. To protect particularly sensitive ecological receptors, concentrations of groundwater cleanup levels in some circumstances may have to be lower than concentrations associated with drinking water standards designed to protect humans.

to make a groundwater use designation.

EPA generally prefers to base its cleanup decisions on State-developed groundwater use designations. In particular, EPA generally intends to defer to a State groundwater use designation when it is part of an EPA-endorsed Comprehensive State Groundwater Protection Program ("CSGWPP") that provides for facility-specific decision making in EPA's remediation programs[5]. Also, in the absence of such an EPA-endorsed CSGWPP, EPA may, where appropriate, rely on an alternative protective State groundwater use designation especially when that designation considers the same factors listed in the CSGWPP guidance (EPA, 1992a). States authorized for corrective action have the lead in making groundwater use designations for cleanups they are overseeing. However, States may choose to use EPA's groundwater use classification (see next question) in the absence of a State groundwater use designation system.

Depending on facility-specific circumstances, EPA may find it appropriate to use its own classification (see next question) to make groundwater use designations. These circumstances could include, for example, when: (1) EPA has the lead role in implementing corrective action at a facility, and (2) a State designation system is not available or is not in EPA's opinion adequately protective. You should consult the lead regulatory agency to determine how they generally determine reasonably expected groundwater use [6].

What is EPA's groundwater use classification?

EPA's groundwater classification system for site-specific groundwater use designations is found in "Guidelines for Groundwater Classification under the EPA Ground-Water Protection Strategy" (EPA, 1986 - available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/gwclass.htm). These guidelines describe three classes of groundwater that represent a hierarchy of groundwater resource values to society: Class I is groundwater that is an irreplaceable source of drinking water and/or ecologically vital. Class II is groundwater currently used or potentially usable as a source of drinking water; and Class III includes groundwater that is not a current or potential source of drinking water.

How can State groundwater use designations enhance protection and flexibility for RCRA

---

[5] A Comprehensive State Groundwater Protection Program (CSGWPP) is a groundwater management strategy developed by a State. EPA reviews CSGWPPs and "endorses" those that successfully meet six strategic activities. EPA outlines specific considerations for each strategic activity in the CSGWPP guidance (EPA, 1992a). In particular, EPA remediation programs review State guidelines in the CSGWPP to prioritize groundwater based upon use, value, and vulnerability. In 1997, EPA's Office of Solid Waste and Emergency Response issued a directive (EPA, 1997e) encouraging EPA's remediation programs generally to defer to State determinations of current and future use when based on an EPA-endorsed CSGWPP that has provisions for facility-specific decisions. A map of States with EPA-endorsed CSGWPPs is available at http://www.epa.gov/safewater/csgwpp.html. Also, refer to the discussion on CSGWPPs in EPA, 1996a.

[6] Some States have groundwater classification schemes based on specific parameters (e.g., total dissolved solids) that mandate particular cleanup standards (e.g., primary and secondary drinking water standards). Links to State hazardous waste programs are available at http://www.epa.gov/epawaste/hazard/correctiveaction/baseline.htm.

cleanups?

Regulators can prioritize their workload to address those facilities overlying more highly valued groundwaters first. In addition, groundwater use designations can serve as a starting place for predicting the reasonably expected use(s) of groundwater. Therefore, for States with protective groundwater use designation systems, regulators may modify groundwater cleanup objectives while still ensuring protection of human health and the environment based on both current and potential future uses.

Flexibility associated with groundwater use designations provides more cleanup options to facilities and regulators. For example, regulators could allow a facility to have an extended cleanup timeframe to clean up groundwater when the facility overlies groundwater designated as a future drinking water source, but where no one is currently using or anticipated to use the water in the foreseeable future.

Another example is that some States have developed groundwater cleanup levels based on industrial or non-drinking water use. These non-drinking water cleanup levels may be higher in concentration than drinking water standards, and may facilitate redevelopment of facilities (e.g., brownfields - http://www.epa.gov/swerosps/bf/topics.htm) that might otherwise remain unused. However, it is important to evaluate various uses of and exposures to groundwater on a facility-specific basis prior to relying on generic cleanup levels to ensure these levels would be protective.

Some States also formally identify groundwater that has no beneficial use. For such situations, as described in the Final Cleanup Goals section of this Handbook, regulators could consider source control and long-term containment rather than cleaning up the groundwater to achieve a particular cleanup level(s) throughout the contaminant plume. When long-term containment is the cleanup objective, regulators should generally establish a point of compliance at the boundary of the containment zone.

Facilities should not interpret that accepting a higher groundwater cleanup level based on a groundwater use designation means that less stringent prevention measures are acceptable. Regardless of the groundwater use designation, facilities should comply with all State and Federal laws for preventing new releases of contamination, and do their part to minimize hazardous waste generation.

How do groundwater management or containment zones relate to groundwater use designations?

Some States[7] formally define existing areas of broadly contaminated groundwater as groundwater management zones. States typically do not use these groundwater management zones to change a groundwater use designation; rather, they generally use groundwater management zones as a type of

[7] Illinois, Delaware and Texas are examples of States that have adopted groundwater management zone approaches. California has a adopted a similar approach called a "containment zone," but does not use it for facilities subject to RCRA corrective action.

institutional control[8] to publically acknowledge that the contaminated groundwater is currently unsuitable for its designated use, and to provide reasonable flexibility to facilities that are implementing long-term groundwater remedies. While some differences exist among States, groundwater management zones typically are granted only if a facility satisfies specific provisions. Some of the more common conditions, which are also consistent with the policies in this Handbook, include:

- the facility has controlled sources of contamination where appropriate;
- the facility has defined existing boundaries of the contaminated groundwater;
- the facility is currently conducting a groundwater cleanup action under regulatory oversight, that is designed to prevent migration of contamination outside the groundwater management zone; and
- the facility recognizes that its obligations to ensure protection of human health and the environment continue until the groundwater is returned to its designated use.

In general, EPA supports and encourages creative and flexible approaches to address contaminated groundwater. As such, EPA supports the use of groundwater management zones when they streamline corrective action decision making, while still ensuring that facilities achieve protective short- and long-term cleanup goals.

References:

EPA, 1997d. State Source Water Assessment and Protection Programs Guidance (EPA/816/R-97/009, August). Available at http://www.epa.gov/OGWDW/source/swpguid.html .

EPA, 1997e. The Role of Comprehensive State Groundwater Protection Programs (CSGWPPS) in OSWER Remediation Programs. OSWER Directive 9283.1-09. Available at http://www.epa.gov/superfund/resources/csgwpp/role.pdf.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant page: 19457.

EPA, 1992a. Final Comprehensive State Groundwater Protection Program Guidance (EPA/100/R-93/001). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/csgwpp.htm.

EPA, 1991b. Protecting the Nation's Groundwater: EPA's Strategy for the 1990's. Office of the Administrator. Washington, D.C. Available at http://www.epa.gov/superfund/resources/remedy/pdf/21z-1020-s.pdf.

[8] To provide overlapping assurances of protection from contamination, EPA recommends that various forms of institutional controls be "layered" (i.e., use of multiple institutional controls) or implemented in a series. For example, prohibitions against installing drinking water wells could be used in conjunction with defining a groundwater management zone.

EPA, 1986. Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy. Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/gwclass.htm.

10. Institutional Controls
(September 2001)

What are institutional controls?

EPA typically describes institutional controls as non-engineered measures[1] such as administrative and/or legal controls that minimize the potential for human exposure[2] to contamination by limiting land or resource use.

EPA expects[3] to use institutional controls, such as water and land use restrictions, primarily to supplement engineering controls as appropriate to prevent or limit exposure to hazardous waste and constituents (EPA, 1996a). Institutional controls are appropriate during all stages of the cleanup process to accomplish various cleanup-related objectives. To provide overlapping assurances of protection from contamination, institutional controls should be "layered" (i.e., use of multiple institutional controls) or implemented in a series.

> **Rationale for Institutional Controls**
>
> EPA recognizes that, depending on the site-specific circumstances, facilities can achieve short-term, intermediate, or final cleanup goals through various combinations of removal, treatment, engineering, and institutional controls. For groundwater that will likely remain contaminated for a considerable period of time, EPA believes that some form of institutional control will typically be a critical part of the groundwater remedy to prevent exposure. Therefore, institutional controls should be evaluated, implemented, and monitored just like any other component of a remedy needed to ensure protection.

What are the general categories and some specific examples of institutional controls?

