Review of State Regulations Regarding Natural Attenuation as a Remedial Option

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Introduction

The AFCEE's risk-based approach to petroleum cleanup is designed to promote risk-based standards and cost-effective technologies to remediate sites with petroleum contamination. One major thrust of AFCEE's approach is to support a wider recognition and acceptance of natural attenuation as a viable alternative for restoring groundwater contaminated with dissolved petroleum products. Natural attenuation is also referred to as intrinsic bioremediation, passive bioremediation, or intrinsic remediation. It is a remediation approach that depends upon natural processes (e.g., dilution, dispersion, sorption, volatilization, chemical transformation, and biodegradation) acting to contain contaminants, reduce contaminant concentrations and mass, and to restore groundwater quality.

The successful application of the natural attenuation alternative depends on the integration of accurate scientific evidence and rational discussion within the context of sound social and regulatory judgment. AFCEE has been developing tools to assist its Base Project Team. The Technical Protocol for Implementing the Intrinsic Remediation with Long-Term Monitoring Option for Natural Attenuation of Dissolved-Phase Fuel Contamination in Ground Water, 1994, developed by AFCEE, outlines an improved site characterization and technical approach to scientifically demonstrate whether natural attenuation alone or in concert with focused source removal approaches can provide protection from unacceptable risk and the proper level of contaminant containment, destruction, and restoration of the ground water. To support these efforts, The MITRE Corporation was tasked to review the state regulations concerning the acceptance of "natural attenuation" as an alternative for remediating groundwater contamination. MITRE's review provides an overview of state regulations to help identify compatible regulatory provisions and to aid discussions with regulators with regard to promoting the proper application of natural attenuation as the final corrective action.

The review generally focused on state laws and regulations on petroleum hydrocarbons, oils, and lubricants (POLs) contamination, but it also examined general contamination where possible. The sheer number of state regulations and the diversity in terminology made an exhaustive review infeasible. Therefore, MITRE focused on identifying patterns in state regulations specifically concerning natural attenuation and on identifying additional compatible approaches used by any states.

One common approach that is compatible, although does not specifically mention natural attenuation, is the regulatory provision allowing for site-specific cleanup standards. These standards are derived through a risk or exposure assessment that considers the location of receptors and environmental fate and transport of contaminants. States with "site-specific" cleanup standards have been identified in "State Summary of Soil and Groundwater Cleanup" (Oliver et al., 1993). The reader is directed to the above-referenced report and "Use of Risk-based Standards for Cleanup of Petroleum Contaminated Soil" (AFCEE, AL, AFIT, June 1994) if they are seeking further information on this topic.

Other approaches that were considered for this review involve regulatory provisions that exempt a portion of contaminated groundwater from meeting the standards, thus allowing natural attenuation to occur within this exempted area. Examples include provisions similar to the RCRA alternate concentration limits (ACLs) and provisions for a groundwater mixing zone.

MITRE's review consisted of a search of the state regulations available on CD-ROM from the Bureau of National Affairs (updated as of July 1994). This search identified instances in the regulations where key phrases (e.g., natural attenuation, natural remediation, monitoring-only, passive, bioremediation, biodegradation, alternate concentration limit, alternate compliance boundary, mixing zone) appeared. The texts of both the identified regulations as well as associated regulations were examined,.

Results—Natural Attenuation

Regulations

The cleanup regulations for several states and the District of Columbia (hereafter referred to as "states") include specific provisions for natural attenuation as a remedial alternative. The following citations have been identified for these provisions:

- Delaware Underground Storage Tank (UST) Regulations Part B, §4.03(B)(1)
- District of Columbia Municipal Regulations: Title 20 Environment; Chapter 62 Reporting of Releases, Investigation, Confirmation, Assessment and Corrective Action, §6208.9
- Florida Administrative Code (FAC) Underground Storage Tank Regulations FAC §17-770.600 and 17-770.630
- Iowa Administrative Code (IAC), Responsible Parties Cleanup Regulations, IAC §567–133.4(3)
- Michigan Compiled Laws, Chapter 299–Natural Resources, §299.831: "Leaking Underground Storage Tank Act"
- North Carolina Administrative Code, Title 15A–Department of Environment, Health, and Natural Resources; Chapter 2 Environmental Management; Subchapter 2L–Groundwater Classification and Standards; §§.0106(d) and (l)
- Ohio Administrative Code Underground Storage Tank Regulations §1301:7-9-13(J)(4)
- Wisconsin Administrative Code (WAC) Department of Industry, Labor and Human Relations §47.335(3)

