Natural Attenuation Monitor

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Table of Contents

Overview of MNA/EA Project ................................................................. 3
Research Projects: From Development to Application ............................ 4
Project Seminar Aimed at Transferring Technical Results of Project to User Community 4
Recent News from the ITRC EACO Team ........................................... 5
Latest on Sharing Technical Advances ................................................ 5
Decision Framework: Enhanced Attenuation’s Place in the Remediation Process ........ 6
Published MNA/EA Project Documents ............................................. 7

Note to Readers: The Monitor is now available on the Savannah River Site public webpage at www.srs.gov under Documents and Publications.

The Natural Attenuation Monitor is published under the direction of the U.S. Department of Energy MNA/EA for Chlorinated Solvents Technology Alternative Project. Editor is Karen Vangelas at the Savannah River National Laboratory, 803-725-5223. Please send information requests, comments, or questions to karen.vangelas@srnl.doe.gov.

Overview of MNA-EA Project

Another six months have passed. It doesn’t seem possible. The team has been putting the finishing touches on the technical development portion of the project and ramping up on technology transfer activities. Several team members continue support to the Interstate Technology Regulatory Council (ITRC) Enhanced Attenuation Chlorinated Organics (EACO) team. The EACO team is making great progress in developing several products that define enhanced attenuation and describe how it will fit into the regulatory/decision process. I am greatly looking forward to their technical regulatory document on enhanced attenuation which is currently under development.

Our true success will be measured by how the concepts and tools that came from our project are used to support the cleanup of chlorinated organic sites across the DOE complex and the nation. Thus, this final phase of our project is a very important one as we make the products available for use. I want to spend the remainder of this overview providing you a cliff notes version of those activities.

The four project documents that describe the three key areas of development (mass balance, enhanced attenuation, and characterization and monitoring to support attenuation based remedies) and the summary level technical document that synthesizes the advances related to those three areas and the results of the research studies are now available. They can be downloaded from www.osti.gov. Theses documents will be available shortly on the project website, www.mnaeacvocs.com, that was designed by and is maintained by MSE Inc.

Ongoing are a series of seminars that will be held at 3 locations across the US and near three of our larger DOE sites, Hanford, Oak Ridge, and Savannah River Sites. The workshops are open to regulators, public stakeholders, consultants, DOE and their contractor personnel, as well as anyone interested in this topic. The first seminar was held March 13th in Oak Ridge, Tennessee. Approximately 30 people attended. Comments received by the project team from the attendees were positive. The remaining seminars will be held on April 18 and April 26.

On May 6, several members of the team along with a member of the ITRC’s EACO team will be conducting a 4 hour short course at the Battelle sponsored In Situ and On-site Bioremediation symposia in Baltimore Maryland.

If anyone would like our team to present the one-day seminar or a shorter version to their organization, please contact me. I am at dinesh.gupta@em.doe.gov.

Dinesh C. Gupta, Project Manager
U.S. Department of Energy
Two products from the research studies have been used in developing remediation strategies at DOE waste sites. The decision-making team at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky, used the Scenarios-Based Framework to aid them in making decisions related to the design of their characterization plan to evaluate the viability of MNA for one groundwater plume at their site. The Scenarios Framework is a guide to provide practitioners with a general level of site specificity to assist in planning characterization, modeling, and implementation of MNA and EA. The trichloroethylene contaminated groundwater at this site is aerobic and the lack of technical guidance for aerobic settings was hindering the team in completing their characterization efforts. Steve Hampson, with the University of Kentucky—Kentucky Research Consortium for Energy and the Environment and a member of the PGDP technical team, shared the following thoughts. “We have conducted several evaluations of TCE attenuation over the past ten years. Those evaluations indicated that attenuation processes were likely acting to decrease TCE concentrations along flowpaths. However, the evaluations did not provide sufficient indication that any particular TCE attenuation mechanism, including anaerobic biodegradation, was occurring and was likely to be a prevalent process. The most recent evaluation of TCE attenuation in PGDP's dissolved phase TCE plumes utilized SRNL’s recently developed "Scenarios Evaluation Tool for Chlorinated Solvent Monitored Natural Attenuation" and the expertise of SRNL scientists. The "Scenarios" evaluation provided compelling evidence that, given the geochemical conditions prevalent in PGDP's dissolved phase plumes, the most likely TCE attenuation mechanism to be occurring would be co-metabolic aerobic biodegradation. Based on the recent "Scenarios" evaluation, PGDP TCE Fate and Transport Project Team members scoped and implemented activities to identify the presence of aerobic bacteria capable of TCE degradation and the related rate of TCE degradation at the site."