There are four general categories of institutional controls:

- governmental controls;
- proprietary controls;

---

[1] Fences that restrict access to sites are often termed institutional controls; however, EPA does not consider fences to be institutional controls because fences are physical barriers instead of administrative or legal measures. Furthermore, while the term "deed restriction" is often used in remedy decision documents to describe easements or other forms of institutional controls, "deed restriction" is not a traditional property law term and should be avoided. For more detailed guidance on institutional controls, refer to a recent document (EPA, 2000b) issued by EPA titled, "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups." You can access this document as well as supporting other related documents and supporting materials at http://www.epa.gov/superfund/action/ic/guide/index.htm.

[2] While institutional controls may limit exposure to human populations, facilities and regulators should ensure that cleanup actions also protect ecologic receptors.

[3] See glossary for a definition of "remedy expectations."

- enforcement tools with institutional control components; and
- informational devices.

Each of these categories is briefly described below. For more detailed descriptions of these categories, including benefits and limitations of different institutional control mechanisms, refer to the institutional control matrix available at:
http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/ics/matrxrv3.pdf.

Governmental Controls - These controls are usually implemented and enforced by State or local governments. Once implemented, local and State entities often use traditional police powers to regulate and enforce the controls. Since this category of institutional control is put in place under local jurisdiction, they may be changed or terminated with little notice to EPA, and EPA generally has no authority to enforce such controls. Examples include zoning, ordinances (e.g., restricting well drilling or water use), statutes, building permits, or other provisions that restrict land or resource use.

Proprietary Controls - These controls rely on legal instruments placed in the chain of title for the subject site or property. The specific instrument may convey a property interest from the owner (grantor) to a second party (grantee) for the purpose of restricting land or resource use. One example of this type of control is an easement that provides access rights for monitoring and inspection. Another example is a covenant not to dig or drill wells in certain areas. A major benefit of these controls is that they can be binding on subsequent purchasers of the property and are transferable. However, enforcement of proprietary controls depends on the party to which the property interest has been granted. Unlike EPA's Superfund Program, RCRA does not authorize EPA to acquire property interests to conduct a cleanup, and, therefore, EPA cannot generally hold or directly enforce proprietary controls associated with a RCRA cleanup.

Enforcement Tools - Federal, State and local governments can, in some circumstances, issue or negotiate permits, orders, or other enforceable agreements that direct a facility to refrain from using a property in specific ways. These tools can be very effective but the major limitation is that most enforcement agreements are only binding on those who enter into the agreement. Furthermore, restrictions based on enforcement tools are not typically transferable through a property transaction.

Informational Devices - These tools are typically used to provide information or notification regarding contamination present at a property. Common examples include State registries of contaminated properties, deed notices, and advisories. Informational devices are not typically enforceable; therefore, they are best used as a secondary "layer" to help ensure the overall reliability of other institutional controls.

How can facilities and regulators use institutional controls to address contaminated groundwater?

For contaminated groundwater, the most common purpose of institutional controls is to protect human health by preventing exposure. As described previously, institutional controls "layered" or used in series provide the best means to ensure protection from contaminated groundwater. For example, to prevent exposure to contaminated groundwater associated with a given facility, institutional controls could include all or various combinations of the following components: (1) State or local governmental controls prohibiting well drilling and use of groundwater in a designated area; (2) a proprietary easement or covenant providing access to monitor groundwater for facility investigations or performance monitoring, and/or restrictions on using groundwater after construction of the remedy is complete; (3) enforceable conditions in a State or EPA permit or administrative order preventing use of contaminated groundwater and requiring training for those who could come in contact with contaminated groundwater; (4) placing a notice on the deed about the existence of contaminated groundwater under the property; and (5) distributing an advisory notice to local citizens in a given area that they should avoid drinking or contact with groundwater. Facilities and regulators should also consider establishing procedures for terminating an institutional control(s) when it is no longer necessary to protect human health and the environment.

How should facilities develop and stakeholders evaluate institutional controls?

It is helpful for stakeholders to consider institutional controls in a similar manner to how they would evaluate, implement and monitor an engineered remedy. Therefore, institutional controls should go through an evaluation, selection, implementation, and an operation and maintenance phase. All four phases are important because institutional controls can work well, work somewhat, or not work at all.

The evaluation phase should involve assessing the purpose and type of institutional control based on how well it would meet a specific short-term protection, intermediate performance, or final cleanup goal. This phase should identify all parties that would need to be involved to successfully implement the institutional control. Additionally, this phase should include evaluation of the approaches facilities and regulators will use to assess the effectiveness of the institutional control.

As with other components of a remedy, the facility should recommend a specific institutional control approach, and regulators should determine, with input from the public, whether the facility's recommendation is satisfactory. This selection phase should be based on EPA's recommended threshold and balancing criteria as discussed in the Final Cleanup Goals section of this Handbook.

The implementation phase typically involves negotiating, drafting, and recording documents to put into place the institutional controls that successfully made it through the evaluation phase. For example, implementing an institutional control could involve placing provisions in a State permit, creating an easement, putting a notice in a deed, and distributing advisories.

Operation and maintenance should include periodic actions serving to ensure that the institutional control is working as designed. Examples of operation and maintenance of an institutional control include: physical inspection of legal documents including deeds, enforcing institutional controls if necessary, and routine distribution of advisories to local citizens.

References:

EPA, 2000b. Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups (EPA/540/F-00/005, September). OSWER Directive 9355.0-74FS-P. Available at http://www.epa.gov/superfund/action/ic/guide/index.htm.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages: 19448-49, and 52.

11. Monitored Natural Attenuation

(September 2001)

What is monitored natural attenuation?

The term "monitored natural attenuation" refers to an approach to clean up environmental contamination by relying on natural processes and monitoring. Natural attenuation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater.

> **Rationale for Monitored Natural Attenuation**
>
> This policy reflects advancements in EPA's understanding of how natural attenuation processes can be part of an effective cleanup strategy. Monitored natural attenuation is not a "no action" cleanup option. Appropriate use of monitored natural attenuation supports EPA's cleanup objectives, which include source control, prevention of plume migration, and returning contaminated groundwater to its maximum beneficial use.

When is monitored natural attenuation a likely cleanup option?

Monitored natural attenuation may be an appropriate cleanup option (EPA, 1996a) when the facility can demonstrate that the remedy is capable of achieving facility-specific groundwater cleanup levels in a reasonable cleanup timeframe. Facilities should evaluate and justify monitored natural attenuation remedies using recommended threshold and balancing criteria discussed in the Final Cleanup Goal section of this Handbook. Monitored natural attenuation should be justified on a facility-specific basis and compared with, where appropriate, other plausible options. In general, monitored natural attenuation proposals are more likely to be acceptable to regulators[1] when:

- the facility can demonstrate that monitored natural attenuation will be able to achieve groundwater cleanup objectives;
- measures for source control of groundwater contamination are already in place;
- the dominant natural attenuation processes cause degradation or destruction of contaminants as opposed to those processes that merely dilute contamination or prevent its movement;

[1] Some States may have specific guidelines, requirements, or restrictions associated with monitored natural attenuation remedies. For example, some States have specific guidelines for when monitored natural attenuation would be acceptable, based on: (1) contaminant concentrations, (2) plume location (i.e., off-site), and (3) anticipated timeframe to clean up the groundwater.

- the contaminant plume(s) is already stable or shrinking in extent;

- the estimated cleanup timeframe[2] to meet cleanup levels is reasonable considering factors such as groundwater use and timeframes required for other remedies, and the timeframe is comparable to that which could be achieved through active remediation (EPA, 1990b - NCP preamble page 8734); and

- the facility uses monitored natural attenuation in conjunction with an active remedial system or as a follow-up measure.[3]

For a more complete list of recommended factors, a list of advantages and disadvantages of monitored natural attenuation remedies, and additional policy and technical guidance, refer to EPA, 1999d, and EPA, 1998b. You can also find additional information concerning monitored natural attenuation in report developed by the National Research Council (NRC, 2000).

Is monitored natural attenuation acceptable when contaminated groundwater is off-site?

The regulator should determine whether monitored natural attenuation will be acceptable for off-site contaminated groundwater.[4] In making this determination, the regulator should consider facility-specific circumstances, as well as any applicable Federal and State requirements and guidance. One situation where a regulator might accept a monitored natural attenuation remedy is where no one is currently exposed to unacceptable levels of contamination and the plume is not expanding (i.e., the facility meets EPA's short-term protection goals). Other very important factors to consider when deciding whether to rely on monitored natural attenuation for off-site contamination include the thoroughness of public participation[5], the ability to conduct long-term monitoring and prevent exposures, and whether the facility is controlling the source of the groundwater contamination.