Terminology

These provisions generally acknowledge that concentrations of degradable contaminants will naturally decline over time and that public health and the environment will be protected as long as the concentrations are reduced to acceptable levels at designated monitoring points. However, different states use different terminology:

Delaware	"contamination is controlled under natural conditions"
District of Columbia	"contamination is controlled under natural conditions"
Florida	"monitoring-only"
Iowa	"passive cleanup*"
Michigan	"natural attenuation"
North Carolina	"natural remediation"
Ohio	"monitoring only"
Wisconsin	"passive bioremediation with long-term monitoring"

*This term may include actions in addition to monitoring the "natural attenuation."

As an example of differences in terminology, it should be noted that "natural attenuation" may not be synonymous with "passive cleanup" or "passive corrective action." States may consider natural attenuation as a subset of the latter. In these cases, the permission for passive cleanup may require more intrusive corrective action (e.g., construct hydraulic barrier, enhance bioremediation) in addition to monitoring the "natural attenuation." Iowa defines "passive cleanup" as the removal or treatment of a contaminant in groundwater or associated environment; this cleanup is done through management practices or the construction of barriers, trenches, and other similar facilities for the mitigation of contaminant migration, as well as the use of natural processes such as groundwater recharge, natural decay, and chemical or biological decomposition. The District of Columbia (DC) defines "passive corrective actions" as including the following technologies:

- Monitoring of natural attenuation
- Non-pressurized positive or negative subsurface venting
- A single injection of biological or chemical agents designed to enhance attenuation of subsurface contamination
- Any other technology involving limited activity, as determined by the Director

Overview

In general, these eight states allow for natural attenuation after (1) action has been taken to eliminate sources of contamination (e. g. repair leaks, etc.) and (2) free-product has been removed to the extent practicable. It appears that North Carolina and Wisconsin have progressed further than other states. North Carolina regulations provide a rather extensive description of the state's position on natural attenuation. Wisconsin has developed Guidance on Natural Biodegradation.

There is also considerable variance among states regarding acceptance of natural attenuation as a viable corrective action. Wisconsin's regulations require consideration of "passive bio-remediation" in state-funded cleanups, as well as a specific justification for a failure to employ it (WAC ILHR 47.355[3][a]). In contrast, both DC and Iowa are rather restrictive in their current regulatory language. The District of Columbia allows monitoring to ensure that the site contamination is controlled under natural conditions only when it is not feasible to achieve cleanup standards through corrective actions. In reference to sites with significant risk, Iowa allows for "passive cleanup," but only in extraordinary circumstances.

Highlights

The above-referenced citations are presented in Appendix A and are summarized below by state:

Delaware

- "A *corrective action work plan* must propose a corrective action option for the site which will ... [*as an option*] monitor the site over time to provide technically-based assurance that the site contamination is controlled under natural conditions and that those conditions will not now, or at some future time, adversely impact human health, safety or the environment."
- Passive corrective action is allowed for two years unless a written consent is issued by the state.
- Passive corrective action may also be used to supplement the active corrective action by conducting it prior to or following active corrective action.

District of Columbia

- "A *corrective action plan* must propose a corrective action option for the site which will reduce the contaminant levels to achieve the standards set forth in §§6210, 6211, and 6212 and any other applicable District of Columbia or federal regulations; if it is not feasible...monitor the site over time to provide technically-based assurance that the site contamination is controlled under natural conditions and that these conditions will not now, or at some future time, adversely impact human health, safety or the environment."

Florida

- The contamination assessment may be concluded and the Contamination Assessment Report, with a "monitoring-only" proposal if the site is contaminated by petroleum products* provided the appropriate analytical procedures are performed.

*The Gasoline Analytical Group, the Kerosene Analytical Group, the Mixed Product Analytical Group, or used oil.

Iowa

- "...passive cleanup may be allowed in extraordinary circumstances [*in cases of significant risk*]."
- "Where significant risk is not currently present, the responsible person may be required to monitor the groundwater and implement reasonable management or other preventative measures to minimize further contamination."

Michigan

- "Corrective action may be deferred under this section for only one 12-month period unless groundwater sampling during this 12-month period shows evidence of natural attenuation. If a consultant retained by the owner or operator determines that groundwater sampling shows evidence of natural attenuation, corrective action may be extended for an additional 12 months."

