

**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**

**October 20, 2003**

**Westinghouse Savannah River Company  
Savannah River Site  
Aiken, SC 29808**

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-96SR18500 with the U. S. Department of Energy.

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**Summary Document**

**of Workshops for**

**Hanford, Oak Ridge and Savannah River Sites**

**as part of**

**the Monitored Natural Attenuation and Enhanced Passive Remediation**

**for Chlorinated Solvents**

**DOE Alternative Project for Technology Acceleration**

**Assembled by**

**Karen M. Vangelas**

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U.S. Department of Energy Savannah River Operations

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Westinghouse Savannah River Company

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Aiken, SC 29808

Operated by:

Westinghouse Savannah River Company  
For the U.S. Department of Energy under Contract No. DE-AC09-96-SR18500

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## Introduction

This document summarizes the result of a series of meetings with regulators, stakeholders, tribal representatives, and end users. The meetings focused on providing information from the Monitored Natural Attenuation and Enhanced Passive Remediation (MNA/EPR) for Chlorinated Solvents, DOE Alternative Project for Technology Acceleration and eliciting feedback on the direction of the project, its usefulness, and its applicability to issues faced by the participants. The meetings were held with the DOE and operating contractor personnel working at and stakeholders/tribal representatives associated with the Hanford, Oak Ridge and Savannah River Sites, as well as EPA regions IV and X and state regulators from Washington, Tennessee and South Carolina. These meetings were conducted over the time period beginning August 12 and culminating September 23, 2003. Approximately 120 people participated in these meetings.

The importance of these meetings and the feedback received from the participants is valuable to the project's Technical Working Group in defining the direction of the project. During the period May through June the members of the Technical Working Group evaluated "lines of inquiry". These "lines of inquiry" are scientific/technical areas that were identified as having the potential to advance the understanding and implementation of MNA or provide additional tools to assist in implementing MNA. The Technical Working Group convened July 7 through 11 at SRS to finalize the work of the individual members and to identify the topics that were agreed upon as being central to the project. A list of technical targets that will be the basis for the research needs of this project were also identified. This work was documented in the draft report titled "Natural and Passive Remediation of Chlorinated Solvents: Critical Evaluation of Science and Technology Targets". This document, called the S&T report, will be the guiding document for the remaining 2.5 years of the project.

Because the S&T report is central to the remaining work of the project, the project team believed it was necessary to discuss the results of this work with those who implement and regulate remedial actions and those who are affected by those actions. The feedback received during these meetings will be used by the Technical Working Group to readjust, if necessary, the emphasis of this project and/or the research areas to fund work.

Each of the meetings opened with a plenary session in which:

- The participants were introduced and the proposed role of the project locally (or regionally) were discussed
- The project background, objectives, structure and schedule were presented
- The central scientific themes developed by the Technical Working Group were summarized along with the lines of inquiry and the identified critical science and technology targets
- Open discussion and questions were encouraged

Following the plenary session, one or more breakout groups (depending on total attendance) were held to elicit detailed and specific feedback on the technical direction of the project. The goal was to allow participants to provide input on issues and sensitivities that the project needs to be aware of as the work advances.

The project team thanks those who took the time to participate in these meetings. We will continue to meet with these parties as the project progresses to provide additional information and gather additional feedback.

The main body of this report summarizes the results of the meetings, the concerns and ideas that were heard at all the meetings and those that were site/region/state specific. The appendices include the slides of the technical presentation that were presented at the meetings and the summaries from the individual meetings.

### **Discussion Sessions**

In an effort to elicit discussion on items identified as key to the work of the Technical Working Group, a set of questions was prepared and populated on flip charts. These questions were the discussion points for each meeting. These questions are provided below.

1. What are the general experiences in (your state or region) implementing and utilizing MNA for chlorinated solvents?
2. Would the idea of using a balance between contaminant loading and attenuation capacity as the conceptual basis for MNA and EPR be useful/acceptable?
3. Are the ground rules used by the Technical Working Group in evaluating the lines of inquiry appropriate?
4. Would the proposed four-phase characterization and monitoring sequence improve MNA/EPR?
5. During characterization, would additional technically based logic/guidance to support the multiple lines of evidence be useful?
6. Does the general idea of “enhanced passive remediation” make sense? Should it be linked to MNA in guidance and protocols?
7. Specifically, what are the potential issues/acceptability for the following types of EPR:
  - Enhancing or expanding the groundwater surface water discharge zone processes.
  - Emplacement of long-term treatment zones in the system (such as permeable treatment beds based on peat wood chips and the like)
  - Addition of missing classes of microorganisms
  - Including volatilization from surface water in the natural attenuation capacity.
8. What is your general assessment of the line of inquiry, issue identification and prioritization process performed by the Technical Working Group?
9. Are the highest priority items appropriate?
10. Did you or people you know receive the historical survey?

During the discussions, there were topics/needs that were identified at each meeting and there was also topics/needs that were site/state/region specific. These are summarized below.

### **Common Topics/Areas of Concern**

#### *General*

MNA/EPR should be coupled with source remediation. Everyone agreed that one must address the source area(s) of the contamination, if one wants to successfully implement MNA/EPR in the remedy.

The linkage of EPR with MNA and the active remedial options needs to be explained in a clear manner.

Cost and time need to be considered in evaluating MNA/EPR. There is concern that over the long-term the monitoring of MNA/EPR may be cost prohibitive. Cost was a particular emphasis for nonfederal regulators and those involved with “dry-cleaner” cleanup programs.

The participants were supportive of the project objectives, the lines of inquiry, the technical working group and the proposed plan. There was particular support for the breadth of the technical working group and the inclusion of independent (non DOE lab) members with national recognition. The commentors believe the structure of the project was somewhat unique and strongly encouraged continuation of this approach as the project moves forward.

#### *Mass Balance Between Contaminant Loading and Attenuation Capacity*

This concept was almost universally accepted to be a good way to evaluate the implementation of MNA/EPR as a remedial option.

There was general concern that calculating the mass balance in a natural system will be difficult. The participants strongly encouraged the project to develop the concept further but believed that the difficult work lies ahead and that acceptability will be related to the details of the final product.

#### *Ground Rules Used by the Technical Working Group*

The terms “closure” and “agreed risk-based end state” did not resonate with the workshop participants. These have regulatory meanings. The participants did not believe the terms were consistent with what the project was trying to express. Need to describe what is meant and not use the latest buzz-words and/or DOE jargon.

Overall, there was agreement that the ground rules make sense.

#### *Four-Phase Characterization and Monitoring Sequence*

The majority of the participants believed this phased approach is consistent with the existing decision-making (regulatory) processes.

None of the four phases were identified as unnecessary but many participants believed that the two characterization phases could be performed together and viewed as substages of an overall characterization effort.

There was concern over the potential for cost increases either in the 2 phased characterization or in the System Performance Monitoring.

#### *Technical Based Guidance to Support the Multiple Lines of Evidence*

Everyone agreed this would be a useful tool. Most of the discussions went in the direction that the guidance should use scenarios based on generic sites and should provide information to assist the user in understanding how and why they are collecting the data. This will help the user make the final decisions on how to proceed, because each site is specific and the guidance is to assist in moving in the right direction. The user must make the final decisions.

#### *Enhanced Passive Remediation (EPR)*

Work needs to be done to better define/describe enhanced passive remediation.

All agreed that EPR must be sustainable. Many voiced the opinion that it is a one-time action. Periodic actions were thought of as active treatment.

All saw EPR and MNA as being linked. However, there was not consensus on whether they should be in the same guidance. It was suggested at several of the meetings that MNA should be a Volume 2 to the existing MNA guidance.

The consensus was that EPR makes sense and is a good segue from active to passive treatment.