The second product to be used at a site, is the

Several DOE facilities will be the hosts for a one-day seminar that will introduce the processes and tools developed through this project. Members of the Technical Working Group as well as several of the researchers will present those concepts developed during the project and those tools identified by the team as most mature and with the broadest application. The seminar is split into two sessions. The morning session summarizes the overall results of the development efforts and how they are being integrated into the regulatory process through the developments of the Interstate Technology Regulatory Council (ITRC). The afternoon session is two concurrent tracks that provide details on specific tools.

The first workshop was held on March 12 for the Oak Ridge Site. The meeting was well attended with representatives from regulators, stakeholders, environmental remediation firms, Oak Ridge site contractors, and the local Department of Energy. The feedback provided by the attendees indicated they thought the concepts and tools that were presented will find application in their remediation efforts at
Recent News from the ITRC EACO Team

Since the last newsletter, the team has brought several activities to closure and embarked on new activities. The case study database is now being populated with a variety of enhancement options. If you have a site, please consider entering it in the database. The Web address for the database is http://www.afcee.brooks.af.mil/products/techtrans/info/default.asp?reset=yes. The available case studies are being reviewed and will be incorporated into the team’s Technical Regulatory document that is currently being drafted. A fact sheet on Enhanced Attenuation is located at http://www.itrcweb.org/Documents/EA_Fact_Sheet.pdf.

The decision-framework document has been finalized and is now available on the ITRC webpage at http://www.itrcweb.org/teampublic_EACO.asp and click on “Resources and Links”. This document provides the key points that must be considered when working through the flowchart. The flowchart and this document are expounded on in the upcoming Technical Regulatory document. We have also developed a presentation that showcases the flowchart and how this new concept of enhanced attenuation (EA) fits into the remediation process. This presentation has been at the core of our outreach activities to date. Both regulator and consultants in the state of Florida are showing interest in this flowchart and the EA concept. We continue to receive requests to make this presentation. Upcoming conferences where we will present this information are: Florida-Bureau of Waste Cleanup Workshop, St. Petersburg, Florida-May 31; Washington Hydrogeology Symposium-May 1-3; MNA-EA Project Seminars (Washington State-Hanford Site, April 18 and South Carolina – Savannah River Site, April 26); the Battelle In Situ and On-Site Bioremediation Symposia, Baltimore, Maryland – May 6; and the Joint Service and Environmental Management, Columbus, Ohio-May 21, 2007

An article introducing the decision-flowchart and summarizing the results of the survey completed by state regulators to gauge their interest in EA and to examine factors affecting success and failure with implementing MNA from their perspective will be published in the Spring issue of Remediation Journal.

In addition to outreach activities, the team is hard at work drafting the Technical Regulatory guidance that will have enhanced attenuation and the decision flowchart at its core. A first draft is well underway, with goals of having a reviewable draft for the ITRC by the last quarter of the calendar year. Concurrently, the team is developing the materials for their web-based training on enhanced attenuation and the decision flowchart.

