IDEM

Nonrule Policy Document

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Title: Monitored Natural Attenuation for Petroleum Contaminated Sites
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Brief Description of Subject Matter: IDEM criteria by which sites requesting Monitored Natural Attenuation (MNA) as a remedial option will be evaluated.
Citations Affected: Indiana Code (IC) 13-23 - Underground Storage Tanks; IC13-24-1 - Petroleum Releases, IC 13-25-5; 329 Indiana Administrative Code (IAC) 9 - Underground

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Purpose

The primary purpose for this non-rule policy document (NPD) is to do the following:

- Identify criteria for evaluating and selecting Monitored Natural Attenuation (MNA) as a remedial option for petroleum contaminated sites.
- Identify monitoring and reporting requirements, when MNA is approved for corrective action.

Definitions

Chemicals of Concern

"Chemicals of Concern" (COCs) for petroleum are potentially harmful chemicals within a mixture that are present in sufficient quantity to serve as indicator compounds for that particular mixture.

Corrective Action Plan

A "Corrective Action Plan" is a plan that is designed to minimize, contain, eliminate, remediate, mitigate, or clean up a release. For purposes of this NPD, the term "Corrective Action Plan" (CAP) will be used interchangeably with the term "Remediation Work Plan".

Monitored Natural Attenuation

"Monitored Natural Attenuation" refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored clean-up approach) to achieve site-specific remedial objectives within a time frame that is reasonable compared to other 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 and ground water. These in-situ processes include, biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants.

Applicability

This NPD applies to remediation of soil and ground water using MNA for refined petroleum releases as defined by IC 13-11-2-160. It is written with the intention of being consistent with all relevant laws and policies including, but not limited to, the Risk Integrated System of Closure (RISC). Information collected during implementation of a MNA CAP may also be used for closures using RISC or any other appropriate program guidance.

Once the soil and ground water investigation is completed, the responsible party may choose to use a RISC closure demonstration or a remediation method, including MNA, as the corrective action plan. When choosing a RISC closure demonstration, the CAP requirements will be satisfied by meeting the requirements of Section 6.3.3 of the RISC Technical Resource Guidance Document.

This NPD is not intended to exclude the use of any closure options available using RISC or other guidance such as a plume stability demonstration. Information collected before or during the MNA monitoring may be used to evaluate a site for closure at any time. The sampling frequency, chemicals of concern, data quality objectives, etc. may vary depending on the program area and contaminant(s).

The use of MNA for hazardous substances as defined by IC 13-11-2-98 or other chemicals of concern is not included in the scope of this NPD. Any decisions regarding the remediation of these substances will be determined on a site-specific basis.

Introduction and Background

As Monitored Natural Attenuation (MNA) has become an accepted remedial technology, the IDEM determined that many CAPs proposing MNA were incomplete or inappropriate. For that reason, the IDEM determined that a NPD is needed for the following reasons:

- Improve the quality of corrective action proposals by providing guidance to the responsible parties and consultants regarding evaluation criteria and proposal format.
- Preserve IDEM and responsible party resources by reducing or eliminating proposals that are incomplete and/or inappropriate.
- Improve consistency within IDEM regarding the approval of MNA corrective action approvals.

Monitored natural attenuation is appropriate as a remedial approach only when it can be demonstrated capable of achieving a site's remedial objectives within a time frame that is reasonable compared to engineered systems and/or source removal. The IDEM expects that monitored natural attenuation typically will be used in conjunction with active remediation measures, e.g. source control or removal, or as a follow-up to active remediation measures that have already been implemented. The amount of site characterization necessary for MNA may be greater than the characterization required for engineered systems since these systems often provide greater hydraulic control of ground water plumes.

Implementation

When considering MNA as a remedial option, developers of CAPs should use a stepped approach. The steps are as follows:

Step 1 - Initial Screening
This step lists the basic conditions which should be met in order to consider MNA as a remedial option.

Step 2 - Generic Approval
This step lists all of the COC concentration limits needed for generic approval. Since the COC limits are relatively low concentration of COCs in the soil and ground water, sites meeting these limits will be approved for MNA under normal conditions.

Step 3 - Site Specific Approval
This step provides more detailed monitoring and demonstration requirements due to relatively high concentrations of COCs in the soil and ground water. If Step 3 is used when developing a CAP, Step 2 is not required.

Site Conditions Suitable for MNA Application

Step 1 - Initial Screening

The following conditions in Step 1 should be met for MNA approval:

- The lateral and vertical extent of soil and groundwater contamination are delineated to "off-site" or "residential" guidelines including the installation of ground water monitoring wells.
- Free product is not present or has been removed to the extent practicable.

- Contamination is not from hydrocarbon oils that do not lend themselves to natural attenuation, such as crude oil, or lubricating and fuel oils, such as virgin motor oil, used/waste oil, hydraulic oil, and fuel oils #4, 5, and 6 (bunker oil).
- A well field or water supply well is not impacted or imminently threatened.
- No other public or environmental receptor exposures exist or are imminently threatened.

If all of the Step 1 conditions are met, proceed to Step 2. If all of the Step 1 conditions are not met, MNA is not acceptable.