North Carolina*

- Natural attenuation is specifically recognized as an acceptable alternative for restoring groundwater quality.
- "Any person required to implement an approved corrective action plan for a non-permitted site pursuant to this [*natural attenuation provision*] may request that the Director approve such a plan based upon natural processes of degradation and attenuation of contaminants. A request submitted to the Director under this Paragraph shall include a description of site-specific conditions, including written documentation of projected groundwater use in the contaminated area based on current state or local government planning efforts; the technical basis for the request; and any other information requested by the Director to thoroughly evaluate the request."

*Further state restrictions are found in detail in Appendix A.

Ohio

- "A remedial action plan may propose a monitoring only remedial program consisting of monitoring of the site for a specific period of time, provided no free product is present, soil contaminants do not exceed twice the sum of the BTEX target levels, and one of the following conditions exist:

  (i) The UST site is located in a sensitive area and the BTEX concentration in ground water is less than the sum of the target levels for each constituent and the benzene concentration is below the target level in wells on the UST site, or

  (ii) The UST site is located in a non-sensitive area and the BTEX concentration in ground water is less than sum of the target levels for each constituent in wells on the UST site."
- "A monitoring only plan shall include a minimum of three monitoring wells, one hydraulically upgradient and one hydraulically downgradient of the contamination and one in the area of greatest contamination. Monitoring shall be conducted for a minimum of one year in accordance with the monitoring frequency and reporting approved in the plan."

Wisconsin

- It is required that at least three cleanup options be evaluated; one of the options "shall be passive bio-remediation"*:
  - "If passive bio-remediation with long-term monitoring is feasible but not the recommended alternative, a clear rationale shall be provided as to why this alternative is not acceptable"
- "Natural Biodegradation as a Remedial Action Option" offers additional guidance

*Although this is mandatory only for responsible party filing a claim for the Petroleum Environmental Cleanup Fund Act (PECFA) program, it demonstrates the state's acceptance of natural attenuation as a viable remedial alternative.

Results—Other Approaches

Several states have established regulations concerning the natural attenuation alternative either in larger contexts (e.g., releases from hazardous waste disposal sites) or in other contexts (e.g., permitting releases to groundwater). There are two basic approaches used in these regulations: (1) provisions similar to the RCRA alternate concentration limits (ACLs) provision (40 CFR 264, Subpart F) and (2) provisions for groundwater mixing zone. These provisions cover groundwater contamination in general and are not specific to petroleum products. In both types of provisions, groundwater in a defined area around a site is allowed to be contaminated above water quality standards as long as the water quality at a specified downgradient location conforms to standards. Therefore, they relieve the requirement of taking more intrusive action to remediate contaminated groundwater. This allows natural attenuation to take place inside the exempted area.

Background

The ACL provision originated in the groundwater protection standard for hazardous waste sites, promulgated by EPA as 40 CFR 264, subpart F—Release from Solid Waste Management Units. The ACL provision is also available in the Superfund program—CERCLA section 121 (d)(2)(B)(ii), and National Contingency Plan, 40 CFR 300.430 (e)(2)(i).

The EPA regulation defines the point of compliance (POC) at which monitoring must be conducted and where the groundwater protection standard applies. The POC is a fixed location and is defined as "...a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated unit."

Typically, the concentration of any contaminant at the POC must not exceed its background levels or the promulgated concentration limits [e.g., maximum contaminant level (MCL)] if the background level is lower. However, variance to this requirement may be accorded with the ACL provision. This provision allows the Regional Administrator to "establish an alternative concentration limit for a hazardous constituent if he finds that the constituent will not pose a substantial threat or potential hazards to human health and the environment as long as the alternative concentration limit is not exceeded." Therefore, contaminant concentrations can exceed the promulgated concentration limits so long as they are at or below the ACLs. This provision essentially allows a portion of groundwater to exceed the promulgated concentration limits if it can be demonstrated that human health and the environment are protected.

The mixing zone concept is another approach. This concept is a key aspect in applying surface water quality requirements, but is less common for the purpose of groundwater protection. It is based on the likelihood that a small area of degradation may exist with negligible adverse effects to the overall water body; therefore, a mixing area is allowed for waste to mix with the receiving water.