The discussion associated with enhancing/expanding the groundwater surface water discharge zone processes indicated a higher comfort level if the discharge zone was within the confines of the "owners" property than if it was off-site. Classification of the surface water may effect acceptance. The attenuation mechanism(s) at work will be

important in acceptance. Responses from several meetings indicated a preference for destructive mechanisms.

There was general skepticism that emplacement of long-term treatment zones in the system would be sustainable (one-time action). This was identified as an active treatment at several of the meetings.

There was a general level of comfort in considering the addition of missing classes of microorganisms if they are indigenous. Understanding the impacts of adding microorganisms to the subsurface system was identified as very important for success with this type of enhancement. The consensus was that genetically engineered microorganisms may be less acceptable than naturally occurring organisms. Understanding why certain classes of biodegrading organisms are not present was identified as being important.

The consensus is that volatilization from surface water may be an acceptable approach – but should be considered on a site specific or case-by-case basis. Several participants identified that eco-risk to receptors must be considered when evaluating this enhancement. Several participants noted that volatilization is occurring, so one should be able to take credit for it.

#### *General Assessment of the Line of Inquiry, Issue Identification and Prioritization Process*

There was overall support for the process.

#### *Appropriateness of Priority Items (Technical Targets)*

No central themes were identified from the meetings. The importance of flux measurements was mentioned at several of the meetings.

#### *Receipt of Historical Survey*

In general, most of the people who participated in this workshop did not participate in the historical survey.

### **Meeting Specific Areas/Topics of Concern**

Meetings were held at Hanford, Oak Ridge and SRS. Several meetings with separate groups were held at SRS to obtain the input and feedback from end users, regulators and stakeholders. The Oak Ridge and Hanford meetings were combined meetings where all parties participated. This section will have three summaries. The results of the individual SRS meetings will be rolled into one summary. There is no summary from the

two meeting with the SRS Citizen's Advisory Board (CAB). The SRS CAB will be writing a recommendation for the project based on the presentations team members made. The summaries of the individual meetings will identify the key points identified by the participants as MNA is relative to their sites, states and regions.

#### *Hanford Meeting Key Points*

MNA will be a part of every remediation. However, the emphasis is source remediation.

Ecological protection and source controls are the emphasis at Hanford in selecting remedial options.

The mass balance concept is good, but the challenge will be in evaluating the components.

Site specific issues, such as the deep vadose zone, site scale (e.g., the large distance from the central plateau to the Columbia River at Hanford) makes many of the classic MNA scenarios inappropriate. The major presence of carbon tetrachloride (rather than chlorinated ethenes) provides a unique need/challenge at Hanford versus many other sites.

When a waste unit is governed under CERCLA, the MNA evaluation should be conducted during the Remedial Investigation phase rather than the Feasibility Study phase.

#### *Oak Ridge Meeting Key Points*

The karst and fractured geologic setting of Oak Ridge will make implementation of MNA difficult. This was strongly emphasized as a critical need for Oak Ridge.

There is sensitivity to having contaminants enter surface water bodies as part of the MNA/EPR process by some regulators and end users, but many participants believed that it could be considered on a case-by-case basis.

Open communication will be vital to obtain concurrence for using bio-augmentation as an enhanced passive remediation option.

#### *Savannah River Meetings Key Points*

MNA needs to be coupled with source remediation.

Cost and time need to be considered when evaluating MNA as a remedy.

Characterization of the site in an efficient and sufficient manner while keeping costs under control is critical.

### Summary of Action Items

Several of the meetings generated action items. The action items and status are summarized below.

- The MNA project staff should include Oak Ridge and Tennessee Department of Environmental Control representatives in the September 10 meeting with EPA Region IV staff. *Status: Complete. Invitations went to Oak Ridge and TDEC personnel.*
- The MNA project staff should utilize the large amount of data from EPA sites. *Status: Ongoing.*
- Copies of the Oak Ridge meeting summary should be sent to the meeting participants. *Status: Complete.*
- The MNA/EPR team will combine the results of meetings with regulators, stakeholders and end users at Hanford, Oak Ridge, and Savannah River and provide these results to all participants. *Status: Complete.*
- Carl Froede, EPA, will provide contacts at the Paducah and Pinellas sites to Karen Adams, DOE-SR, for follow-up to determine if they would like to meet with the MNA/EPA team. *Status: Complete. A DOE representative from Pinellas contacted Karen Adams. He indicated they do not wish to meet with the team at this time, but would like to remain informed of the progress of the project.*
- The MNA/EPR team will provide copies of the EPA meeting summary to the meeting participants. *Status: Complete. Sent as summary document.*
- The MNA/EPR team will send copies of the Hanford meeting summary to the meeting participants, hopefully in time for the Hanford Advisory Board's River and Plateau Committee meeting on October. *Status: Complete. Sent as summary document.*
- Maynard Plahuta will talk with the chair of the Hanford Advisory Board's River and Plateau Committee about including a brief outline of the workshop with the agenda item on the carbon tetrachloride plume at Hanford at the committee's October 8 meeting and explore interest in bringing information on the MNA/EPR project to the committee and the full Board. *Status: The MNA/EPR project is on the RL HAB's River and Plateau Committee Agenda for November 12. Tyler Gilmore, PNNL, and John Morse, DOE-RL, will present the research project and representatives from EPA and Ecology will present the regulators perspective.*

### Summary

The input received from these meetings, along with the comments from an independent peer review of the S&T document and comments from a newly formed Inter-State Technology Regulatory Council (ITRC) team of the S&T document, will be provided to the Technical Working Group. The Technical Working Group will evaluate all the input

and comments prior to finalizing the document. Once the final document is released to the public it will be available on the Office of Scientific and Technical Information (OSTI) website.

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Appendix A. Technical Presentation Slides

Appendix B. Oak Ridge Meeting Summary

Appendix C. Savannah River Site – Soil and Groundwater Closure Project (SGCP)  
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Control Meeting Summary

Appendix E. EPA Region IV Meeting Summary

Appendix F. Hanford Meeting Summary

**APPENDIX A**

**TECHNICAL PRESENTATION SLIDES**

**FOR**

**MONITORED NATURAL ATTENUATION**

**AND ENHANCED PASSIVE REMEDIATION (MNA/EPR)**

**FOR CHLORINATED SOLVENTS**

**TECHNOLOGY ALTERNATIVE PROJECT**

## **Project Background**

- Chlorinated solvents represent many of the largest and most challenging plumes at DOE sites across the country – including the Savannah River Site, Oak Ridge Site, and the Hanford Site.
- To facilitate implementation of MNA and EPR, the DOE Office of Environmental Management has sponsored an Alternative Project.
- The project narrowly focused, *provides the scientific and policy support to facilitate implementing appropriate passive cleanup and cost effective monitoring strategies leading to responsible completion of remediation activities at high risk DOE waste sites.*
- A technical working group with broad national representation was formed to strategically guide the project.

## **Project End Product and Desired Outcome**

End Product: A technical guidance document that will provide additional information for implementing MNA.