Step 2 - Generic Approval

If all of the following Step 2 conditions are met, then the CAP is generally acceptable. If all of the Step 2 conditions are not met, proceed to Step 3.

- Benzene detected in groundwater is less than 300 parts per billion (ppb) on-site (On-site may mean the area for which there is site control.) and 15 ppb off-site.
- The contamination source(s) is removed and/or the maximum total petroleum hydrocarbons (TPH) in the soil vadose zone is less than 1,500 parts per million (ppm) on-site and 300 ppm off-site. (No specific MNA screening values exist for specific COCs in the soil such as benzene, toluene, ethyl benzene, xylene, MTBE, or any of the target semivolatile organic compounds at this time.)
- MTBE in groundwater is less than 45 parts per billion (ppb) on or off-site.

Step 3 - Site-Specific Approval

If Step 1 conditions are met, but not Step 2, then a justification may be required for approval. When evaluating sites for MNA using Step 3, IDEM will need the following additional information:

- Primary Evidence - Historical ground water and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration. In the case of sites that meet the limits of Step 2, this is not generally needed for CAP approval. In some instances, sites may have limited primary evidence. In these instances, secondary evidence is more critical.
- Secondary Evidence - Hydrogeologic and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes and the rate at which such processes will reduce contaminant concentrations. Biochemical indicators are listed in the next section of this document.
- Other Factors - Other factors that may be considered when evaluating a site for MNA as a remedial option include the nature and volume of the spilled material, property control, pathways or conduits for exposure, and proximity to receptors.

The justification should include, but is not limited to, a computer generated site model to predict the fate and transport of the contaminants, remediation objectives and timeframe for achieving the remediation objectives. Under most circumstances, closure objectives should be reached

within three (3) times the time it would take using an engineered system while not exceeding 15 years.

IDEM reserves the right to make site specific decisions regarding additional information requests or MNA CAP approval based on the nature of the contaminants, age of the release and site conditions.

Additional Information Required for CAP Approval

The following discussion items should be included in the CAP along with other information that may be required by the individual remediation program:

- For all sites, the site's hydrogeologic conditions should be included.
- For all sites, a discussion of remedial options other than MNA should be included, in case MNA proves to be unacceptable or ineffective.
- For sites using Step 3, an indication that conditions exist on the site to support the biological activity necessary for biodegradation processes should be evaluated. An initial round of ground water sampling is required for MNA indicator parameters in addition to those parameters required in the Underground Storage Tank (UST) Branch Guidance Manual, Voluntary Remediation Program (VRP) Resource Guide, or other appropriate and applicable guidance. MNA indicator parameters that can be measured in the field include: dissolved oxygen, dissolved ferrous iron, hydrogen sulfide, and Oxidation-Reduction Potential (ORP). The following MNA indicator parameters should be based on laboratory analysis: nitrate, nitrite, and sulfate. (See Tables 1 and 2 titled "Analytical Parameters for Monitored Natural Attenuation Sites" and "Data Collection and Analytical Methods.")
    - The reasons for monitoring these indicators are based on the availability of trend data for the COCs, in the ground water as well as site specific conditions. Ground water samples should be collected from within the contaminant plume and from background locations for comparison purposes. The results of the analyses of the above parameters should be included in the "sampling" discussion of the site characterization or CAP.

Additional Information Required for CAP Approval for Sites Making Claims to the Excess Liability Trust Fund

- A cost comparison of the MNA approach to alternative methods should be included. The cost estimate for the MNA approach should be based on usual and customary industry standards and assumptions given the nature of the contamination and site specific geological conditions. The following is a list of items to be included in the cost estimate for the MNA method:
    1. Long term MNA costs should include: Quarterly Corrective Action Progress Reporting (CAPR) including laboratory analysis (per the UST Branch Guidance Manual, VRP Resource Guide, or other appropriate and applicable guidance) and MNA indicator monitoring costs (See "Additional Information Required for CAP

Approval"). MNA monitoring costs may require the installation of additional wells for background samples.
    2. Soil laboratory analysis/monitoring costs (The interval of monitoring to be determined by IDEM staff, but assume annually for cost comparison purposes).
    3. Provide a discussion concerning the total estimated cost and estimated remediation time.
- The cost estimate for the alternative methods should also be based on usual and customary engineering/industry standards and assumptions given the nature of the contamination. Include the site-specific geological conditions. The following is a list of items to be included in the cost estimate for the alternative methods:
    1. Initial set-up costs including: remedial system design, system purchases (or short term lease), system building/housing, utility hook-up costs, system installation (piping, trenching, well installation, etc.), discharge permitting (air and water), and estimated miscellaneous installation costs.
    2. Long-term engineering system estimated costs including: annual operation and maintenance (O&M) costs, annual utility costs, laboratory monitoring costs, other miscellaneous costs.
    3. Groundwater laboratory analysis/monitoring costs (per the UST Branch Guidance Manual, VRP Resource Guide, or other appropriate and applicable guidance), field testing parameters (anticipated air monitoring, discharge water testing to Publicly Owned Treatment Works (POTW) / National Pollutant Discharge Elimination System (NPDES), etc.).
    4. Final soil laboratory analysis/monitoring costs.
    5. A brief discussion concerning the total estimated cost and estimated remediation time.