Latest on Sharing Technical Advances

As this project nears completion, several technical transfer activities are underway. To facilitate technical transfer of the tools and processes that have resulted from this project to the DOE community, a one-day seminar has been developed that will be presented at various sites across the DOE complex to DOE, subcontractor, regulator, public stakeholder organizations and others interested in DOE programs (see article titled Project Seminar Aimed at Transferring Technical Results of Project to User Community). A second outreach activity will be a short course to be presented at the Battelle sponsored In Situ and On-site Bioremediation Symposia to be held in Baltimore Maryland. The short course will be presented on Sunday afternoon, May 6, and will emphasize several of the modeling and decision-making tools, as well as the Interstate Technology Regulatory Council (ITRC) developed Decision Flowsheet (see article Decision Framework: Enhanced Attenuation’s Place in the Remediation Process). The last presently identified outreach activity is the development of a web-based training class to be conducted by the ITRC that focuses on Enhanced Attenuation and how it fits into the current remediation process through the use of the Decision Flowsheet.
A central component of the Interstate Technology Regulatory Council’s (ITRC) Enhanced Attenuation Chlorinated Organics (EACO) team has been the development of a decision flowchart for the use of Monitored Natural Attenuation (MNA), and associated description and use of Enhanced Attenuation (EA) in the remediation process. The goal in developing the flowchart is to encourage a decision process that is both innovative and disciplined, enabling users to identify and implement appropriate remedial alternatives at different stages of remediation. The use of EA within the framework emphasizes how mass balances fit into the toolkit for reaching remedial objectives. While allowing flexibility in designing the remediation process, the decision framework also provides sufficient scientific rigor documenting details of the reasons for remedy adjustments and the specific remedial goals.

The EA decision framework offers the site manager three broad areas of use as a comprehensive site management tool:
1. How and when to appropriately choose and implement MNA (ie: how to get a site into MNA);
2. A structured methodology for deselecting MNA if conditions or needs change in the context of risk, performance, economics, or future use; and
3. A structured methodology for when to modify a treatment train, which includes MNA, through implementation of additional remedial actions to source zones or dissolved phases, or suitable complementary technologies to enhance overall site performance.

Important to this decision process is developing the site conceptual model of the source(s), plume(s), and discharge point(s) as “one system” to be evaluated and remediated as a whole, rather than as independent components that have no effect on each other. Sustainability of each treatment and its impact on the mass balance of the entire system and ultimate shrinkage of the plume and meeting remedial goals (RGs) should be evaluated in the initial design phase. For example, one may want to choose a source treatment that would promote downgradient conditions resulting in biological degradation processes and rates to remove toxic contaminants and daughter products.

(Continued on page 10)
Published MNA/EA Project Documents

A running list of all documents that are a product of this project are presented here. Documents will be added to the list once they have been approved for public release. Most documents will be available from the Office of Scientific and Technical Information’s website (www.OSTI.gov). Each listing will include the document title, hot link, and short description. Those documents presented in previous issues will not include a description.


Advancing the Science of Natural Enhanced Attenuation for Chlorinated Solvents. WSRC-STI-2006-00377, December 27, 2006. Brian B. Looney (SRNL), T.O. Early (GEO Consultants), T. Gilmore (Pacific Northwest National Laboratory [PNNL]), N. Cutshall (consultant), J. Ross (Bechtel Savannah River Inc), M. Ankeny (Idaho National Laboratory), M. Heitkamp (SRNL), D. W. Major (Geosyntec), C. J. Newell (Groundwater Services Inc. [GSI]), W. J. Waugh (S.M. Stoller), G. Wein (Savannah River Ecology Laboratory), K.M. Vangelas (SRNL), K. M. Adams (US DOE), C. H. Sink (USDOE). This is the project’s final technical document. This document is intended to summarize the advances made in this project and identify ongoing development and management needs. (http://www.osti.gov/bridge/product.biblio.jsp?query_id=0&page=0&osti_id=897537)

Several of the researchers reports are now available. Each report has an introduction written by K.M. Vangelas and B. B. Looney that attempts to make the link between the reported research effort and the overall objectives of the MNA/EA project. The documents and research teams are listed below.


Previously described articles, documents, and presentations. Only the lead author is identified for previously presented items.