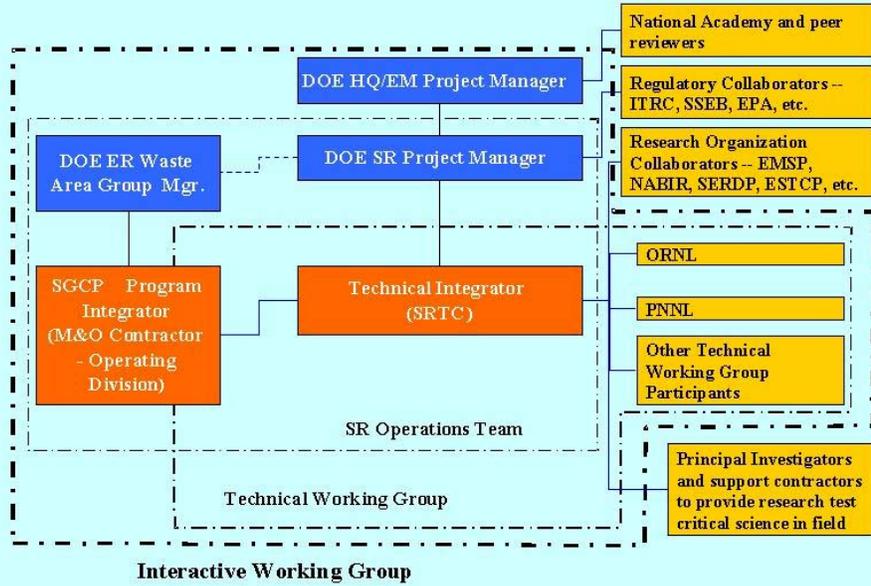
Desired Outcome: The end product of this project will provide value to and be used by the regulator and end user communities.

Strategy: In parallel with developing and implementing the technical strategy, we will gather and incorporate the issues, needs and concerns of the regulators, stakeholders and end users.



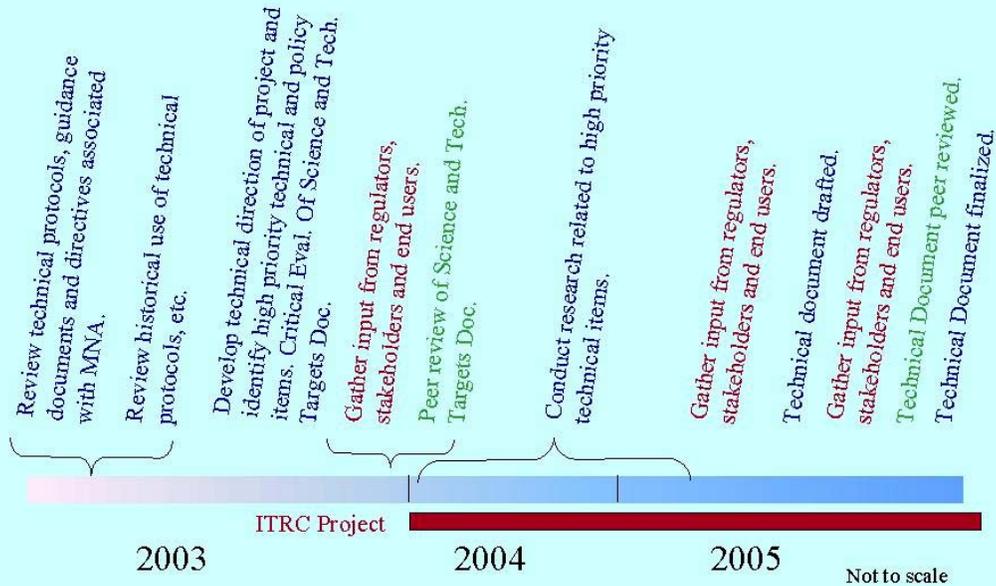
DOE MNA/EPR Acceleration Project

MNA Project Structure and Integration



DOE MNA/EPR Acceleration Project

Project Timeline



## Definitions

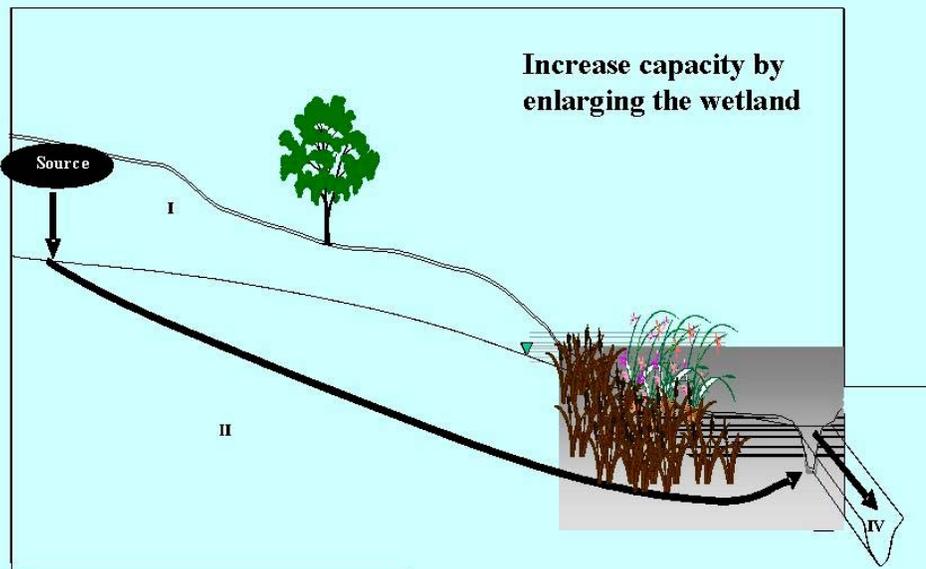
**MNA – Monitored Natural Attenuation –** Managing all or part of a contaminant plume in soil and groundwater by utilizing the existing decontamination and attenuation mechanisms of the natural system and by documenting the resulting attenuation capacity. EPA definition states “no human intervention”.

**EPR- Enhanced Passive Remediation –** Managing all or part of a contaminant plume in soil and groundwater by initiating and/or augmenting natural and sustainable decontamination and attenuation mechanisms of the natural system and by documenting the resulting attenuation capacity.

**Attenuation Capacity –** The sum of all physical, biological, and chemical processes serving to disperse, biodegrade, chemically transform, immobilize, or permanently sequester chlorinated ethenes in a groundwater system.

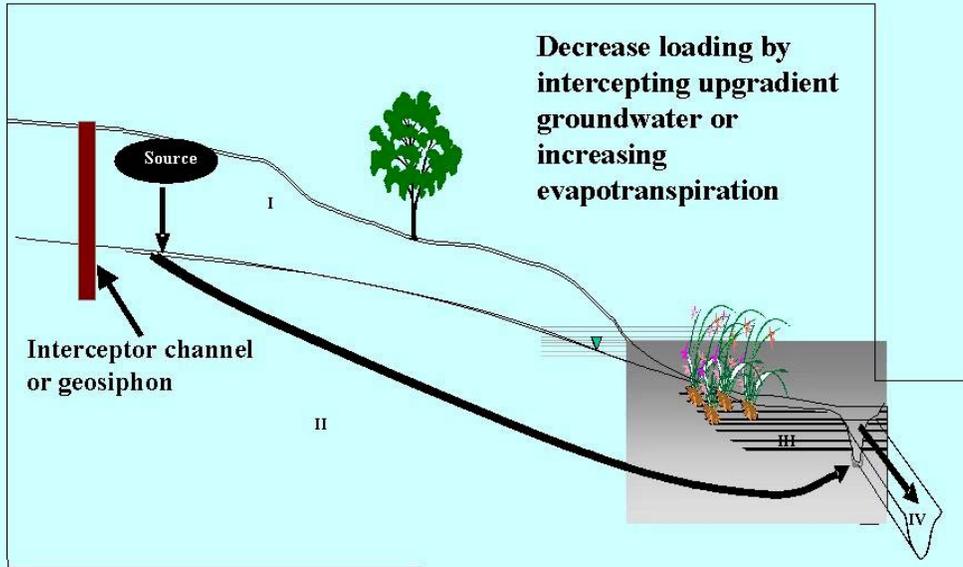


### DOE MNA/EPR Acceleration Project



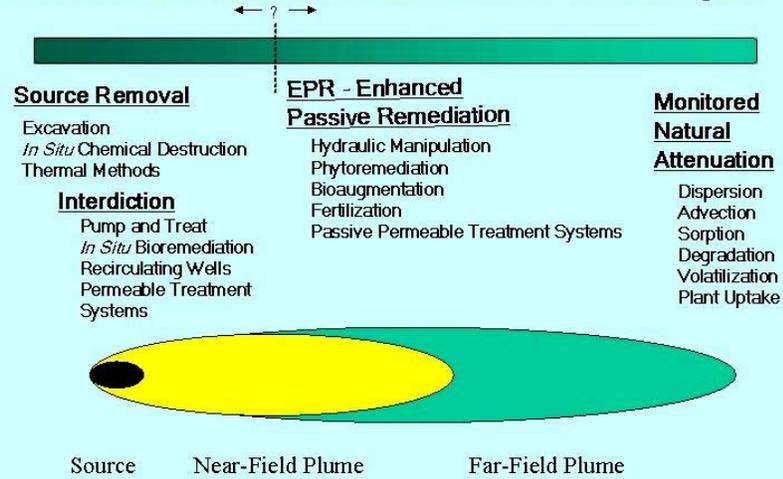


DOE MNA/EPR Acceleration Project



DOE MNA/EPR Acceleration Project

Continuum of Individual Remediation Technologies



**Key Objectives:**

*“To examine opportunities to incorporate recent science and expanded conceptual approaches to encourage appropriate use of MNA/EPR...”*