Should monitored natural attenuation remedies include formal contingency measures?

In general, EPA recommends that facilities and regulators evaluating monitored natural attenuation as a cleanup option should consider the need for identifying one or more contingency remedies (EPA,

---

[2] EPA recommends that proposals for monitored natural attenuation remedies include estimates of the time needed to achieve groundwater cleanup levels. EPA realizes that such estimates are based on numerous assumptions, but they are still helpful for comparisons between cleanup options.

[3] While EPA believes regulators will generally be more likely to approve monitored natural attenuation remedies that involve other more active source control and treatment measures, we recognize that there will be some situations where monitored natural attenuation may be sufficient as a stand-alone remedial alternative.

[4] EPA's policy (EPA, 1999d) on monitored natural attenuation does not distinguish between on-site and off-site contaminated groundwater.

[5] Some State programs might require formal concurrence of adjacent property owners for monitored natural attenuation remedies proposed to address off-site contaminated groundwater.

1999d). A contingency measure (or contingency plan or contingency remedy) is a cleanup approach specified in a remedy decision document that functions as a "backup" remedy in the event that the "selected" remedy fails to perform as anticipated. Contingency measures should generally be flexible, allowing for new information about risks and technologies. Contingency measures are especially appropriate for a monitored natural attenuation remedy that is selected based primarily on predictive analyses rather than documented trends of decreasing contaminant concentrations.

How long should a facility monitor a monitored natural attenuation remedy?

A facility should monitor a monitored natural attenuation remedy until the groundwater cleanup levels are met at the point of compliance for the final cleanup goals, and longer, where appropriate, for example where the final remedy involves a component designed for long-term containment. EPA specifically added the term "monitored" to the name of this cleanup alternative to emphasize the importance of long-term performance monitoring. EPA's Policy Directive States, "Performance monitoring should continue until remediation objectives have been achieved, and longer if necessary to verify that the facility no longer poses a threat to human health or the environment." However, the Directive also emphasizes that it is important to include flexibility sufficient to adjust the frequency (more frequent or less frequent) of monitoring as the situation warrants.

References:

EPA, 1999d. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites (April 21). OSWER Policy Directive 9200.4-17P. Available at http://www.epa.gov/swerust1/directiv/d9200417.htm. Other helpful links regarding MNA available at http://www.epa.gov/swerust1/cat/mna.htm and http://www.epa.gov/swerust1/oswermna/mnalinks.htm

EPA, 1998b. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (EPA/600/R-98/128). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/rem_eval/protocol.pdf

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages: 19451-52.

EPA, 1990b. National Oil and Hazardous Waste Contingency Plan (55 FR 8666 and 40 CFR 300). The preamble is available at http://www.epa.gov/superfund/action/guidance/remedy/pdfs/ncppreamble61.pdf. The CFR is available through http://www.access.gpo.gov/nara/cfr/waisidx_00/40cfrv20_00.html.

NRC, 2000. Natural Attenuation for Groundwater Remediation. Committee on Intrinsic Remediation, Water Science and Technology Board, Board on Radioactive Waste Management, National Research Council. Available at http://www.nap. edu/catalog/9792.html

12. Technical Impracticability
(September 2001)

What does technical impracticability mean?

Technical impracticability (TI) for contaminated groundwater refers to a situation where achieving groundwater cleanup levels associated with final cleanup goals is not practicable from an engineering perspective (EPA, 1996a; EPA, 1995a; and EPA, 1993a). The term "engineering perspective" refers to factors such as feasibility, reliability, scale or magnitude of a project, and safety. For example, a certain cleanup approach might be technically possible, but the scale of the operation might be of such magnitude that it was not technically practicable.

> **Rationale for Technical Impracticability**
>
> EPA believes that it is appropriate to recognize the limitations of current technologies to clean up groundwater to its maximum beneficial use. This policy provides facilities a recommended framework to technically justify such limitations and to focus resources on protective alternative remedial strategies. EPA's policy concerning technical impracticability does not, however, signal a scaling back of efforts to address contaminated groundwater. Rather, this policy reaffirms EPA's commitment to protect human health and the environment from contamination associated with RCRA corrective action facilities. In particular, the policy encourages regulators to (1) base their technical impracticability decisions on sound science, and (2) where technical impracticability is adequately justified, ensure that facilities maintain their alternative remedial strategies (e.g., containment) as long as necessary to protect both human health and the environment.

What are the primary factors that might lead to a technical impracticability determination?

Reasons for technical impracticability generally fall into one of two categories[1]:

(1) Hydrogeologic factors, or
(2) Contaminant-related factors.

Examples of limiting hydrogeologic factors include very low-permeable or highly heterogeneous soils, or complex fractures or solution cavities in bedrock. A contaminant-related factor could be presence of residual non-aqueous phase liquids (NAPLs). Other contaminant-related factors could be associated with extensive volume of or limited access to contaminated material.

EPA expects that poor cleanup performance due to inadequate remedial design would not be sufficient justification for a technical impracticability determination. Design inadequacies could stem from, for

---

[1] For further information regarding challenges associated with groundwater cleanups, refer to ***Alternatives for Ground Water Cleanup*** (NRC, 1994), available at http://www.nap.edu/books/0309049946/html/. Also, you can find numerous resources concerning cleanup technologies at EPA's Technology Innovation Office's Web site (http://www.clu-in.org/), including the feature called "Technology Innovation Office's Perspectives" (http://www.clu-in.org/tiopersp/) where you can view several recent articles summarizing current cleanup technology practices and developments.

example, inadequate characterization, selecting inappropriate technologies, or deficiencies associated with implementing a particular technology.

Is the mere presence of non-aqueous phase liquids (NAPLs) sufficient to justify a technical impracticability determination?

No. In determining that it is technically impracticable to achieve a set cleanup level, regulators should not rely solely on the presence of NAPLs[2]. The presence of NAPL is just one of many factors facilities and regulators should consider when evaluating technical impracticability. Other factors to consider are the type, amount, and location of NAPL, as well as the technologies that are available to clean up the NAPL. Facilities should, therefore, avoid basing their technical impracticability justification solely on the presence of NAPL or the apparent inability of any one technology (e.g., pump-and-treat). A technical impracticability evaluation should be based on a comprehensive understanding of hydrogeologic factors, chemical characteristics, and conventional as well as innovative technologies.

What should facilities include in a technical impracticability evaluation?

EPA generally expects that technical impracticability determinations would be based on an evaluation by the facility. EPA's guidance (EPA, 1993a) on technical impracticability suggests that this evaluation generally include the following:

- Spatial area (the TI zone) over which the TI decision would apply;
- Specific groundwater cleanup levels, consistent with the groundwater use designation, that are considered technically impracticable to achieve;
- Conceptual site model that describes geology, hydrology, groundwater contamination sources, transport, and fate;
- Evaluation of the "restoration potential" of the TI zone;
- Cost estimates;
- Any additional information EPA or the State program deems necessary; and
- Description of an alternative remedial strategy.

When should a facility recommend technical impracticability?

Considering technical impracticability early in corrective action (e.g., during facility characterization) is a good idea if available information suggests that a facility has hydrogeologic or chemical-related cleanup limitations. The facility should submit a technical impracticability evaluation along with a recommendation for a final remedy. However, as a general matter, we recommend facilities do not devote significant resources on a technical impracticability evaluations until they achieve short-term protection goals (i.e., environmental indicators).

---

[2] Additional information and reports concerning NAPL contamination is available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/non_aqu.htm See also EPA, 1995b and 1994c.

Should regulators make technical impracticability determinations prior to a facility's attempt to meet groundwater cleanup levels?

In many case, regulators should make technical impracticability determinations only after facilities implement pilot or full-scale groundwater cleanup systems because it is often difficult to predict the effectiveness of remedies based solely on site characterization data. However, in some cases, regulators could make technical impracticability determinations prior to remedy implementation. Regulators should base these pre-implementation or "front-end" technical impracticability determinations on appropriate site characterization that define the most critical limitations to meeting a groundwater cleanup level.

If a regulator makes a formal technical impracticability determination, has the facility satisfied all of their corrective action obligations for groundwater?

