



Natural Attenuation Monitor

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This publication is published by the US DOE Monitored Natural Attenuation and Enhanced Attenuation for Chlorinated Solvents Technology Alternative Project to provide to all interested parties the latest information on this project.

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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.

*Cover Photo: Chuck Newell, left (Groundwater Services, Inc.), and Mike Truex, right (Pacific Northwest National Laboratory), presenting the **Scenarios Evaluation Tool for Chlorinated Solvent MNA** at the research review meeting for the MNA/EA Project, held May 18 and 19, 2006.*



Overview of MNA-EA Project

Greetings to you all! As the new kid on the block I am on a steep learning curve. I feel fortunate to inherit a project that has made such positive progress on technical topics as well as forming collaborations with regulators to facilitate transition of the technical advances into application.

The project team has been busy completing the 14 research studies, as well as synthesizing the advances related to mass balance, enhanced attenuation, and characterization and monitoring into a summary level technical document. This document will be the final product of this project. A peer review panel was convened by my office to provide a review of this document. The peer review team consists of nationally recognized scientists, engineers, and regulators involved in the environmental field. The reviewers have been requested to complete their reviews in early September.

We are very excited about some of the products coming out of the research projects. The push-pull tests are a simple, inexpensive method to determine attenuation rates within a groundwater plume for both MNA sites and biostimulated sites. These tests were originally used in the oil industry and have been adapted for environmental applications in basic science programs such as the DOE Office of Science Basic Environmental Research program. The passive flux meters, developed at the University of Florida, are a down-hole sampler that allows contaminants to be quantified in terms of flux rather than concentration. This supports calculation of mass balance. An oxygen sensor adapted from the world of oceanography and based on fluorescence shows much promise as a long-term monitoring tool of a parameter that is a strong indicator of the oxidative conditions of the groundwater. Modules supporting natural

and enhanced attenuation processes have been added to the RT3D fate and transport model, available from Pacific Northwest National Laboratories. BIOBALANCE, a model based on the Department of Defense and EPA co-sponsored BIOCHLOR model, was developed to provide users a tool that calculates plume growth over-time providing an estimate of when a plume will reach its greatest length. For reductive degradation this model also evaluates how much electron donor is needed to overcome competing electron acceptors in the system to sustainably degrade the contaminant of interest. While RT3D supports detailed groundwater modeling of contaminant plumes, BIOBALANCE will support early choices of potentially viable MNA and biostimulation options.

I would be very interested to have you share with me your comments on this project. I am at dinesh.gupta@em.doe.gov.

Dinesh C. Gupta, Project Manager
U.S. Department of Energy

Research Studies Nearing Completion

The fourteen research projects supporting the development of mass balance, enhanced attenuation, and characterization and monitoring to support attenuation based remedies are nearing completion. These studies began in 2004 and range from developing simple spreadsheet decision tools to developing molecular-based characterization tools. On May 18 and 19, the Principal Investigators for these projects met with the members of the Technical Working Group and invited guests to share the results of their research. There were approximately 50 people in attendance representing a broad technical base. The meeting was split into topic areas: molecular tools and degradation processes: abiotic processes, decision analysis tools, characterization and monitoring tools, and models and analysis tools. In addition to providing a forum for the researchers to present their results, the meeting provided an opportunity to bring together members of the technical community with differing backgrounds to weigh in on these important and emerging topics related to natural and enhanced attenuation remedies for chlorinated solvents, as well as provide a forum for the Technical Working Group to review the progress of the researchers.

A special thank you goes to Dr. Frank Loeffler of the Georgia Technical University who hosted our meeting on the campus in Atlanta, Georgia.

The research teams are presently finishing their final reports. All reports will be available to the public through the Office of Scientific and Technical Information at <http://www.osti.gov>.

partment of Energy had the benefit of Claire's energy and enthusiasm for promoting science and its use to solve environmental problems. Through numerous programs Claire worked to develop improved research and development organizations structures and reduce them to practice resulting in better end products, be that advanced technology or improved interactions between diverse organizations. In the mid-1990's Claire worked on the Rapid Commercialization Initiative, a program involving state regulators, federal agencies and the private sector to demonstrate new technologies to facilitate wide-spread implementation, as well as supporting technology policy development working for Tom Grumbly and Clyde Frank. The MNA/EA Project was the final project Claire led with the vision of an interdisciplinary team driving science and technology development that included end users and regulators to develop and gain acceptance of innovative environmental remediation technologies for multi-site application.

Another of Claire's many contributions was directed towards the Savannah River National Laboratory. She played a major part in supporting SRNL's growth as a national laboratory.

We wish to express our thanks for her belief in this project and the team of scientists who participated and we wish Claire well in her new pursuits.