- Develop the concept of enhanced passive remediation and all forms of sustainable passive natural remediation.
- Gain regulatory concurrence in the states and regions overseeing the Savannah River Site, Hanford, and Oak Ridge – work with interstate and national regulatory partners to contribute to national MNA efforts.
- Advance the science and broaden the understanding of natural attenuation and remediation systems.
- Establish and document new monitoring paradigms that provide high levels of performance for reduced costs.

**Technical Working Group:**

*“This group is critical to the project success – they will specify and document the scientific approaches that will serve as the foundation of the project. As a result, a diverse group of recognized experts will participate.”*

Brian Looney, Savannah River Technology Center – Chairperson

Todd Wiedemeier, T. H. Wiedemeier and Associates

Tom Early, Oak Ridge National Laboratory

Frank Chapelle, U.S. Geological Survey

Jody Waugh, S.M. Stoller

David Major, GeoSyntec, Inc.

Tyler Gilmore, Pacific Northwest National Laboratory

Michael Heitkamp, Savannah River Technology Center

Gary Wein, WSRC-BSRI, Soils and Groundwater Engineering

**Key Technical Resources and Project Team Members:**

Ken Lovelace, U.S. EPA, Office of Environmental and Remedial Response

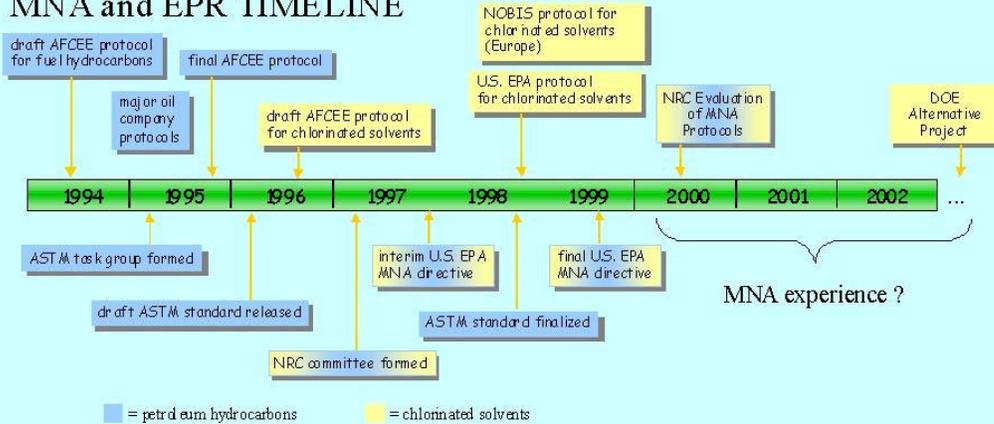
Chuck Newell, Groundwater Services Inc.



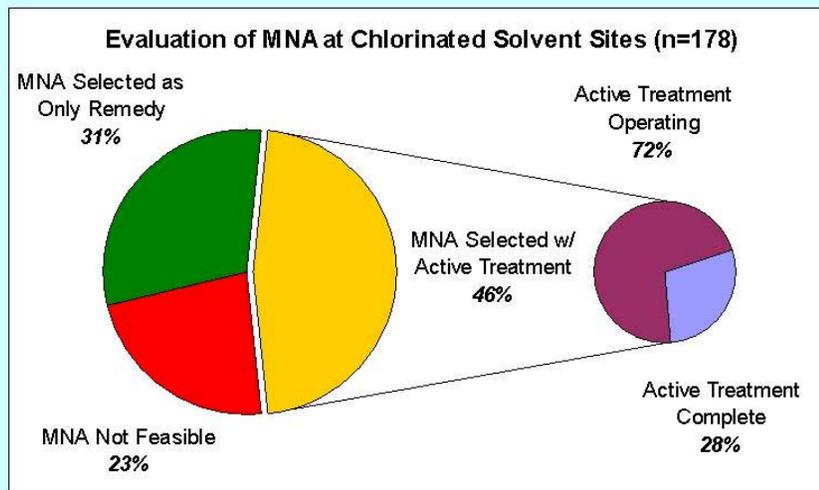
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**Recent Historical Development of MNA/EPR for Petroleum Hydrocarbons and Chlorinated Solvents** (modified from Wiedemeier and Barden, 2002)

**MNA and EPR TIMELINE**



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**Technical Organization:**

*“The project will critically examine opportunities for expanding MNA by following ground rules and directed lines of inquiry within the topics: Scientific Basis and Characterization/Monitoring”*

**Scientific Basis - Ground Rules**

- Processes must be based on natural mechanisms.
- Processes must be sustainable and allow closure of the site from the perspective of active treatment.
- Develop the concept of EPR that allows enhancements and reconfiguration (as long as the resulting mechanisms are naturally sustainable) to increase the capacity of the naturally occurring processes.
- New approaches should build on and link to past MNA protocols.
- New approaches should focus on the basis for transitions from active to passive to MNA/EPR and defining a valid and environmentally protective exit strategy for active remediation.
- New approaches should emphasize the concept of working toward an “agreed” risk-based end state.

**Characterization/Monitoring - Ground Rules**

- Develop clear strategies for the distinct needs associated with MNA/EPR characterization and then long-term monitoring.
- Develop responsive characterization and monitoring approaches that beneficially use data to refine and improve decisions and interpretations.
- Emphasize integrating measures, such as flux, remote sensing and other averaging and volumetric methods.
- Refine the idea of “multiple lines of evidence” in current protocols and develop a defensible approach to define a “quorum of evidence” that will be acceptable (given natural variability and uncertainty).
- Emphasize large-scale design and monitoring concepts. Document performance and robustness using overall mass balances and MNA process/condition mapping to supplement or replace the traditional requirement of “plume stability”.
- Emphasize system and ecosystem monitoring concepts.

**Summary Lines of Inquiry – Scientific Basis**

- Natural Processes
- Natural Processes with Enhancements
  - Microbial
  - Phyto
  - Interfaces
  - Scenarios

### **Summary Lines of Inquiry – Characterization and Monitoring**

- Strategy
- Multiple Lines of Evidence
- Enhancements to Characterization and Monitoring
  - Non-standard Monitoring Concepts
  - Modeling
  - Sensors
  - Configuration of Monitoring Systems
  - Advanced Bioassessment Tools

### **Path Forward – A Three Month Window**

- Peer Review of Science and Technology Targets document.
- Conduct competitive process for selecting studies to support high ranked science and technology targets.
- Conduct briefings for end users, regulators and stakeholders associated with Savannah River, Hanford and Oak Ridge Sites.
- Initiate newly approved project with the Inter-State Technology Regulatory Council.



