STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION

MNA Excerpt from Examples of Approved Groundwater Corrective Measures For Solid Waste Management Facilities

Monitored Natural Attenuation (MNA)

Monitored natural attenuation (MNA) is the sum of natural processes that leads to the decreasing of contaminant concentrations in groundwater over time. 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. MNA as a remedial alternative is highly dependent on a good understanding of localized hydrogeologic conditions and may require considerable information and monitoring over an extended period of time. Please refer to the Environmental Protection Agency (EPA) MNA guidance documents on the EPA's website: www.epa.gov.

There are certain site specific conditions that can limit the effectiveness of MNA. If any of the following conditions are present, MNA cannot be utilized as the sole remedy to address groundwater contamination:

- An advancing groundwater plume indicates that the natural attenuation capacity of the system is unable to control the migration of contaminants.
- The contaminated media is difficult to assess as in some bedrock aquifers.
- Contaminant concentrations exceed groundwater standards established in 15A NCAC 02L .0202 beyond the relevant point of compliance.
- Points of exposure other than the property boundary are currently impacted.
- Mobile free product is present at the site, and no remedial method addressing the free product removal has been proposed.
- One or more of the other four exposure pathways (Subsurface Soil Leachate to Groundwater, Surficial Soil, Groundwater to Indoor Air Inhalation and Soil Vapor to Indoor Air Inhalation) exists at the site, and no active remediation method has been proposed to eliminate them.
- Contaminants are present which do not readily biodegrade.
- Fractured bedrock contamination.
- Contamination that has impacted receptors or creates an imminent threat to receptors (e.g.,drinking water wells, surface water, other environmental receptors)
- Source water protection areas.
- Well head protection areas.

Monitoring Well Network

An initial period of monitoring of an approved monitoring well network is needed to establish the effectiveness of MNA as a remedial option. An approved monitoring well network shall be

sampled for all MNA performance parameters on a semiannual basis for at least two calendar years (four semiannual sampling events) to establish baseline trends. The groundwater monitoring well network shall consist of compliance wells, performance wells, and sentinel wells. The performance wells are used to prove the MNA is working at the landfill, and the sentinel wells are used to monitor the plume movement toward adjacent properties and receptors. The groundwater monitoring well network shall have the ability to provide data on the horizontal and vertical extents of the groundwater plume.

MNA Performance Parameters

The MNA performance parameters provide insight into the microbial and biogeochemical reactions and processes that are occurring within the subsurface. As a result, the baseline sampling shall include the following MNA performance parameters:

- Dissolved Oxygen
- Nitrate
- Iron
- Sulfate
- Sulfide
- Methane
- Ethene, Ethane
- ORP
- TOC/BOD/COD
- CO_2
- Alkalinity
- Chloride
- Hydrogen
- Volatile Fatty Acids
- pH
- Temperature
- Conductivity
- Turbidity

All of the above MNA performance parameters should be sampled at each background monitoring well, all performance monitoring wells, and all sentinel monitoring wells. An EPA approved MNA screening model shall be performed during each semiannual baseline event and submitted with the facility's semiannual groundwater monitoring report. The screening model must include the ability to measure mass flux.

After the completion of the baseline sampling events, the MNA performance parameters may be re-evaluated to determine if the sampling frequency may decrease for a specific MNA performance parameter or if a specific MNA performance parameter may be removed from the corrective action sampling program based upon its technical relevance (example anaerobic conditions instead of aerobic conditions). It is necessary to determine after the baseline sampling events, which reactions and processes are driving the subsurface biogeochemistry. A mass balance assessment must also be completed. There must be balance between source loading and

plume attenuation capacity. Any changes to the MNA performance parameter list must be approved by the Solid Waste Section.

MNA Effectiveness

Pursuant to EPA guidance documents, MNA is effective based upon the following technical and scientific demonstrations:

1. The reduction of the contaminant concentrations is caused by chemical or biological attenuation of the contaminant;
2. The sampling analytical results show that the plume has stabilized horizontally and vertically in size and is not migrating; and
3. A statistical reduction in the contaminant concentrations along specific flow paths can be shown.

Plume stability (chemical, biological, and physical) must be determined in evaluating trends along specific flow lines within the contaminant plume and along the contaminant plume boundary. The interpretation of the MNA performance parameter data and the technical evaluation of MNA as a remedy at the facility shall be presented in a comprehensive MNA Corrective Action Evaluation Report at least once every five calendar years. The initial MNA Corrective Action Evaluation Report required for submission coincides with the minimum number of independent sampling data points required for most statistical or regression analyses. In the five calendar years, ten MNA sampling events should have been conducted, and the MNA Corrective Action Evaluation Report shall include interpretations of the three technical and scientific demonstrations above. It is important to note that site specific conditions may require additional technical information to obtain a better characterization of the processes occurring at the facility.

After the baseline sampling events have been completed, an EPA approved MNA screening model is required at least annually to simulate the groundwater remediation at the facility and determine the mass flux and mass balance.

In addition, institutional controls (land use restrictions) will be imposed as part of MNA. The land use restrictions will be imposed on the permitted facility and any buffer that has been acquired to help ensure that the migration of groundwater (and landfill gas) from the landfill is confined to property owned and controlled by the responsible party.

Corrective Action Contingency

The approved MNA program shall include a contingency plan with a list of triggering events and established responses to those triggering events. If MNA is not performing in accordance with the objectives set forth in the approved Corrective Action Plan (CAP) after the first five consecutive calendar years, the contingency plan must be implemented immediately. If contaminants migrate off site, active remediation shall be initiated and adjacent property owners notified. Also, if the contingency plan is found not to be effective at the facility, then the public participation process pursuant to 15A NCAC 13B .1635 may be required and a new CAP shall

be submitted for approval.

Uncertainty associated with estimated rates of attenuation over extended periods of time is a major consideration with MNA. Hydrologic and geochemical conditions amenable to MNA can change due to (1) natural or anthropogenic causes, and (2) changes in the mobility of a plume over time. 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 considering cost, technical practicability, remedial objectives, and protection of human health and the environment

Suggested Readings

- EPA OSWER Directive 9200.4-17P Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, dated April 21, 1999.
- Monitored Natural Attenuation of Petroleum Hydrocarbons, U.S. EPA Remedial Technology Fact Sheet dated May 1999.
- Monitored Natural Attenuation of Chlorinated Solvents, U.S. EPA Remedial Technology Fact Sheet dated May 1999.
- Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action, Section 11, Monitored Natural Attenuation, U.S. EPA, September 2001.
- Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128, September 1998.