Changing of the Guard

As you may have noted this issue's project overview article was not written by Claire Sink. Claire, who has been our project manager from the inception of this project, retired on July 1, 2006 and handed the project reins to Dinesh Gupta. For the past twenty-four years, the De-



Researchers Maggie Millings (SRNL), Jack Istok (OSU), Kirk Hatfield (U of FI), and Kirk Cantrell (PNNL) discuss challenges associated with characterization and monitoring tools during research review meeting.

News from the ITRC EACO Team

The last six months have been a busy time for the Enhanced Attenuation Chlorinated Organics team with new products being developed and works in progress reaching completion. The case study database is now available for technologists to upload information on remedial projects where they have used Enhanced Attenuation or monitored natural attenuation (MNA) as remedial approaches on chlorinated solvent plumes. Examples of appropriate remediation projects for Enhanced Attenuation that can be uploaded are permeable reactive barriers, wetlands (natural or engineered), addition of carbon donors, passive vapor extraction from the vadose zone (e.g. use of baroballs), caps or covers, and water diversion features constructed to decrease influx of surface water into a contaminant source. The projects do not have to be completed at this time (with the exception of MNA), and the team is particularly concerned in regards to the input of "lessons learned" information. The database is available on the Air Force Center for Environmental Excellence website at <http://www.afcee.brooks.af.mil/products/techtrans/info/default.asp>. Anyone who has a chlorinated site they think would be appropriate should enter their information in the database. Data submitted will provide insight into the use of EA and conclusions incorporated into future EACO team documents.

A decision-framework document is being developed at this time. This document will provide guidance on evaluating a site in terms of plume stability and how and when Enhanced Attenuation will fit into a remediation plan. The detailed outline of the document is complete and the team members writing the document are now adding the text. A draft of the report will be available for the full EACO team review in late August. This decision-framework will be a central piece of the team's tech-reg guidance document to be written in 2007.

Results of the team's survey of regulators on the use of MNA and interest in EA and mass balance (article in the March 2006 issue of the *Monitor*) were presented at the Battelle sponsored Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds in May 2006. Judie

Kean, EACO team co-chair, presented the survey results in the session that Claire Sink, DOE HQ, and Kimberly Wilson, EACO team co-chair, co-chaired titled MNA and Enhanced Attenuation for Chlorinated Solvents: New Tools and Approaches. In addition, Judie represented the EACO team regulators on a panel session titled Advances in Monitored Natural Attenuation for Chlorinated Solvents.

Update on Sharing Technical Advances

In the March 2006 Issue of the *Monitor* we identified several conferences at which project information was to be presented: National Groundwater Association's (NGWA) Groundwater Summit 2006, the Battelle sponsored Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, and the American Geophysical Union's 2006 Joint Assembly. The panel session at the Battelle meeting, Advances in Monitored Natural Attenuation for Chlorinated Solvents, garnered the greatest attendance with approximately 250 people. Over 200 CDs containing project reports, ITRC products, and documents/protocols associated with MNA were distributed at that meeting. The panel session catalyzed a synthesis of ideas from several technical sessions including those addressing sustainability, MNA/EA concepts, and source treatment. There was lively discussion on emerging characterization and monitoring tools (such as push-pull tests and state-of-the-art microbial assays) and on the general topic of MNA performance. The discussion also explored methods that have been employed to make decisions about how much source removal is needed and when MNA and EA should be considered. Though smaller than the Battelle meeting, the session on Enhanced Attenuation at the NGWA meeting was well attended with approximately 75 people. The case studies showcasing technologies that can

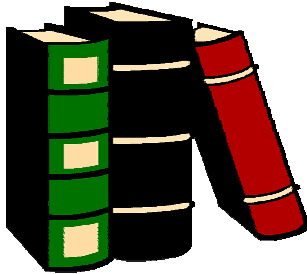
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Published MNA/EA Project Documents

A running list of all documents that are a product of this project will be 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 that were presented in previous issues will not include a description.



Monitored Natural Attenuation of Chlorinated Solvents – Moving Beyond Reductive Dechlorination. Karen Vangelas, B.B. Looney, T.O. Early, T. Gilmore, F.H. Chapelle, K.M. Adams, C.H. Sink. *Remediation, The Journal of Environmental Cleanup Costs, Technologies, and Techniques*. Summer, 2006. This is a summary article on the project to date related to the topics of mass balance and enhanced attenuation.

Papers presented at the Battelle sponsored 5th International Conference for Remediation of Chlorinated and Recalcitrant Compounds, May 22—25, 2006. Battelle Press.

Closing the Mass Balance on Sources, Donors, Competing Reactions, and Attenuation Processes at Chlorinated Solvent Sites. Roopa Kamath (Groundwater Services, Inc.), C.J. Newell, D. Adamson, B.B. Looney, K.M. Vangelas.