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Technical Progress and Status



**Scientific Basis Ground Rules**

- Processes must be based on natural mechanisms.
- Processes must be sustainable and allow closure of the site from the perspective of active treatment.
- Develop the concept of EPR that allows enhancements and reconfiguration (as long as the resulting mechanisms are naturally sustainable) to increase the capacity of the naturally occurring processes.
- New approaches should build on and link to past MNA protocols.
- New approaches should focus on the basis for transitions from active to passive to MNA/EPR and defining a valid and environmentally protective exit strategy for active remediation.
- New approaches should emphasize the concept of working toward an “agreed” risk-based end state.

### **Characterization and Monitoring – Ground Rules**

- Develop clear strategies for the distinct needs associated with MNA/EPR characterization and then long-term monitoring.
- Develop responsive characterization and monitoring approaches that beneficially use data to refine and improve decisions and interpretations.
- Emphasize direct measures of processes rather than indirect where possible.
- Emphasize integrating measures, such as flux, remote sensing and other averaging and volumetric methods.
- Refine the idea of “multiple lines of evidence” in current protocols and develop a defensible approach to define a “quorum of evidence” that will be acceptable (given natural variability and uncertainty).
- Emphasize large-scale design and monitoring concepts. Document performance and robustness using overall mass balances and MNA process/condition mapping to supplement or replace the traditional requirement of “plume stability”.
- Emphasize system and ecosystem monitoring concepts.

### **Summary Lines of Inquiry – Scientific Basis**

- Historical and Retrospective Evaluation
- Natural Processes
- Natural Processes with Enhancements
  - Microbial
  - Phyto
  - Interfaces
  - Scenarios

### **Summary Lines of Inquiry – Characterization and Monitoring**

- Strategy
- Multiple Lines of Evidence
- Enhancements to Characterization and Monitoring
  - Non-standard Monitoring Concepts
  - Modeling
  - Sensors
  - Configuration of Monitoring Systems
  - Advanced Bioassessment Tools

### **Existing MNA Protocols**

- do a good job of identifying what needs to be measured at a site.
- do a poor job of explaining **why** those measurements should be made.

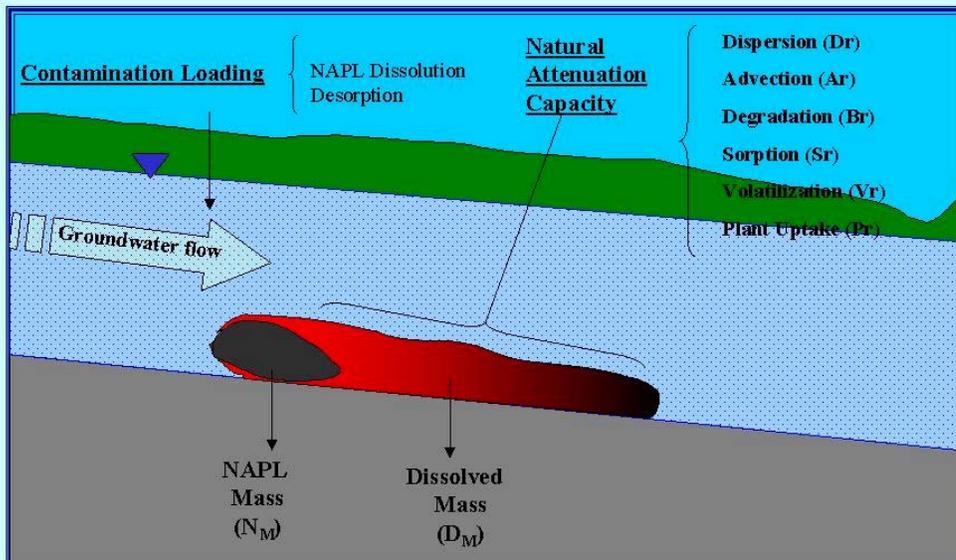
## How can we improve use/acceptance of MNA?

- Do a better job of explaining why, when, and how certain measurements are useful.
- One way to do this is to focus the MNA paradigm to one of contaminant loading versus attenuation capacity.



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### MNA as a balance between contaminant loading and natural attenuation capacity



## **Plume Stability**

- $D_m = D_r + A_r + B_r + S_r + V_r + P_r$
- Contaminant loading is equal to the sum of the removal mechanisms
- This is a central concept and product of the technical work to date

## **A Mass Balance Paradigm**

- Assess Contaminant Loading
- Assess Natural Attenuation Capacity
- Efficiency of MNA depends on how loading is balanced by attenuation capacity.

**The Mass Balance Approach is conceptually simple and easy to understand.**

- It is an excellent organizing principle.
- Why then, is assessing MNA, and obtaining regulatory acceptance so difficult?

**Consider biodegradation . . .**

- Reductive dechlorination
- Anaerobic oxidation
- Aerobic oxidation
- Fermentation
- Co-metabolism

**These processes are difficult to measure directly.**

**Rather a series of indirect measurements are used to deduce their presence/absence/rates.**



DOE MNA/EPR Acceleration Project

**A shadow of its former self ...**

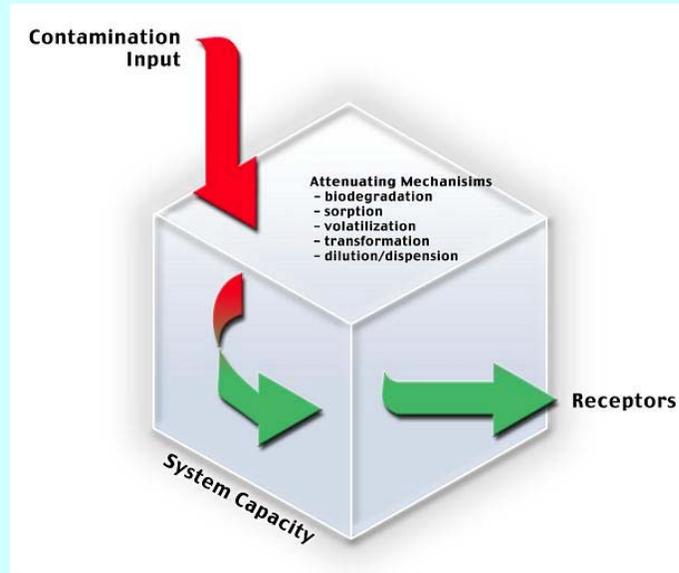
- *The different components of natural attenuation capacity contributing to the mass balance of a given site cannot be directly measured.*
- Actual evaluations of natural attenuation must rely on indirect measurements and indicators for each component of the mass balance problem.