Closing the Mass Balance on Sources, Donors, Competing Reactions, and Attenuation Processes at Chlorinated Solvent Sites. R. Kamath (GSI)

Natural Attenuation in the Balance – Evolution of a Good Idea.....  B.B. Looney (SRNL)

Monitored Natural Attenuation and Enhanced Attenuation: A National Overview – Results of an ITRC Survey. J. Kean (Florida Dept. of Envr. Protection)

Using Mass and Energy Balance to Assess Monitored and Enhanced Natural Attenuation. F. Chapelle, (USGS)


Papers presented at the Battelle sponsored 8th International In Situ and On-Site Bioremediation Symposium, June 6 - 9, 2005. Battelle Press.

Next Generation – Monitored Natural Attenuation and Enhanced Attenuation – Chlorinated Solvents. K.M. Vangelas (SRNL)

Empirical and Deterministic Methods for Assessing Monitored Natural Attenuation. F. H. Chapelle (USGS)

Enhancements to Natural Attenuation Processes: New Approaches to Plume Management. T.O. Early (GEO Consultants)

Push-Pull Tests to Determine In Situ Site Wide Natural Attenuation Capacity and Microbial Activity at Savannah River CMP Pits and C-Area. E.J. Raes (Engineering & Land Planning).

Paper presented at the American Society of Civil Engineers (ASCE), World Water & Environmental Resources Congress 2005, May 15 – 19, 2005. ASCE.


(Continued on page 9)
Historical Analysis of Monitored Natural Attenuation: A Survey of 191 Chlorinated Solvent Sites and 45 Solvent Plumes. T. M. McGuire (GSI)

Project Documents (all are available at the US Dept. of Energy, Office of Scientific and Technical Information, Oak Ridge, TN www.osti.gov)


A Mass Balance Approach to Monitored Natural Attenuation. F. Chapelle (USGS)

Facilitating MNA and Enhanced Passive Remediation (EPR) of Chlorinated Solvents. B. B. Looney (SRNL)

Trends in Monitored Natural Attenuation Application at Chlorinated Solvent Sites. C. J. Newell (GSI)

(Continued on page 10)
Putting the Third Line of Evidence First—Advances in Molecular Technologies. D. W. Major (GeoSyntec)

Characterization and Monitoring Strategy for Monitored Natural Attenuation. T. Gilmore (PNNL)

From a traditional perspective of active source/plume treatment followed by MNA, EA can be considered when the transition to MNA will not result in meeting RGs, based on the questions in the column of diamonds in the flowchart. EA provides the user the ability to employ a treatment option that will result in attenuation rates that are sustainable for the period of time determined as necessary to reach site restoration. This additional loop within the flowchart should encourage a smoother, more efficient, and defensible transition to MNA from traditional source treatment and traditional plume treatment.

Important to the EA evaluation is to ensure that options are being evaluated against the criteria that would routinely eliminate MNA as a remedial strategy. For example, the first time while following the decision boxes, assuming the use of natural attenuation processes, it is determined the plume is not and will not be stable or shrinking. The user is then sent to the right side of the flowchart to evaluate enhancement options. The enhancements must be evaluated to determine if any options will result in the plume being stable or shrinking by either decreasing the mass flux or increasing the attenuation capacity of the aquifer. If so, the enhancement is implemented. If not, the user will evaluate the use of additional active and/or source treatments (rectangle at the top of the flowchart).

The decision framework provides not only the regulator, but also the site manager, with documentation attached to each specific endpoint. The decision flow process is not cumbersome or technically complicated, and the deployment of EA technologies results in natural sustainable treatments that require less energy and investment to reach environmental cleanup goals. For simple sites a few iterations through the flowchart may result in cleanup. However, for complex sites multiple iterations may be needed.

The EACO team will provide a Technical Regulatory Document in early 2008 describing this decision process in more detail. For additional details on the decision flowchart visit http://www.itrcweb.org/teampublic_EACO.asp and click on “Resources and Links.”