Additional Information Required Upon CAP Approval

If the site is approved to use MNA for corrective action, IDEM may require one or both of the following:

- Ground water monitoring of MNA indicator parameters in addition to those parameters required in the RISC, UST Branch Guidance Manual, VRP Resource Guide, or other appropriate and applicable guidance may be required depending on the site conditions. MNA indicator parameters that can be measured in the field include the following: dissolved oxygen, dissolved ferrous iron, hydrogen sulfide, and ORP. The following MNA indicator parameters should be based on laboratory analysis: nitrate, nitrite, and sulfate. (See Tables 1 and 2 titled "Analytical Parameters for Monitored Natural Attenuation Sites" and "Data Collection and Analytical Methods.") Please note that these samples should be collected from within and outside the contaminant plume for comparison purposes.
    - Any changes in the procedures for sample acquisition, sample preservation, shipping, time and storage, chain of custody, decontamination of equipment between samples, or signed certificate of laboratory must be noted when submitting this information quarterly. Decisions regarding the frequency of monitoring MNA parameters beyond the initial baseline analysis will be

determined based on site-specific conditions. Typically, a quarterly sampling frequency may be appropriate.

- Periodic sampling of soils may be required if the contamination levels on the site warrant this action. The time intervals at which these samples will be collected should be recommended by the responsible party. Typically, an annual sampling frequency may be appropriate. However, site specific conditions may dictate the frequency.

Summary

This is a non-rule policy document, not a law or regulation. Special circumstances and/or site conditions may allow for modified action. Information collected during the monitoring period, may be used for closure determination under the relevant program guidance.

Table 1 Analytical Parameters for Monitored Natural Attenuation Sites

Parameter	Purpose
Dissolved Oxygen (DO)	Identify reducing zones, estimate assimilative capacity. Dissolved oxygen is an electron acceptor; assimilative capacity should be based on change in DO, compared to upgradient concentration.
Nitrate (NO_3-)	Identify reducing zones, estimate assimilative capacity. Nitrate is an electron acceptor; assimilative capacity should be based on change in NO_3-, compared to upgradient concentration.
Sulfate (SO_4^{2-})	Identify reducing zones, estimate assimilative capacity. Sulfate is an electron acceptor; assimilative capacity should be based on change in SO_4^{2-}, compared to upgradient concentration.
Soluble Ferrous Iron (Fe^{2+})	Identify reducing zones, estimate assimilative capacity. Ferrous iron is a byproduct of the biodegradation reaction. Assimilative capacity is based on the measured Fe^{2+} concentration.
Oxidation-Reduction Potential (ORP)	Identify reducing and oxidizing zones. Validate DO measurements.
Benzene, Toluene, Ethyl benzene, Xylene, (BTEX) and Methyl tertiary Butyl Ether (MTBE)	Primary indicator that provides evidence of plume status and decreasing trend.

Table 2 Data Collection and Analytical Methods

Parameter	Method Description	Reference	Method Number
Oxidation-Reduction Potential (ORP)	ORP/Eh Meter	See Manufacturer Guidance	
Dissolved Oxygen (DO)	Membrane Electrode (Field)	MCAWW[1]	360.1
Hydrogen Sulfide (H_2S)	Color Chart (Field)	Hach ®	HS-C Test
	Colorimetric (Lab)	SMEWW[2]	4500-S2-D
Sulfate (SO_4^{2-})	Anion Chromatography (Lab)	SW-846	9056A, 9035, 9036, 9038
Soluble Ferrous Iron (Fe^{2+})	Colorimetric (Field)	SMEWW	3500-FeD
	Colorimetric (Field)	Hach®	25140-25
Nitrate (NO_3-)	Anion Chromatography (Lab)	SW-846[3]	9056A

Notes: Field tests can also be performed by simple colorimetric methods supplied by CHEMetrics, Inc. For various field tests, CHEMetrics, Inc. and Hach® provide detailed instructions on how to perform the analysis.

References

1. Indiana Department of Environmental Management. February 15, 2001. Risk Integrated System of Closure - Technical Resource Guidance Document, Final.
2. OLQ Geological Services Technical Memorandum. 1998. Monitored Natural Attenuation.
3. U.S. Environmental Protection Agency. 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, EPA Directive 9200.4-17P, Office of Solid Waste and Emergency Response. Washington, D.C.

Footnotes

U.S. Environmental Protection Agency. Revised 1993. Methods for Chemical Analysis of Water and Wastes, Environmental Monitoring and Support Laboratory, EPA-600/4-79-020. Cincinnati, Ohio.

Standard Methods for the Examination of Water and Wastewater, 1992. American Public Health Assoc., American Water Works Assoc., Water Environment Assoc., 18th Edition

Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, EPA SW-846, 3 rd Edition, 1986, Update 1, July 1992, Updates II and IIa, 1994, Update III, 1996, and proposed Updates IVa, and proposed IVb, 1998.