**Characterization and  
Monitoring Strategy  
for MNA and EPR**



## System Capacity



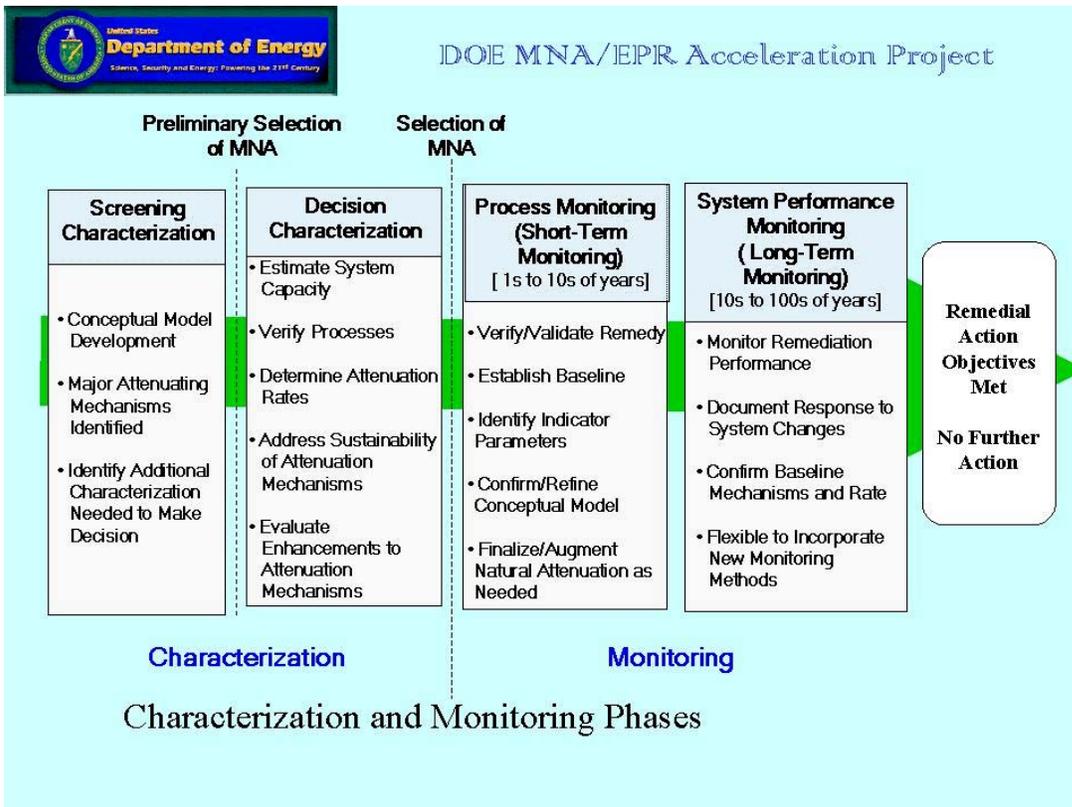
### Characterization and Monitoring Objectives

*MNA is viable if the sum of the various mechanisms are sufficient to attenuate the contaminants and protect potential receptors.*

- **Characterization** provides evidence that the attenuation capacity in the system is sufficient and sustainable.
- **Monitoring** verifies the attenuation capacity is maintained over time and as conditions vary until remediation objectives are met.

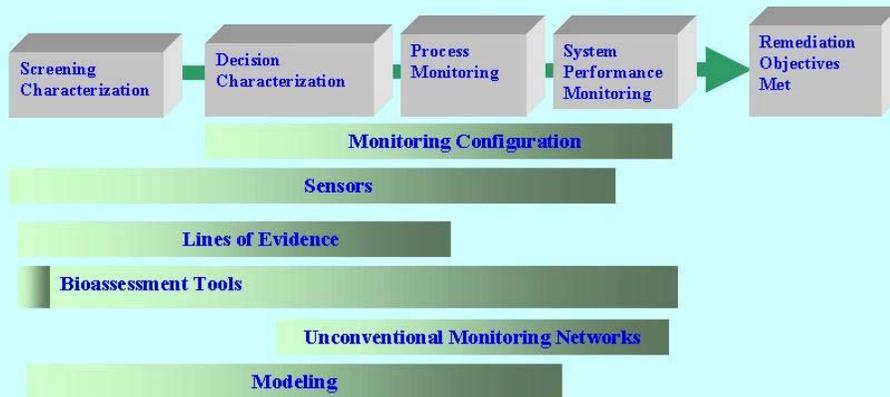
## Incorporate Latest Research

Relevant scientific and technical advances have been made on diverse topics ranging from subsurface access, to ecosystem structure and function, to bioassessment tools.





## DOE MNA/IEPR Acceleration Project



### Screening Characterization

- Conceptual model development
- Major attenuating mechanisms identified
- Identify additional characterization needed to make a decision

## Decision Characterization

- System Capacity Estimated
- Verify Processes
- Determine Rates of Attenuation
- Address Sustainability
- Evaluate Enhancements (EPR)



### DOE MNA/EPR Acceleration Project

## Considerations for Selecting Modeling Approach Based on Site Properties

KEY:



Modeling Approach <sup>1</sup>	Sites with supportive geochemical/hydrologic conditions		Sites with hydrologic &/or geochemical complexity/challenges		
	Simple site with stable or shrinking plume	Plume stability & geochemical footprints uncertain	Documented plume growth or outcrop... may be stable in the future	Geochemical conditions uncertain and/or complex hydrologic conditions	Attenuation process enhancement evaluation
<u>Conceptual Model</u> - Identify contributing processes and the active zones within a plume	●	○	●	●	●
Conceptual Model plus Analytical Model or <u>Mass Balance Calculation</u>	○	●	○	○	○
Conceptual Model, possible analytical model and numerical model	●	○	●	●	●

<sup>1</sup>Underlining indicates the primary modeling analysis considered for the table row.

<sup>2</sup>Numerical modeling is not necessarily preferred because costs may not be justifiable for the offsetting benefits in terms of uncertainty reduction, monitoring optimization, etc. However, numerical models may be selected if it is necessary to provide better estimates of time frames and better assurance of meeting certain types of remediation goals (e.g., concentration targets) than can be obtained with analytical modeling.

<sup>3</sup>Conceptual models are good to use for planning and site management, but may not be suited as primary support for decision making at complex sites or sites that have high uncertainty because conceptual models do not allow testing of uncertainty and parameter sensitivity and do not strongly support a detailed evaluation of enhancements.

## **Process Monitoring**

- Verify/validate remedy
- Establish baseline
- Identify indicator parameters
- Confirm/refine conceptual model
- Augment attenuation as needed

## **System Performance Monitoring**

- Monitor remediation performance
- Document response to system changes
- Confirm baseline mechanisms and rate
- Flexible to incorporate new monitoring methods.

- **Technical defensibility**
- **Cost savings through efficient characterization and monitoring**

## **Costs**

*Characterization and monitoring are the primary costs of MNA*

- If traditional monitoring techniques are used the costs of MNA may be too high
- Efficient long-term monitoring is where most cost-savings will be realized

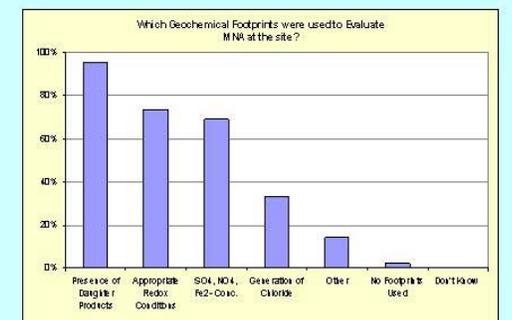
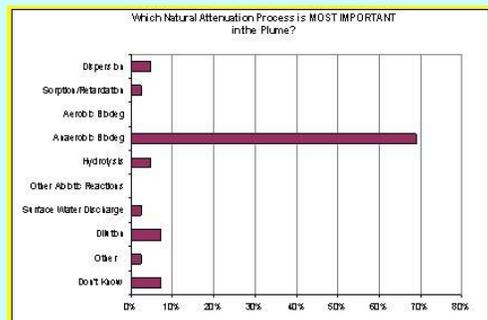
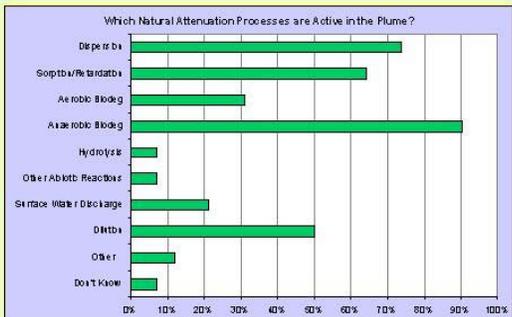
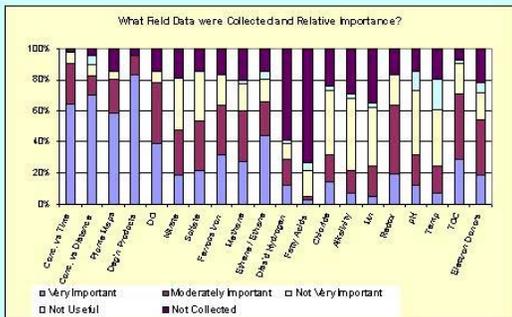
## Attributes of Long-term Monitoring