Natural Attenuation in the Balance – Evolution of a Good Idea..... Brian B. Looney, K.M. Vangelas, C.H. Sink.

Monitored Natural Attenuation and Enhanced Attenuation: A National Overview – Results of an ITRC Survey. Judie Kean, K. Wilson, K.M. Vangelas.

Using Mass and Energy Balance to Assess Monitored and Enhanced Natural Attenuation. Frank Chapelle, B.B. Looney, T.H. Wiedemeier, C.H. Sink.

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

Characterization and Monitoring of Natural Attenuation of Chlorinated Solvents: A System Approach, WSRC-TR-2005-00199, Rev. 0. February 2006. Tyler Gilmore (PNNL). As of this printing, this document has not been posted on the OSTI website. Contact K. Vangelas to obtain a copy of this document. This document is presently being revised.

Enhanced Attenuation: Approaches to Increase the Natural Treatment Capacity of a System, WSRC-TR-2005-00198, Rev. 0. January 2006. Tom Early (GEO Consultants). As of this printing, this document has not been posted on the OSTI website. Contact K. Vangelas to obtain a copy of this document. This document is presently being revised.

Remediation Forum Question to the Panel on the Acceptability of the term Integrated Mass Flux. Karen M. Vangelas (SRNL). *Remediation, The Journal of Environmental Cleanup Costs, Technologies, and Techniques*. Winter, 2005. Wiley Publishers

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. Karen M. Vangelas (SRNL).

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

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Enhancements to Natural Attenuation Processes: New Approaches to Plume Management. Thomas 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. Eric 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.

Monitored Natural Attenuation and Enhanced Attenuation for Chlorinated Solvent Plumes – It's all about balance. Karen A. Adams (US DOE).

Articles published in Remediation, The Journal of Environmental Cleanup Costs, Technologies, & Techniques, Winter 2004, Volume 15, Number 1. Wiley Publishers.

Accelerating Environmental Cleanup at DOE Sites: Monitored Natural Attenuation/Enhanced Attenuation – A Basis for a New Paradigm, C. H. Sink (US DOE).

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)

Multiple Lines of Evidence Supporting Natural Attenuation: Lines of Inquiry Supporting Monitored Natural Attenuation and Enhanced Attenuation of Chlorinated Solvents. WSRC-TR-2003-00331, December 2004. As of this printing, this document has not been posted on the OSTI website. Contact K. Vangelas to obtain a copy of this document.

Scientific Basis for Monitored Natural Attenuation and Enhanced Passive Remediation for Chlorinated Solvents – DOE Alternative Project for Technology Acceleration Implementation Plan, WSRC-RP-2003-00286, February 20, 2003.

(www.osti.gov/bridge/product.biblio.jsp?osti_id=810006&queryId=1&start=0).

Historical and Retrospective Survey of Monitored Natural Attenuation: A Line of Inquiry Supporting Monitored Natural Attenuation and Enhanced Passive Remediation of Chlorinated Solvents, WSRC-TR-2003-00333, October 20, 2003.

(www.osti.gov/bridge/product.biblio.jsp?osti_id=820972&queryId=1&start=0).

Summary Document of Workshops for Hanford, Oak Ridge and Savannah River Site as part of the Monitored Natural Attenuation and Enhanced Passive Remediation for Chlorinated Solvents - DOE Alternative Project for Technology Acceleration, WSRC-RP-2003-1044, October 20, 2003.

(www.osti.gov/bridge/product.biblio.jsp?osti_id=820971&queryId=1&start=0).

Natural and Passive Remediation of Chlorinated Solvents: Critical Evaluation of Science and Technology Targets, WSRC-TR-2003-00328, February 2004. (www.osti.gov/bridge/product.biblio.jsp?osti_id=822824&queryId=2&start=0).

Baseline Natural Attenuation Processes: Lines of Inquiry Supporting Monitored Natural Attenuation of Chlorinated Solvents, WSRC-TR-2003-00329, May 18, 2004. (www.osti.gov/bridge/product.biblio.jsp?osti_id=828468&queryId=1&start=0).

Papers presented at the Battelle sponsored 4th International Conference for Remediation of Chlorinated and Recalcitrant Compounds, May 24–27, 2004. Battelle Press.

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

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

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Looney (SRTC).

Trends in Monitored Natural Attenuation Application at Chlorinated Solvent Sites, C. J. Newell (Groundwater Services, Inc.).

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).

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be designed to meet the requirements for Enhanced Attenuation generated a great deal of interest from the audience. The two case studies were on permeable reactive barrier walls presented by Erica Becvar of the Air Force Center for Environmental Excellence and on the use of phreatophytes in arid environments presented by Jody Waugh of S.M. Stoller representing the Department of Energy's Office of Legacy Management.