A technical impracticability determination does not override the RCRA statutory obligation that remedies protect human health and the environment. When the regulator determines that achieving groundwater cleanup levels associated with final cleanup goals is technically impracticable, the regulator should select an "alternative remedial strategy" that protects human health and the environment and:

- is technically practicable;
- achieves short-term protection goals and, if appropriate, intermediate performance goals;
- controls the sources of contamination;
- achieves groundwater cleanup levels outside the TI zone;
- provides for appropriate long-term operation, maintenance, and monitoring; and
- is consistent with the overall cleanup goals for the facility.

Why should facilities conduct investigations within the technical impracticability zone?

Facilities should characterize within the TI zone to: (1) support the technical impracticability evaluation; (2) identify sources that they should control, even within the TI zone; (3) evaluate the potential for cross-media transfer of contamination they may need to manage (e.g., from groundwater to air) as part of an alternative remedial strategy; and (4) support the development of an alternative remedial strategy as discussed above. The particular circumstances of the facility will govern the amount of characterization needed to accomplish these objectives.

Why should facilities control sources within the technical impracticability zone?

Source control is typically an important part of an acceptable alternative remedial strategy and is one EPA's three recommended threshold criteria associated with final cleanup goals. Source control prevents the continued input of contamination into surrounding environmental media and can help improve the likelihood that the alternative remedial strategy will be effective in the long term. Controlling sources within the technical impracticability zone will help to limit the amount of contamination facilities will need to address if and when achieving the groundwater cleanup levels becomes technically practicable in the future. However, as mentioned previously in this Handbook (see Final Cleanup Goals and Source Control), EPA believes the exact balance between treating, removing, and containing the source, even in the context of a technical impracticability determination, is best evaluated on a case-by-case basis.

How does a technical impracticability determination affect the point of compliance?

Even when regulators make a technical impracticability determination, they should establish a point of compliance as necessary to track progress in meeting cleanup goals associated with the alternative remedial strategy. For example, when an alternative remedial strategy involves returning a portion of the plume to its maximum beneficial use, regulators should generally establish a point of compliance throughout the contaminated groundwater outside of the technical impracticability zone. Additionally, if the alternative remedial strategy involves long-term containment, regulators should generally establish a point of compliance at the boundary of the technical impracticability zone to verify that the containment system is working as intended.

How long should a technical impracticability determination last?

EPA generally recommends that, for RCRA corrective action, technical impracticability determinations and the responsibility of the facility to maintain its alternative remedial strategy remain in place until subsequent advances in technology make achievement of the groundwater cleanup levels within the TI zone technically practicable. Facilities should realize that a technical impracticability determination for many circumstances could warrant ongoing[3] care to ensure long-term protection.

Should regulators and/or facilities revisit technical impracticability determinations?

Technical impracticability determinations are based on current understanding of capabilities and limitations of cleanup technologies. Cleanup goals that are technically impracticable today could become technically practicable at some point in the future. Therefore, EPA's 1993 guidance on technical impracticability (EPA, 1993a) recognizes that regulators overseeing RCRA corrective action may require, where appropriate, facilities to "undertake additional remedial measures in the future if subsequent advances in remediation technology make attainment of media cleanup objectives technically practicable." Examples could include situations where new information or new technologies become available that indicate the facility could achieve groundwater cleanup levels that were previously determined to be technically impracticable. Sometimes, the facility might want to revisit the technical impracticability determination without prompting by the regulator. For example, the facility might want to try a new technology that has the ability to achieve the original cleanup objectives rather

[3] Some cleanup programs (e.g., New York State -- see http://www.clu-in.org/eiforum2000/prez/ppframe1.cfm?id=81) have referred to long-term containment of contaminated groundwater in terms of "perpetual care" obligations.

than continuing to implement an alternative remedial strategy. Therefore, EPA recommends that both facilities and regulators periodically re-evaluate the technical impracticability decision as part of routine performance monitoring.

References:

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant page: 19451.

EPA, 1995a. Consistent Implementation of the FY 1993 Guidance on Technical Impracticability of Ground Water Restoration at Superfund Sites (January). OSWER Directive 9200.4-14. Additional information available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/tec_imp.htm.

EPA, 1995b. Groundwater Issue: Light Non-Aqueous Phase Liquids (EPA/540/S-95/500). Available at http://www.epa.gov/ada/download/issue/lnapl.pdf.

EPA, 1994c. DNAPL Site Characterization (EPA/540/F-94/049). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/dnapl.pdf.

EPA, 1993a. Guidance for Evaluating the Technical Impracticability of Groundwater Restoration (EPA/540/R-93/080, September). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/techimp.htm.

NRC, 1994. *Alternatives for Ground Water Cleanup* / Committee on Ground Water Cleanup Alternatives, Water Science and Technology Board, Board on Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, National Research Council. National Academy Press, 1994. Available at http://www.nap.edu/books/0309049946/html/.

13. Reinjection of Contaminated Groundwater

(September 2001)

Can facilities reinject groundwater that is contaminated with hazardous wastes back in the subsurface as part of corrective action?

RCRA section 3020(a) bans hazardous waste disposal by underground injection into or above a [geologic] formation that contains (within 1/4 mile of the well used for such underground injection) an underground source of drinking water. However, RCRA section 3020(b) exempts from that ban the injection of groundwater contaminated with hazardous wastes provided that certain conditions are met.[1]

> **Rationale for Reinjection of Contaminated Groundwater**
>
> EPA's policy on reinjection of contaminated groundwater encourages facilities and regulators to consider opportunities for using in-situ bioremediation and other in-situ treatments where such technologies are protective and offer advantages over other cleanup alternatives.

What are the specific conditions facilities have to meet prior to reinjecting groundwater contaminated with hazardous waste into the subsurface?

The exemption provided by RCRA section 3020(b) allows facilities to reinject groundwater that is contaminated with hazardous wastes back into the aquifer from which it was withdrawn if: (1) the re-injection is part of a response action under section 104 or 106 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), or part of RCRA corrective action intended to clean up such contamination; (2) the contaminated groundwater is treated to substantially reduce hazardous constituents prior to such reinjection; and (3) the cleanup will, upon completion, be sufficient to protect human health and the environment.

The second element of the statutory provision in the preceding paragraph means that treatment must occur prior to reinjection, and the treatment substantially reduces hazardous constituents in the groundwater either before or after reinjection of the contaminated groundwater back into the aquifer from which it was withdrawn (EPA, 2000a; also, see EPA, 1989a).

---

[1] 40 CFR 144.13 and 144.23 of the Underground Injection Control (UIC) Program regulations include an exemption for Class IV wells (wells involving the injection of hazardous waste) similar to that found in RCRA section 3020(b). Under the UIC Program, these Class IV wells are authorized by rule. Prior to construction of such wells, facilities must notify their state UIC Program and submit inventory information as required by 144.26. You can access UIC regulations at http://www.gpoaccess.gov/cfr/retrieve.html or http://www.epa.gov/safewater/uic/uicregs.html.

Does section 3020(b) allow the reinjection of contaminated groundwater after the addition of nutrients or other in situ treatment products?

Yes. Section 3020(b) allows the reinjection of contaminated groundwater containing these additives as long as the hazardous constituents in the groundwater are substantially reduced, either before reinjection or as a result of subsequent in-situ treatment consistent with section 3020(b)(2). The remedy must also comply with sections 3020(b)(1) and (3) described in the previous question. Furthermore, the substantial reduction should occur in a reasonable period of time (i.e., in a time period consistent with the CERCLA and/or RCRA cleanup objectives made for the groundwater) and the regulator should consider whether hydraulic containment would be appropriate to ensure protection of the groundwater resource. Also, stakeholders should be aware that while the RCRA statute could allow for such reinjection, facilities may also have to comply with requirements of State Underground Injection Control (UIC) programs. Therefore, facilities should coordinate with State regulators to obtain, as necessary, variances, waivers, construction permits, approvals, etc.

What if a facility wants to re-inject groundwater that is contaminated with nonhazardous wastes as part of corrective action?

The ban on injecting hazardous wastes described in RCRA Section 3020(a) does not apply if the reinjected groundwater does not contain hazardous wastes. However, injection wells that re-inject groundwater that is contaminated with nonhazardous wastes are Class V wells and facilities must still comply with all UIC Program requirements, including notifying the UIC Program prior to construction of any injection well. Facilities should also consult with their State regulators because many States have stricter groundwater protection laws that could prohibit the reinjection of any contaminated groundwater, regardless of whether it is hazardous or not. For more information about State UIC Programs, refer to http://www.epa.gov/safewater/uic/primacy.html. For information about EPA's UIC Program, refer to http://www.epa.gov/safewater/uic.html.