- ? Passive
- ? Robust
- ? Flexible
- ? Utilize leading (failure) indicators
- ? Measure change from baseline
- ? Utilize indicator parameters
- ? Low maintenance
- ? Low cost
- ? Measures volume or flux
- ? Measures of ecological health

*Adherence to these attributes should promote non-traditional monitoring configuration*



### DOE MNA/EPR Acceleration Project



## **High Priority Technical and Implementation Targets**

### **Characterization and Monitoring**

- Advanced bioassessment tools for determining ongoing microbial processes...
- Develop correlations between species, functional genes and degradation rate and potential.
- Further research on bioassessment oxidative and reductive processes.
- Scenarios based framework to support characterization monitoring and modeling decisionmaking.
- Direct measures and sensors for abiotic attenuation mechanisms.
- Develop specific alternative monitoring configurations to collect data at substantial cost savings during system performance monitoring stage.
- New sentinel monitoring strategies.
- Remote sensing of evapotranspiration and similar parameters.
- IR spectroscopy methods.
- Other optical spectroscopy techniques.
- Flux measurements.
- Samplers that integrate over distance and volume.

## **High Priority Technical and Implementation Targets**

### **Modeling Targets**

- Improve integration of modeling into MNA evaluation and implementation process.
- Improve reaction forms and include variable equilibrium partitioning coefficients within analytical models.

### **Process and Enhanced Process Targets**

- Microbiology - Bioaugmentation
- Modifying Large-scale Hydrology

## **High Priority Policy Targets**

- Develop decision process (based on science) to transition from active to more passive treatment.
- Develop concurrence with the stages of characterization and monitoring.
- Develop acceptance of central concept defining MNA/EPR – Balancing attenuation capacity and loading.
- Acceptance of framework for selecting the analytes and interpreting the results.

## **Advanced Biomonitoring Tools**

## **Role of Biomonitoring Tools**

- Support MNA decisions
  - Verify key processes (part of tiered approach)
  - The “third-line” of evidence
- Assessment of Capacity
  - How fast, how much
- Replace other parameters?
  - i.e., becomes a direct measurement not a third-line of evidence

## **Molecular Tools**

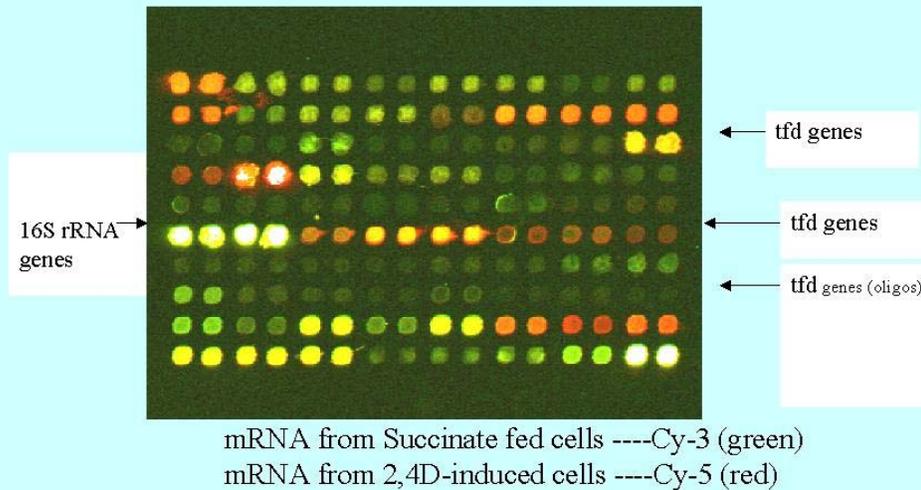
- DNA Microarrays
  - 1000's of “functional” genes from species or whole communities are placed on a chip
  - Samples extracted and chips exposed
  - Correlate which genes “light up” and their intensity to identify and quantify the metabolic processes that are occurring
    - How fast and where is TCE being dechlorinated?
    - How is an electron donor being metabolized?
    - Identify new or assess metabolic processes that are not as well characterized.



## DOE MNA/EPR Acceleration Project

# Prototype DNA Microarray

## 64 Genes, mixed & pure cultures, over time



## Summary

Provide an overview of the MNA/EPR for Chlorinated Solvents Project.

Introduce concepts developed by the TWG to further the appropriate use of MNA.

Initiate a dialogue to elicit feedback from stakeholders, regulators and end users to provide input to the project's technical team.

**APPENDIX B**

**OAK RIDGE MEETING SUMMARY**

**August 12, 2003**

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration**

**Oak Ridge, TN  
August 12, 2003**

**Meeting Summary**

Representatives of DOE's alternative project on monitored natural attenuation and enhanced passive remediation (MNA/EPR) for chlorinated solvents met with staff of the Tennessee Department of Environment and Conservation (TDEC), members of the Oak Ridge Citizens Advisory Board, and representatives of DOE-Oak Ridge, Bechtel Jacobs, and ORNL on August 12, 2003, at TDEC's offices. An attendance list is provided in Attachment A and the agenda for the meeting is presented in Attachment B. The objectives of the meeting were to:

- Provide information about the project to regulators, stakeholders, and end users.
- Elicit feedback and gather input on the direction of the project, its usefulness, and its applicability to the issues with which the respective sites, states, and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

Welcoming remarks were made by Gerald Boyd, Manager of DOE-OR, Steve McCracken, DOE-OR Assistant Manager for Environmental Management, and Paul Clay, Vice President and Deputy General Manager, Bechtel Jacobs. Claire Sink, DOE-EM, provided a background on the creation of the MNA/EPR alternative project and introduced the key members of the MNA/EPR project team, including the role of the ITRC.

Following introductions and an overview of the agenda by Tom Early, ORNL, an overview of the project was provided by Karen Vangelas, SRTC. She outlined the purpose of the project, project structure, and schedules. She also summarized areas for improvements to existing MNA approaches, a new way of expressing the problem, enhanced passive remediation and how it complements MNA, and the strategy for long-term monitoring and the transition from active to passive systems.

Brian Looney, SRTC, provided a description of the technical activities and strategy for the MNA/EPR project. He outlined the ground rules developed by the technical working group and the lines of inquiry identified by this group. He discussed the concept of balancing contaminant loading with natural attenuation capacity and outlined a four-step strategy for characterization and monitoring to support MNA/EPR. He presented an overview of the prioritization of technical, policy, and implementation activities developed by the technical working group and then opened the floor for questions and discussion.

The meeting participants then went into two breakout groups for (1) regulators and stakeholders and (2) end users. However, it should be noted that several regulators also participated in the end user breakout session. The results of discussions in the two breakout groups are summarized below.