Regulations

The following is a list of state regulations containing provisions for ACL:

- Illinois Administrative Code, Standards for New Solid Waste Landfills (35 Ill, Adm Code 811), Subpart C, and Standards for Existing Landfills and Units (35 Ill, Adm Code 814), Subpart D
- Kentucky Administrative Regulation (KAR) Title 401—Natural Resources and Environmental Protection Cabinet—Department for Environmental Protection—Division of Waste management, Chapter 30—General Administrative Procedures, Definitions for 401 KAR Chapters 30 to 49, 401 KAR 30:010
- Missouri Code of State Regulations, Water Quality, 10 CSR 20-7
- New Hampshire, Groundwater Management Zone, Env-Ws 410.26H
- North Carolina Administrative Code Title 15A—Department of Environment, Health, and Natural Resources; Chapter 2 Environmental Management; Subchapter 2L—Groundwater Classification and Standards §.0102
- South Dakota, Groundwater Discharge Permits, Chapter 74:03:16

- Tennessee, Solid Waste Disposal Control System: General, 1200-1-7-.01
- Virginia, Solid Waste Management Regulations, Open Dump Criteria, VA 672-20-10 §4.1
- Wisconsin Administrative Code, Chapter NR 140—Groundwater Quality, Subchapter I—General

The following is a list of state regulations containing provisions for groundwater mixing zone:

- Florida Administrative Code, Ground Water Classes, Standards, and Exemptions, 17-520
- Maryland, Title 26—Department of the Environment, Subtitle 08—Water Pollution, Chapter 01—General
- South Carolina Regulation, Water Classifications and Standards, 61-68

Terminology

Although based on similar concept, there is little uniformity in the terminology used by the states when referring to their ACL and mixing zone provisions. In contrast to the EPA approach, where ACL is defined for fixed POCs, most states define alternative POC for groundwater standards or define the region exempted from the standards. Missouri is the only state on this list that defines alternative criteria.

	ACL
Illinois	"zone of attenuation", "alternate compliance boundary"
Kentucky	"alternative [waste] boundary"
Missouri	"alternative criteria"
New Hampshire	"boundary of the groundwater management zone"
North Carolina	"compliance boundary"
South Dakota	"perimeter of operation pollution (POP)"
Tennessee	"alternative [compliance] boundary"
Wisconsin	"point of standards application"
	Mixing Zone
Florida	"zone of discharge"
Maryland	"mixing zone"
South Carolina	"mixing zone"

Overview

The location of an alternative compliance boundary (or the boundary of the region exempted from meeting the groundwater standards) at the onset is bounded by (1) the edge of waste management unit and (2) the property boundary. Its final determination is based on additional constraints that limit the boundary to within a fixed distance from a reference location (usually the boundary of the waste management) or several site-specific factors. When more than one specified distance is listed, the closest one represents the location of the alternative compliance boundary. A few states consider both specified distance and site-specific factors (Table 1). The relevant text from state regulations is included in Appendix B.

Table 1. Approaches Used by States in Defining an Alternative Compliance Boundary

State	Specified Distance	Site-Specific Factor
ILLINOIS	Less than 150 m from the edge of waste unit	(1), (2), (3), (4), (5), (6), (7)
KENTUCKY	Within 250 ft of the waste unit boundary	(1), (2), (3), (4), (5), (6), (7)
NEW HAMPSHIRE	Boundaries by induced hydraulic gradient control Natural hydrogeologic boundaries such as groundwater divides or surface water bodies Boundaries created by natural attenuation of contamination	Similar to (1) and (3)
NORTH CAROLINA	Within 250 ft of the waste boundary if licensed after December 30, 1983 Within 500 ft of the waste unit if licensed before December 30, 1983	N/A
SOUTH DAKOTA	Within 0.25 mile of the point of entry for leachate Outside the radius of influence of any beneficial use water supply	N/A
TENNESSEE	N/A	(1), (2), (3), (4), (5), (6), (7)
VIRGINIA	N/A	(1), (2), (3), (4), (5), (6), (7)
WISCONSIN	Location of present groundwater Design management boundary (default dimension is 100 to 300ft from the waste unit boundary depending on the type, and these dimensions may be modified by considering specific factor listed on the left)	N/A

Site-Specific Factor:
(1) The hydrogeological characteristics including any natural attenuation and dilution characteristics of the aquifer
(2) The quantity and characteristics of the leachate
(3) The quantity, quality, and direction of flow of ground water underlying the facility
(4) The proximity and withdrawal rates of ground water users
(5) The availability of alternative drinking water supplies
(6) The existing quality of the ground water
(7) Public health, safety, and welfare effects

Both Florida and Maryland allow groundwater standards to be exceeded within the mixing zone but provide little description for defining the dimension of the mixing zone. The South Carolina regulation is most illustrative. It states that the size of the mixing zone shall be kept to a minimum and be determined on an individual project basis considering biological, chemical, engineering, hydrological, and physical factors. The state will grant the mixing zone application if (1) reasonable measures have been taken or committed to mitigate the contamination, (2) the zone is confined to a shallow geologic unit with little potential of being a drinking-water source, (3) contamination will not migrate outside the property boundary, and (4) contaminants are not dangerously toxic, mobile, or persistent. The relevant text from all three states is included in Appendix C.