References:

EPA, 2000a. Applicability of RCRA Section 3020 to In-Situ Treatment of Ground Water. Memorandum from Elizabeth Cotsworth, Director, Office of Solid Waste to RCRA Senior Policy Advisors (December 27). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/remwaste/refrnces/pol-mem3.pdf.

EPA, 1989a. OSWER Directive 9234.1-06, "Applicability of Land Disposal Restrictions to RCRA and CERCLA Groundwater Treatment Reinjection Superfund Management Review: Recommendation No. 26," (November 27). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/remwaste/refrnces/14_3020b.pdf.

14. Performance Monitoring

(September 2001)

What is performance monitoring?

EPA defines performance monitoring as the periodic measurement of physical and/or chemical parameters to evaluate whether a remedy is performing as expected. Facilities should conduct performance monitoring to evaluate whether the facility is making progress toward achieving short-term protection goals, intermediate performance goals, or final cleanup goals.

> **Rationale for Performance Monitoring**
>
> Properly designed performance monitoring programs are especially important for groundwater cleanups because the concentration and distribution of contamination in groundwater often change with time. Likewise, natural and human factors (e.g., seasonal precipitation or nearby groundwater usage) can influence the ability of cleanup actions to control migration of contaminated groundwater. Performance monitoring can assess changes in groundwater so that facilities can modify cleanup actions to ensure maximum efficiency, protectiveness, and compliance. Performance monitoring can also demonstrate whether or not a cleanup action is performing as expected.

What should the performance monitoring accomplish?

Facilities should design performance monitoring[1] programs to, for example:

- detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of the remedy;
- identify any potentially toxic and/or mobile transformation products;
- verify that the plume(s) is not expanding above levels of concern (either down gradient, laterally, or vertically);
- assess effectiveness of the cleanup or treatment system[2];
- evaluate whether advances in technologies or approaches could improve the ability of a remedy to achieve cleanup goals;
- verify no unacceptable exposure to down gradient receptors;
- detect new releases of contaminants to the environment that could impact the effectiveness of the remedy;
- demonstrate the effectiveness of institutional controls that were put in place to protect potential receptors; and

---

[1] For more information, refer to the numerous documents EPA has produced that address groundwater monitoring (EPA, 1997b; EPA, 1997g; EPA, 1996a; EPA, 1996c; EPA, 1994a; and EPA, 1992b; EPA, 1992c; and EPA, 1992d).

[2] Such evaluations can also provide information facilities can use to verify or adjust their estimates of cleanup timeframes.

- verify attainment of short-term, intermediate, or final goals.

What should a performance monitoring program include?

Facilities should include the specific approaches they intend to use to periodically assess remedy effectiveness towards meeting short-term, intermediate, or final goals. The performance monitoring program should include a description of the location(s), frequency, type[3] and quality of samples, techniques, and measurements that a facility will use to collect information needed to make decisions associated with a particular cleanup goal. However, EPA urges facilities and regulators to design performance monitoring approaches to be flexible and easily adaptable to account for changing conditions and information needs.

How often should a facility monitor?

The frequency of monitoring should be adequate to detect, in a timely manner, the potential changes in facility conditions listed above. This means that the rate of groundwater flow and contaminant movement are important factors to consider when facilities and regulators determine monitoring frequency. The monitoring plan should include flexibility for adjusting the monitoring requirements over the life of the remedy. For example, it may be appropriate to decrease the monitoring frequency (e.g., semiannually, annually, or for even longer time periods) and number of constituents once it has been determined that the remedy is performing as expected and very little change is observed from one sampling round to the next. In contrast, the monitoring frequency may need to be increased, for example: (1) when unexpected conditions (e.g., plume migration or change in groundwater use) occur, or (2) to determine the effect of modifications to a cleanup action (e.g., changes in pumping rates).

How long should performance monitoring continue?

For final remedies that involve restoring contaminated groundwater to its maximum beneficial uses, facilities should generally continue performance monitoring for a specified period (e.g., 3 years) after the facility achieves the groundwater cleanup levels at the throughout-the-plume/unit boundary point of compliance. Extending the performance monitoring to this point helps to verify that the groundwater no longer poses a threat, and that concentrations of contaminants will not rise (i.e., "rebound") after the facility shuts down its active cleanup system. In general, regulators will typically determine how long performance monitoring needs to continue for any given facility. For final cleanup objectives based on containment, performance monitoring should continue as long as the containment is necessary to protect human health and the environment.

---

[3] Many stakeholders only associate performance monitoring with chemical analysis of groundwater samples. For some cleanup actions, especially those involving hydraulic containment, facilities can often demonstrate performance with frequent hydrogeologic measurements (e.g., groundwater elevation monitoring) supplemented with less frequent groundwater quality measurements.

References:

EPA, 1997b. Rules of Thumb for Superfund Remedy Selection (EPA/540/R-97/013). Available at http://www.epa.gov/superfund/resources/rules/rulesthm.pdf.

EPA, 1997g. Groundwater Issue Paper: Design Guidelines for Conventional Pump and Treat Systems (EPA/540/S-97/504). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/pmptreat.htm

EPA, 1996c. Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites (EPA/540/R-96/023, October). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/pum_tre.htm

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant pages: 19452-53.

EPA, 1994a. Guidance for the Data Quality Objective Process (EPA/600/R-96/055, September). Available at: http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/qa/epaqag4.pdf.

EPA, 1992b. RCRA Groundwater Monitoring Draft Technical Guidance (November). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/sitechar/gwmonitr/rcra_gw.pdf.

EPA, 1992c. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities -- Addendum to Interim Final Guidance (July). Available at: http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/sitechar/gwstats/gritsstat/download/addendum pdf.

EPA, 1992d. Methods for Evaluating Attainment of Cleanup Standards Volume 2: Groundwater (EPA/230/R-92/014). Available at http://www.clu-in.org/download/stats/vol2gw.pdf

15. Completing Groundwater Remedies

(January 2004)

What does it mean to complete a groundwater remedy?

EPA generally recognizes two phases of completing[1] a final groundwater remedy:

- implementing the final remedy such that all components of the remedy are in place and operating as intended;
- achieving final cleanup goals

> **Rationale for Completing Groundwater Remedies**
>
> This policy on completing groundwater remedies is meant to encourage regulators and facilities to recognize construction completion as well as achievement of final cleanup goals for groundwater remedies. Recognition of these phases of completion can demonstrate progress and promote transfer of ownership of the property and facilitate reuse of industrial property. This policy also recognizes that EPA typically considers groundwater remedies to be complete when final goals are met, even though long-term controls are required.

What does it mean to complete the implementation phase of a groundwater remedy?

Completing the implementation phase of a final groundwater remedy means that physical construction has been completed and the remedy is operating as designed. At this point, cleanup objectives have not necessarily been met, but the remedial measures are in-place and operating as intended. Cleanup activities would typically be limited to continued operation, maintenance and monitoring of the remedy.

How does EPA acknowledge when a facility achieves the implementation phases of a final remedy?

EPA generally uses "Construction Completion" to describe when a facility completed the implementation phase of its final remedy for all media throughout the site (EPA, 1999f).[2]

---

[1] This Handbook addresses corrective action completion only in the context of contaminated groundwater and sources of groundwater contamination. Facilities often have cleanup activities other than those associated with groundwater that they need to address to fulfill all of their corrective action obligations. This section of the Handbook was updated from the original September 2001 version to incorporate new Agency guidance (EPA, 2003) that describes how corrective action can be considered "complete" with or without controls.

[2] EPA's RCRA data management system (EPA, 1999f; available at http://www.epa.gov/epawaste/hazard/correctiveaction/facility/ca-diction.pdf) describes construction completion as code CA550 titled "Certification of a Remedy Completion or Construction Completion."

What does it mean to achieve the final cleanup goals for a groundwater remedy?

As conveyed earlier in this Handbook, a facility achieves final cleanup goals for groundwater by taking actions as necessary to ensure protection of human health and the environment from contaminated groundwater. As a means to demonstrate achieving this overall statutory and regulatory mandate, EPA recommends that facilities achieve site-specific media cleanup objectives[3], and control surface and subsurface sources (see Source Control) to the extent practicable (see Technical Impracticability) that would otherwise result in increases of contaminants in groundwater above levels of concern.

For example, for a final remedy designed to return contaminated groundwater to a condition suitable for a drinking water use designation, this phase of completing a remedy typically means that the facility achieved drinking water standards at a throughout-the-plume/unit boundary point of compliance and it has controlled further releases of contaminants that might recontaminate the groundwater. Alternatively, if the final remedy involves long-term containment, this phase of completion could, for example, correspond to the facility successfully controlling sources and achieving groundwater cleanup levels at and beyond an appropriate point of compliance typically located outside but near the containment area.

