Monitored Natural Attenuation

History

In the early 1990s, Monitored Natural Attenuation (MNA) became a popular remedy applied to many contaminated groundwater sites. Subsequent decades of experience with the process indicates it is often much slower than anticipated, and, in some cases, largely ineffective. This is especially true when source material remains in place, when the site conditions are poorly understood, or when site conditions are not conducive to biological attenuation.

Need for Good Site Characterization

In DEQ's experience, if a site is not well understood, remedies, especially MNA, may not work well. DEQ recommends, and in many cases may require, high-resolution site characterization before MNA is approved as part of a remedy. It is important to know what the conditions are at the site, including if there is a continuing release from source materials such has contaminated soil, or residual non-aqueous liquids. Inadequate source identification or removal can lead to, literally, decades of ineffective efforts.

Chlorinated Solvents vs. Petroleum Hydrocarbons

Chlorinated solvents and petroleum hydrocarbons behave much differently in the environment. EPA has MNA fact sheets for both, links to which can be found on the next page.

Chlorinated solvents biologically degrade best in anaerobic (low oxygen) conditions. Much of the shallow first groundwater in Oklahoma is aerobic (oxygen rich), which can make them very poor candidates for natural attenuation of many chlorinated solvents. At chlorinated solvent sites DEQ requires evaluation using the "EPA Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater" to determine if the site is a viable candidate for natural attenuation. A link to this document can be found on the next page.

Degradation of petroleum hydrocarbons can create reducing conditions, which may in turn, mobilize metals, creating secondary environmental issues. Mobilized arsenic is commonly found at petroleum-contaminated sites; however, this does not mean that secondary arsenic contamination is not an environmental issue.

Objective of MNA

The primary objective of MNA is to demonstrate that natural processes will reduce contaminant concentrations in groundwater to levels below regulatory standards before a point of compliance is reached. A moving, or unstable, plume is clearly not a good candidate for MNA.

Sole Remedy

DEQ rarely approves MNA as a sole remedy. Source identification and removal, including free-product removal, should be parts of an overall remedy and may accelerate natural attenuation.

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General Requirements

Full delineation of the contaminant plume, including sentinel wells that are below the maximum contaminant level (MCL), is needed. It must be demonstrated that conditions conductive to natural attenuation exist and attenuation is occurring. A steady or decreasing plume front must be established. Institutional controls will be required with any MNA remedy. This includes recordable notices to county land records restricting use of groundwater until appropriate levels have been confirmed. Other controls may be needed.

Initial Period of Monitoring

An initial period of monitoring of an approved monitoring well network is needed to establish the effectiveness of MNA as a remedial option. The monitoring well network should include contaminated wells and appropriate sentinel wells. An approved monitoring well network would normally be sampled quarterly for at least two years to establish baseline trends. If MNA is approved, the sampling frequency and number of wells may ultimately be reduced depending on site-specific conditions.

MNA Parameters

Parameters evaluated to determine natural attenuation would be site-specific, however, common indicator parameters include the presence or absence of degradation daughter products, temperature, pH, Oxidation Reduction Potential (ORP), and evaluation of local concentrations of iron, oxygen, sulfate and nitrates in groundwater.

Need for Long-Term Monitoring

A major consideration with MNA is the amount of time estimated to achieve desired levels. Hydrologic and geochemical conditions amenable to natural attenuation can change due to natural or man-made causes, and the mobility of a plume can change over time. As an example, removing buildings or parking lots can increase rain water infiltration, mobilizing a previously-stable plume. Natural attenuation of contaminants in groundwater must be monitored over significant periods of time to evaluate the continued performance of natural attenuation. MNA should not be considered a presumptive remedy, but should be evaluated along with active-remediation options to restore groundwater to its designated beneficial use. Because of the long term aspects, MNA should not be considered a fast route to closure.

Lines of Evidence

There are three general lines of evidence to support that natural attenuation is occurring. Depending on site conditions, all three lines of evidence may be required:

- Observed reduction of contaminant concentrations along the flow path.
- Documented loss of contaminant mass at the field scale.
- Data that supports the occurrence of degradation and gives rates of degradation.

Contingency Plan

Any approved MNA program should include a contingency plan with a list of triggering events. For example, exceeding a regulatory level in a sentinel well, or significant changes in one or more specified marker parameters. The plan should have established responses to triggering events such as increases in sentinel wells or other indications a groundwater plume is not stable. If contaminants leave the site or have left the site above a regulatory level, active remediation should be initiated and adjacent property owners notified.

Suggested Reading

"Citizen's Guide to Monitored Natural Attenuation," EPA 542-F-12-014, U.S. EPA Fact Sheet dated September 2012

https://go.usa.gov/xQruT

"EPA Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater." 1998

https://clu-in.org/download/remed/protocol.pdf

"Framework for Site Characterization for Monitored Natural Attenuation of Volatile Organic Compounds in Ground Water," EPA 600/R-12/712, December 2012

https://go.usa.gov/xQrub

"Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites," EPA OSWER Directive 9283.1-36, August 2015.

https://go.usa.gov/xQruj

"Monitored Natural Attenuation of Chlorinated Solvents" (EPA fact sheet 1999)

https://go.usa.gov/xpjF5

"Monitored Natural Attenuation of Petroleum Hydrocarbons" (EPA fact sheet 1999)

https://go.usa.gov/xpjFQ