Discussion and Recommendations

Many of the state regulations that MITRE reviewed contain language that supports the application of the natural attenuation alternative for remediating contaminated groundwater.

Wisconsin, North Carolina, Florida, Michigan, and Delaware have explicit language that allows natural attenuation to be used for petroleum-contaminated groundwater. Several other states have provisions for an alternative compliance boundary and a mixing zone that can be used to allow for natural attenuation if the contaminated groundwater plume is confined within the property boundary.

MITRE predicts that there will be wider acceptance of natural attenuation than the specific findings of our review suggest. This prediction is based on the following:

- Because of the diversity in the terminology with regard to natural attenuation, this review may not have captured all of the states with similar provisions.
- A state regulation may not reflect the flexibility in its practice. For example, the state of Texas has developed "Risk-Based Corrective Action for Leaking Storage Tank Sites" and is considering the possibility of developing the guidance for natural attenuation (Chris Chandler, Petroleum Storage Tank Division personal communication.)
- Numerous states have provisions for risk-based corrective action. For example, the state of Michigan employs three methods, A, B, C, for site cleanup. Methods B and C include risk-based cleanup for residential and site-specific exposure scenarios, respectively. Also, the Act 307 Advisory Group is incorporating the Technical Protocol for Implementing the Intrinsic Remediation with Long-Term Monitoring Option for Natural Attenuation of Dissolved-Phase Fuel Contamination in Ground Water, 1994, developed by AFCEE, into their revised guidance on bioremediation: natural and enhanced (Mr. John Shauver, MI DNR, personal communication).
- State regulations may contain exemption clauses and variance provisos that will grant exceptions to standards and requirements, thus allowing for natural attenuation.
- EPA established a baseline framework for evaluating and approving a UST corrective action plan by directing the implementing agency to consider several factors including exposure assessment (40 CFR 180.66 (b)). The consideration of exposure assessment in remediation decision making provides opportunities for natural attenuation similar to those provisions for site-specific cleanup standards, ACL and mixing zone. State regulators may have greater confidence in applying this general framework after seeing the specific regulatory examples that have been identified in this review.
- Recently, EPA has indicated their growing acceptance of natural attenuation as a remedial alternative (Tomassoni, 1994). Examples of EPA initiatives include the following:
  - *Preamble to Proposed RCRA Subpart S* (FR Vol. 55, No. 145, pp. 30825, and pp 30827, 1990)
  - *Guidance for Evaluating the Technical Impracticability of Ground Water Restoration*
  - *Evaluating Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers* (to be available in fall 1994)

Therefore, AFCEE makes the following recommendations:

- The use of the natural attenuation alternative should be encouraged at any site with favorable site characteristics, regardless of the state in which the site is located.
- The Base Project Team should begin by identifying regulations that specifically provide for natural attenuation. If direct provisions are not found, the team should investigate site-specific cleanup standards, exemption and variance in groundwater standards, and the consideration of exposure assessment in corrective action plan. When discussing these regulatory opportunities with implementing agencies, the team could introduce the ACL and mixing zone approaches to support the use of natural attenuation as a remedial alternative.
- The Base Project Team should follow the approaches outlined in the technical protocol (AFCEE, 1994) for data collection, groundwater

modeling, and /exposure assessment to provide the evidence for the occurrence of natural attenuation and to ensure the protection of human health and the environment. The Base Project Team should also follow the technical protocol for a long-term monitoring plan to demonstrate the team's commitment to proving the effectiveness of natural attenuation.

- The Base Project team should work with EPA headquarters, EPA region, and state regulatory representatives to promote the acceptance and implementation of recent EPA initiatives described above. Numerous states are revising their regulations regarding risk-based cleanup and/or natural attenuation (e. g. Florida, Michigan, Texas, etc.). Thus, the Base Project Team should check with state regulatory directors for pertinent current or near term regulations.

Points of Contact

This document is comprised of the above summary section as well as two appendices (A & B).. Appendices A & B contain excerpts from specific regulations. This document and appendices are available from:

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