How do facilities and regulators typically decide when a groundwater remedy achieves media cleanup objectives?

Facilities and regulators often rely on statistical procedures to determine whether a remedy has achieved specific media cleanup objectives. Interested stakeholders can refer to EPA's detailed guidance on this subject contained in "Methods for Evaluating the Attainment of Cleanup Standards Volume 2: Groundwater" (EPA, 1992d) which is available at http://www.clu-in.org/download/stats/vol2gw.pdf. Some of the helpful topics and resources addressed in that guidance include:

- Introduction to statistical concepts and decisions;
- Defining attainment objectives (e.g., cleanup levels);
- Designing the sampling and analysis plan used to determine success of cleanup;
- Descriptive statistics (e.g., mean and variance) and hypothesis testing;
- Deciding to terminate treatment; and,
- Statistical tables, examples, and blank worksheets.

---

[3] Media cleanup objectives refer to broad cleanup objectives that often include the more specific concepts of media cleanup levels, points of compliance, and cleanup time frames. In the Overview section of this Handbook, we explain that you could consider these three concepts as the "what, where, and when" elements of a cleanup. In the 1996 ANPR (EPA, 1996a), EPA referred to media cleanup objectives as media cleanup standards; we now use media cleanup objectives to avoid confusion with the term "standard," which is often associated with just numeric values.

How does EPA acknowledge when a facility achieves final cleanup goals for all media?

EPA recommends that regulatory agencies acknowledge when a facility achieves final cleanup goals for all media with a "Corrective Action Complete with Controls" or "Corrective Action Complete without Controls" determination (EPA, 2003). In addition, a completion determination might apply to the entire facility or a portion(s) of a facility. We recommend that individuals review the Final Guidance for Completion of Corrective Action Activities at RCRA Facilities (68 FR 8757; available at http://www.epa.gov/epawaste/hazard/correctiveaction/pdfs/compfedr.pdf) for more guidance on these two types of corrective action completion, their use, and procedures for acknowledging corrective action complete determinations.

What is the difference between Corrective Action Complete without Controls and Corrective Action Complete with Controls?

Corrective Action Complete without Controls means that the facility meets the final site-specific cleanup objectives for all media, and no further activity or controls are necessary on the part of the regulator or the facility to maintain protection of human health and the environment. Since the facility will not need to conduct operation, maintenance, or monitoring of a remedy, or any engineered or institutional controls, it is likely that the facility will be eligible for a release from financial assurances for corrective action.

In contrast, a Corrective Action Complete with Controls determination means that the facility meets the final cleanup objectives, but on-going operation, maintenance and monitoring obligations of engineered controls, and/or compliance with and maintenance of institutional controls are necessary to ensure continued protection of human health and the environment. Since the facility will often have ongoing obligations for which they are responsible, continuation of financial assurance for corrective action may be necessary.

What type of Corrective Action Complete determination can a facility achieve for a final remedy where groundwater cleanup is a component of the remedy?

The type of Completion determination generally depends on the groundwater cleanup objectives selected as part of the final remedy. EPA has discovered that the universe of facilities subject to corrective action requirements includes facilities that vary widely in complexity and level of risk presented at the facility. To address this wide variation, EPA has developed multiple approaches to achieving the final remedy goal of "protection of human health and the environment." However, one of the key distinctions among remedies is whether they rely upon controls (engineering and/or institutional[4]) to ensure that they remain protective.

---

[4] Institutional controls could, where appropriate, include administrative measures for which the facility owner /operator and/or some other entity, such as a state or local government, is responsible.

In some cases the regulator selects a final remedy that requires cleanup of groundwater and all other contaminated media to unrestricted use[5] levels. Once the facility achieves those unrestricted use levels for all contaminated media, no controls are necessary to ensure protection; therefore, a corrective action complete without controls determination would generally be appropriate. In other cases, the regulator selects a remedy that allows some contamination to remain on site, but relies on engineering and/or institutional controls to ensure appropriate protection. At sites where final groundwater cleanup objectives allow contaminated groundwater to remain in place above concentrations suitable for unrestricted use, a Corrective Action Complete with Controls determination would generally be appropriate because the remedy would be relying on engineering and/or institutional controls to prevent future exposure to the contaminated groundwater in such a situation.

References:

EPA, 2003. Final Guidance on Completion of Corrective Action Activities at RCRA Facilities (68 FR 8757, February 25). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/pdfs/compfedr.pdf.

EPA, 1999f. Resource Conservation and Recovery Act Data Element Dictionary - version 7.2.0. Available at http://www.epa.gov/epawaste/hazard/correctiveaction/facility/ca-diction.pdf.

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf. Particularly relevant page: 19453.

EPA, 1992d. Methods for Evaluating Attainment of Cleanup Standards Volume 2: Groundwater (EPA/230/R-92/014). Available at http://www.clu-in.org/download/stats/vol2gw.pdf

[5] "Unrestricted use" refers to a walk-away situation, where no further activity or controls are necessary to protect human health or the environment at the facility. For groundwater, cleaning up to drinking water standards would generally represent unrestricted use. By comparison containment or cleanup of groundwater to levels in excess of drinking water standards would usually not be an unrestricted use scenario.

Appendix 1 - References

EPA, 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/vapor.htm.

EPA, 2001a. EPA Indian Policy (July 11). Available at http://www.epa.gov/indian/pdfs/reaffirmindpol01.pdf.

EPA, 2001b. ECO-UPDATE: The Role of Screening Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecologic Risk Assessments (EPA/540/F-01/014, June). Available at http://www.epa.gov/superfund/programs/risk/ecoup/slera0601.pdf.

EPA, 2001c. Risky Business (EPA/530/F-00/032, February). Available at http://www.epa.gov/epawaste/inforesources/pubs/riskfinal.pdf.

EPA, 2001d. RCRA Cleanup Reforms Round II -- Fostering Creative Solutions (EPA/530/F-01/001, January). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/reforms/index.htm.

EPA, 2000a. Applicability of RCRA Section 3020 to In-Situ Treatment of Ground Water. Memorandum from Elizabeth Cotsworth, Director, Office of Solid Waste to RCRA Senior Policy Advisors (December 27). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/remwaste/refrnces/pol-mem3.pdf.

EPA, 2000b. Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups (EPA/540/F-00/005, September). OSWER Directive 9355.0-74FS-P. Available at http://www.epa.gov/superfund/action/ic/guide/index.htm.

EPA, 2000c. Proceedings of the Ground-Water/Surface-Water Interactions Workshop (EPA/542/R-00/007, July). Available at http://www.epa.gov/tio/tsp/download/gwsw/gwsw_part1.pdf, http://www.epa.gov/tio/tsp/download/gwsw/gwsw_part2.pdf, and http://www.epa.gov/tio/tsp/download/gwsw/gwsw_part3.pdf.

EPA, 1999a. Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities (64 FR 54604, October 7). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gen_ca/withdrwl.htm.

EPA, 1999b. Safe Drinking Water Act, Section 1429 Groundwater Report to Congress (EPA/816/R-99/016, October). Available at http://www.epa.gov/ogwdw000/gwr/finalgw.pdf.

EPA, 1999c. RCRA Cleanup Reforms (EPA/530/F-99/018, July). For more information, refer to http://www.epa.gov/epawaste/hazard/correctiveaction/reforms/index.htm

EPA, 1999d. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites (April 21). OSWER Policy Directive 9200.4-17P. Available at http://www.epa.gov/swerust1/directiv/d9200417.htm. Other helpful links regarding MNA available at http://www.epa.gov/swerust1/cat/mna.htm and http://www.epa.gov/swerust1/oswermna/mnalinks.htm

EPA, 1999e. Interim Final Guidance for RCRA Corrective Action Environmental Indicators (February 5). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/eis/ei_guida.pdf

EPA, 1999f. Resource Conservation and Recovery Act Data Element Dictionary - version 7.2.0.

EPA, 1998a. RCRA Orientation Manual (EPA/530/R-98/004). Available at http://www.epa.gov/epawaste/inforesources/pubs/orientat/index.htm.

EPA, 1998b. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (September). EPA/600/R-98/128. Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/rem_eval/protocol.pdf.

EPA, 1998c. Memorandum from Elizabeth Cotsworth to RCRA Senior Policy Advisors titled, Risk-Based Clean Closure (March 16). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/risk/cclosfnl.pdf.

EPA, 1998d. Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Management Facilities: Post-Closure Permit Requirement and Closure Process; Final Rule (63 FR 56710). Available at http://www.epa.gov/fedrgstr/EPA-WASTE/1998/October/Day-22/f28221.pdf.

EPA, 1997a. Memorandum from Elliott P. Laws and Steven A. Herman to RCRA/CERCLA Senior Policy Managers titled, "Use of the Corrective Action Advance Notice of Proposed Rulemaking as Guidance" (January 17). Available at http://yosemite.epa.gov/osw/rcra.nsf/documents/8BF009F9B3672563852566110072DA71.

EPA, 1997b. Rules of Thumb for Superfund Remedy Selection (EPA/540/R-97/013). Available at http://www.epa.gov/superfund/resources/rules/rulesthm.pdf.

EPA, 1997c. A Citizen's Guide to Understanding Presumptive Remedies (EPA/540/F-97/019, October). Available at http://www.epa.gov/superfund/resources/presump/finalpdf/citizen.pdf.

EPA, 1997d. State Source Water Assessment and Protection Programs Guidance (EPA/816/R-97/009, August). Available at http://www.epa.gov/OGWDW/source/swpguid.html.

EPA, 1997e. The Role of Comprehensive State Groundwater Protection Programs (CSGWPPS) in OSWER Remediation Programs. OSWER Directive 9283.1-09. Available at http://www.epa.gov/superfund/resources/csgwpp/role.pdf.

EPA, 1997f. Exposure Factors Handbook (EPA/600/P-95/002F). Available at http://www.epa.gov/ncea/exposfac.htm.

EPA, 1997g. Groundwater Issue Paper: Design Guidelines for Conventional Pump and Treat Systems (EPA/540/S-97/504). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/pmptreat.htm

EPA, 1996a. Advance Notice of Proposed Rulemaking (61 FR 19432, May 1). Available at http://www.epa.gov/docs/fedrgstr/EPA-WASTE/1996/May/Day-01/pr-547.pdf.

EPA, 1996b. Memorandum from Steven A. Herman and Elliott P. Laws to RCRA/CERCLA Senior Policy Managers titled, "Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities" (September 24). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gen_ca/coordmem.pdf.

EPA, 1996c. Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites (EPA/540/R-96/023, October). Available at http://www.epa.gov/superfund/resources/gwguide/gwfinal.pdf.

EPA, 1996d. RCRA Public Participation Manual (EPA/530/R-96/007). Available at http://www.epa.gov/epawaste/hazard/tsd/permit/pubpart/manual.htm. Particularly relevant pages: 2.5-2.7.

EPA, 1996e. Soil Screening Guidance Fact Sheet (EPA/540/F-95/041, July). Available at http://www.epa.gov/oerrpage/superfund/resources/soil/.

EPA, 1995a. Consistent Implementation of the FY 1993 Guidance on Technical Impracticability of Ground Water Restoration at Superfund Sites (January). OSWER Directive 9200.4-14. Additional information available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/tec_imp.htm.

EPA, 1995b. Groundwater Issue: Light Non-Aqueous Phase Liquids (EPA/540/S-95/500). Available at http://www.epa.gov/ada/download/issue/lnapl.pdf.

EPA, 1994a. Guidance for the Data Quality Objective Process (EPA/600/R-96/055, September). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/qa/epaqag4.pdf.

EPA, 1994b. The RCRA Corrective Action Plan (EPA/520/R-94/004, May). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gen_ca/rcracap.pdf.

EPA, 1994c. DNAPL Site Characterization (EPA/540/F-94/049). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/dnapl.pdf.

EPA, 1993a. Guidance for Evaluating the Technical Impracticability of Groundwater Restoration (EPA/540/R-93/080, September). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/techimp.htm

EPA, 1993b. Waste Management Area and Supplemental Well Guidance (June). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/wma_sup.htm.

EPA, 1992a. Final Comprehensive State Groundwater Protection Program Guidance (EPA/100/R-93/001). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/csgwpp.htm.

EPA, 1992b. RCRA Groundwater Monitoring Draft Technical Guidance (November). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/sitechar/gwmonitr/rcra_gw.pdf.

EPA, 1992c. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Addendum to Interim Final Guidance (July). Available at: http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/sitechar/gwstats/gritsstat/download/addendum.pdf.

EPA, 1992d. Methods for Evaluating Attainment of Cleanup Standards Volume 2: Groundwater (EPA/230/R-92/014). Available at http://www.clu-in.org/download/stats/vol2gw.pdf

EPA, 1991a. Managing the Corrective Action Program for Environmental Results: The RCRA Stabilization Effort (October 25). Available at http://yosemite.epa.gov/osw/rcra.nsf/d8382df2d09b646685256528005197 45/27d1baa5c1dbb8f38525670f006be76d?OpenDocument.

EPA, 1991b. Protecting the Nation's Groundwater: EPA's Strategy for the 1990's. Office of the Administrator. Washington, D.C. Available at http://www.epa.gov/superfund/resources/remedy/pdf/21z-1020-s.pdf.

EPA, 1991c. A Guide to Principal Threats and Low Level Threat Wastes. Superfund Publication 9380.3-06FS (November). Available at http://www.epa.gov/oerrpage/superfund/resources/gwdocs/threat.pdf.

EPA, 1991d. USEPA's User's Guide for the Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings. Available at http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/guide.pdf. The model itself can be downloaded from http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm.

EPA, 1990a. The Nation's Hazardous Waste Management Program at a Crossroads: The RCRA Implementation Study (EPA/530/SW-90/069).

EPA, 1990b. National Oil and Hazardous Waste Contingency Plan (55 FR 8666 and 40 CFR 300). The preamble is available at http://www.epa.gov/superfund/action/guidance/remedy/pdfs/ncppreamble61.pdf. The CFR is available through http://www.access.gpo.gov/nara/cfr/waisidx_00/40cfrv20_00.html.

EPA, 1990c. Corrective Action for Solid Waste Management Units at Hazardous Waste management Facilities; Proposed Rule (55 FR 30798).

EPA, 1989a. OSWER Directive 9234.1-06, "Applicability of Land Disposal Restrictions to RCRA and CERCLA Groundwater Treatment Reinjection Superfund Management Review: Recommendation No. 26," (November 27). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/remwaste/refrnces/14_3020b.pdf.

EPA, 1989b. National Priorities List for Uncontrolled Hazardous Waste Sites – Final Rule Covering Sites Subject to the Subtitle C Corrective Action Authorities of the Resource Conservation and Recovery Act (commonly referred to as the RCRA Deferral Policy). Available in Section V, which appears on 54 FR 41004-41006. Available at http://www.epa.gov/superfund/sites/npl/f891004.htm#41000.

EPA, 1989c. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part A). Available at http://www.epa.gov/superfund/programs/risk/ragsa/index.htm.

EPA, 1988. OSWER Directive 9283.1-2, "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites," (December 1).

EPA, 1987. Alternate Concentration Limit Guidance (EPA/530/SW-87/017). Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/acl.htm.

EPA, 1986. Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy. Available at http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/gw/gwclass.htm.

NRC, 2000. *Natural Attenuation for Groundwater Remediation*. Committee on Intrinsic Remediation, Water Science and Technology Board, Board on Radioactive Waste Management, National Research Council. Available at http://www.nap.edu/catalog/9792.html

NRC, 1994. *Alternatives for Groundwater Cleanup* / Committee on Groundwater Cleanup Alternatives, Water Science and Technology Board, Board on Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, National Research Council. National Academy Press, 1994. Available at http://www.nap.edu/books/0309049946/html/.

Appendix 2 - Links to Other Helpful Internet Resources

EPA's Corrective Action Programs Branch	http://www.epa.gov/correctiveaction/
RCRA On-line - enables users to locate documents, including publications and other outreach materials	http://www.epa.gov/rcraonline/
EPA's Superfund Program	http://www.epa.gov/superfund/
EPA's Enforcement Program	http://www.epa.gov/compliance
EPA's Office of Underground Storage Tank	http://www.epa.gov/swerust1/index.htm
EPA's Water Program	http://www.epa.gov/OW/
EPA's Technology Innovation Office	http://www.clu-in.org/
The Training Exchange (TRAINEX) S provides a range of training information concerning hazardous waste management and remediation.	http://www.trainex.org/
EPA's Remediation and Characterization Innovative Technologies (REACH IT)	http://www.epareachit.org/index3.html
Government Performance and Results Act	http://www.epa.gov/ocfo/planning/gpra.htm
EPA's Brownfields Homepage	http://www.brownfieldstsc.org/
EPA's Office of Research and Development - Subsurface Protection & Remediation Division	http://www.epa.gov/ada/
Association of States and Territorial Solid Waste Management Officials	http://www.astswmo.org/
Tribal Association on Solid Waste and Emergency Response	http://www.taswer.org/
American Indian Environmental Office	http://www.epa.gov/indian/
RCRA Hotline	http://www.epa.gov/epawaste/inforesources/pubs/hotline/mrqs.htm

Appendix 3 - Glossary

Glossary Internet Links

Terms of Environment (including a list of common acronyms) produced by EPA's Office of Communication, Education and Public Affairs (OCEPA) - available at http://www.epa.gov/OCEPAterms/

Glossary of Integrated Risk Information System (IRIS) Terms - available at http://www.epa.gov/iris/gloss8.htm

Office of Water Glossary - available at http://www.epa.gov/safewater/glossary.htm

Handbook Glossary of Terms[1]

cleanup - The term "cleanup" or the phrase "cleaning up" refers to the range of activities that could occur in the context of addressing environmental contamination at RCRA facilities. For example, cleanup activities could include removing waste or contaminated media (e.g., excavation, and pumping groundwater), in-place treatment of the waste or contaminated media (e.g., bioremediation), containment of the waste or contaminated media (e.g., barrier walls, low-permeable covers, and liners), or various combinations of these approaches. The term cleanup is often used interchangeably with the term remediate.

cleanup timeframes - The cleanup timeframe, with respect to groundwater, is an estimate of when groundwater quality will achieve a certain level at a specified location and/or the schedule developed to take an action or construct a remedy designed to achieve a particular short-term protection, intermediate performance, or final cleanup goal. (source - EPA, 1996a)

Comprehensive State Groundwater Protection Program (CSGWPP) - a groundwater management strategy developed by a State. EPA reviews CSGWPPs and "endorses" those that successfully meet six strategic activities. EPA established recommended adequacy criteria for each strategic activity in CSGWPP guidance. In particular, EPA remediation programs review State guidelines in the CSGWPP to prioritize groundwater based upon use, value, and vulnerability. EPA's Office of Solid Waste and Emergency Response issued a directive (EPA, 1997e) encouraging EPA's remediation programs to defer, where appropriate, to State determinations of current and future use when based on an EPA-endorsed CSGWPP that has provisions for facility-specific decisions. (source - EPA, 1992a)

contamination - describes media containing contaminants in any form (e.g., non-aqueous phase

[1] The definitions in this Glossary are for the purposes of this Handbook only.

liquids, dissolved in water, vapors, and solids) that are subject to cleanup under RCRA and are present in concentrations in excess of appropriately protective levels of concern. (source - EPA, 1999e)

contingency plan - (or contingency remedy or a contingency measure) is a cleanup approach specified in a remedy decision document that functions as a "backup" remedy in the event that the "selected" remedy fails to perform as anticipated. (source - EPA, 1999d)

dense non-aqueous phase liquids (DNAPLs) - such as chlorinated solvents, creosote-based wood-treating oils, coal tar wastes, and pesticides are immiscible (i.e., they are not dissolved in water) fluids [most commonly organic] with a density greater than water. (source - EPA, 1994c and EPA, 1995b)

environmental indicators (for RCRA corrective action) - two corrective action environmental indicators, Current Human Exposures Under Control and Migration of Contaminated Groundwater Under Control, are measures of program progress and are being used by the Agency to track whether it meets the goals set under the Government Performance and Results Act (GPRA). In general terms, these measures indicate current "environmental conditions"– whether people are currently being exposed to environmental contamination at unacceptable levels, and whether any existing plumes of contaminated groundwater are getting larger or adversely affecting surface water bodies. Environmental indicator guidance for the RCRA Corrective Action Program is available at http://www.epa.gov/correctiveaction/eis.htm. (source - EPA, 1999e)

excess lifetime risk - the additional or extra risk of developing cancer due to exposure to a toxic substance incurred over the lifetime of an individual (source: Glossary of IRIS Terms available at http://www.epa.gov/iris/gloss8.htm).

groundwater use designation - a determination of reasonably anticipated use, resource value (e.g., priority), and/or vulnerability of groundwater in a particular area. (source - adapted from EPA, 1992a)

groundwater cleanup levels - facility-specific chemical concentrations in groundwater that regulators generally establish when defining groundwater cleanup levels for final remedies. (source - adapted from EPA, 1996a)

groundwater cleanup objectives - includes three components: groundwater cleanup levels, point of compliance, and cleanup timeframes. (source - EPA, 1996a)

institutional controls - non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use. (source - EPA, 2000b).

maximum beneficial groundwater use - within the range of reasonably expected uses, the maximum (or highest) beneficial groundwater use warrants the most stringent groundwater cleanup levels. (source

- adapted from EPA, 1996a)

monitored natural attenuation - refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a timeframe that is reasonable compared to that offered by other more active methods. The natural attenuation processes that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentration of contaminants in soil or groundwater. (source - EPA, 1999d)

non-aqueous phase liquids (NAPLs) - are hydrocarbons that exist as a separate immiscible phase when in contact with water or air. Differences in the physical and chemical properties of water and NAPLs result in the formation of a physical interface between the two fluids which prevent the two fluids from mixing. NAPLs are typically classified as either light non-aqueous phase liquids (LNAPLs), which have densities less than that of water, or dense non-aqueous phase liquids, which have densities greater than that of water. (source - EPA, 1995b). [Note, some professionals have referred to NAPLs with densities close to that of water as neutrally buoyant non-aqueous phase liquids (NNAPLs).]

presumptive remedies - preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of how well technologies perform. You can access EPA's guidance on presumptive remedies at http://www.epa.gov/superfund/resources/presump. (source - EPA, 1997c)

principal threats - source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. (Source - EPA, 1997b and EPA, 1991c)

point of compliance - for groundwater, represents where a facility should monitor groundwater quality and/or achieve specified levels of groundwater quality to achieve facility-specific cleanup goals. (source - adapted from EPA, 1996a)

RCRA regulated units - surface impoundments, waste piles, land treatment units, and landfills that received hazardous waste after July 26, 1982. (source - 40 CFR 264.90)

releases - any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous or toxic chemical, or extremely hazardous substance. (source - http://www.epa.gov/OCEPAterms/rterms.html)

remedy expectations - are not binding requirements; rather, they reflect collective experience and are designed to guide development of remedial alternatives. In effect, remedial expectations allow program implementers and facility owner/operators to profit from prior EPA experience and focus resources on the most plausible remedial alternatives. (source - EPA, 1996a, page 19448)

source control - Source control refers to a range of actions (e.g., removal, treatment in place, and containment) designed to protect human health and the environment by eliminating or minimizing migration of or exposure to significant contamination. (source - adapted from EPA, 1996a)

source materials - material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir (either stationary or mobile) for migration of contamination to groundwater, to surface water, to air (or other environmental media)], or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material although non-aqueous phase liquids (occurring as residual or free-phase) may be viewed as source materials. (source - EPA, 1991c)

stabilization - refers to "stabilizing" a situation so that, for example, the contamination does not represent unacceptable near-term threats or does not continue to spread. Stabilization used in this context does not refer to engineered treatment used to "solidify" wastes although such technologies could be used as a stabilization action. (source - EPA, 1991a)

stakeholders - term used in this Handbook collectively referring to State and EPA regulators, owners and operators of facilities subject to RCRA corrective action, members of tribal governments, and members of the public and affected communities. The "public" in the context of RCRA refers not only to private citizens, but also representatives of consumer, environmental, and minority associations; trade, industrial, agricultural, and labor organizations; public health, scientific, and professional societies; civic associations; public officials; and government and educational associations.

technical impracticability (TI) - refers to a situation where achieving groundwater cleanup levels associated with final cleanup goals is not practicable from an "engineering perspective." The phrase "engineering perspective" refers to how factors such as feasibility, reliability, scale, and safety influence the ability to achieve groundwater cleanup objectives. (source - EPA, 1993a)

usable groundwater - EPA recognizes that "usable" groundwater may serve a variety of purposes. Common purposes of groundwater include, for example, drinking water, agricultural irrigation, car washes, and manufacturing. Groundwater also has less formally acknowledged purposes such as replenishing adjacent aquifers or surface water bodies. For more guidance regarding groundwater use, see the groundwater use designation policy in this Handbook.