<b>Main Themes</b>	
<b>Regulator &amp; Stakeholder Breakout Responses</b>	<b>End User Breakout Responses</b>
<ul style="list-style-type: none"> <li>• The definition of MNA should not be limited to groundwater.</li> <li>• Regarding the four stages of characterization and monitoring, participants liked the flexibility to include new technology in the fourth stage (long-term monitoring).</li> <li>• There is discomfort with records of decision that call MNA “No Action” without documentation.</li> <li>• Enhanced Passive Remediation (EPR) should be clearly defined as a response to language in the EPA protocol stating that MNA involves “no human intervention.”</li> <li>• Communication is needed about issues regarding bioaugmentation. Acceptability is a function of communication – the importance of communication in building acceptance of a remedy should not be second-guessed.</li> </ul>	<ul style="list-style-type: none"> <li>• The existence of karst systems and fractured rock will make monitored natural attenuation at Oak Ridge difficult because these geologies allow rapid groundwater flow, severely reducing residence times that are needed for natural attenuation processes to work.</li> <li>• The concept of developing a taxonomy to guide the development of multiple lines of evidence will be helpful to reach a certain level, but at that point it will be necessary to consider site-specific conditions.</li> <li>• The use of long-term treatment zones should not be considered a form of enhanced passive remediation because these are not passive and sustainable, requiring periodic replacement of the treatment materials.</li> <li>• Consideration of bioaugmentation as a form of enhanced passive remediation can be expected to generate significant public and regulatory issues relating to introduction of foreign species, safety, and ability to contain the species to the intended location only.</li> <li>• Enhanced passive remediation that involves volatilization from surface waters, especially streams, is not allowed under Tennessee Department of Environmental Control regulations. Such an approach would have to occur prior to reaching streams; coupling with phytoremediation would help with its acceptability.</li> </ul>

**Question: What are the general experiences at OR and in Bechtel implementing and utilizing MNA for chlorinated solvents?**

- Is MNA feasible, is it encouraged or discouraged for these plumes and why?
- What are the key implementation and cost issues?

<b>Regulatory &amp; Stakeholder Breakout Session</b>	<b>End User Breakout Session</b>
<ul style="list-style-type: none"> <li>• General experiences are positive. MNA is currently being used at one facility onsite (south campus) where there is TCE contamination. It is a mature, stable plume. The ROD is generally acceptable.</li> <li>• MNA is being used for petroleum plumes throughout the state, with caveats on permanence, etc.</li> <li>• Experimental enhanced bioremediation of a carbon tetrachloride plume at Union Valley ITRD site.</li> <li>• Stakeholders have limited exposure to MNA but several participated in a relevant training course in 1999.</li> <li>• At the S3 pond the contamination is mostly U but also contains TCE. Active bioremediation is being used by NABIR's Field Research Center.</li> <li>• There is a great deal of public support for NABIR – several stakeholder groups wrote letters of support.</li> </ul>	<ul style="list-style-type: none"> <li>• Passive remediation has been employed for a small plume that the site is watching. Sampling for some parameters was done but the site lost funding before this work could be completed. A score of “maybe” for monitored natural attenuation was determined from this limited data.</li> <li>• The Environmental Sciences Division also looked at indicators of biodegradation at Y-12 and ETP. Results at ETP were equivocal and reached the point of DCE stall.</li> <li>• Many places at the site have reached DCE stall.</li> <li>• Complete TCE degradation occurred at WAG-5 at ORNL.</li> <li>• The dynamic groundwater situation at Oak Ridge makes natural attenuation monitoring, including both concentrations and locations, very difficult. The presence of clay and karst systems complicates determinations whether natural attenuation worked or the contamination just leaked out of the location through the karst structures.</li> </ul>

**Question: Would the idea of using a balance between contaminant loading and attenuation capacity as the conceptual basis for MNA and EPR be useful/acceptable?**

- How is it different than the existing protocol?
- What are the potential pitfalls or problems with the approach?

<b>Regulatory &amp; Stakeholder Breakout Session</b>	<b>End User Breakout Session</b>
<ul style="list-style-type: none"> <li>• There is support for the conceptual basis – it is “easily understood” and “a great concept.”</li> <li>• MNA has been perceived as a deferral of real action.</li> <li>• It must be clear exactly what is being monitored.</li> <li>• The definition of MNA is poor, making some stakeholders think of “smoke and mirrors.” MNA is not only about groundwater – the definition does not limit it to groundwater and that should be clear.</li> <li>• A participant criticized the University of Oklahoma’s questionnaire about MNA because all questions were phrased in the negative.</li> <li>• There is some concern that use of MNA could be project-driven rather than science-driven.</li> </ul>	<ul style="list-style-type: none"> <li>• Yes, this approach envelops all parameters. It balances infiltration and water balances with natural attenuation. The approach helps focus on terms that are site-specific.</li> <li>• For approaches to reduce contaminant loading, it may be difficult to control or engineer in areas where upwelling occurs.</li> <li>• The approach is geared for dissolved phase contamination rather than NAPL.</li> <li>• What is the role of source removal as part of reducing contaminant loading?</li> <li>• MNA should not be used in lieu of source term removal or treatment but rather should supplement these remedial activities.</li> </ul>

**Question: Are the ground rules used by the Technical working group in evaluating the lines of inquiry appropriate?**

- Are there any that should be eliminated?
- Are there other important issues that need to be addressed through new or modified ground rules?
- Do any of these ground rules move in an undesirable direction?

<b>Regulatory &amp; Stakeholder Breakout Session</b>	<b>End User Breakout Session</b>
<ul style="list-style-type: none"> <li>• Participants were generally supportive of both sets of ground rules.</li> <li>• In particular, people liked the idea of moving toward a more direct measure of processes and the transition concept.</li> </ul>	<p><b>Science Ground Rules</b></p> <ul style="list-style-type: none"> <li>• The ground rules should recognize that there may be sites for which MNA/EPR is inappropriate. For example, at some sites, complete removal is possible. Other examples include sites with karst or clastic systems that do not allow enough residence time for natural attenuation processes or for which modeling does not help. The appropriateness of MNA will need to be determined on a case-by-case basis.</li> <li>• A ground rule should be added to recognize the uniqueness of karst or fractured rock systems.</li> </ul> <p><b>Characterization &amp; Monitoring Ground Rules</b></p> <ul style="list-style-type: none"> <li>• There is skepticism about remote sensing. What information does it provide? The focus of remote sensing should be on plant health and evapotranspiration.</li> <li>• Refining the multiple lines of evidence will be helpful.</li> <li>• What is “responsive” characterization and monitoring? This should be explained.</li> </ul>

**Question: Would the proposed four-phase characterization and monitoring sequence improve MNA/EPR?**

- Is it consistent with decision-making processes?
- Are any of the phases unnecessary?
- What should be done to avoid increasing costs?
- What are the potential problems and pitfalls with the idea?

<b>Regulatory &amp; Stakeholder Breakout Session</b>	<b>End User Breakout Session</b>
<ul style="list-style-type: none"> <li>• It is a good idea to have the flexibility to include new technology in the fourth phase (long-term monitoring).</li> <li>• Current records of decision (ROD) have not traditionally allowed flexibility, but recent RODs have had more flexibility.</li> <li>• The five-year review may be an opportunity to transition to the fourth phase.</li> </ul>	<ul style="list-style-type: none"> <li>• Why start with direct measurements during characterization and then switch to indirect measurements during monitoring?</li> <li>• There is a need to look at costs in optimizing characterization.</li> <li>• This approach does not fit with the CERCLA process at all. The four-step process could lead to modifying records of decision since some steps are post-decision. A large amount of discussion will have to take place during the decision process for this approach to work.</li> <li>• If MNA is simply monitoring, then the approach is okay. If active management is required, this will have to be known upfront. Conversely, if the monitoring results show the source has not been adequately removed, active management will be necessary.</li> <li>• The characterization snapshot may not capture changing conditions (e.g., drought or high precipitation years) that impact on the effectiveness of MNA.</li> <li>• At what point can monitoring be discontinued (e.g., when it has demonstrated that the process is occurring as predicted)? When can the frequency of monitoring be reduced?</li> <li>• Monitoring results may not support accurate predictions in the Oak Ridge karst system.</li> <li>• Characterization to a level that is comfortable and supports confidence in predictions and decision-making is difficult at Oak Ridge because of the karst.</li> <li>• A step needs to be added for projection of performance and determination of the time required to achieve the remedial action objective(s).</li> <li>• Under this approach, characterization costs may be higher but the long term costs may be lower. “Optimistic” characterization can lead to expensive re-work later.</li> <li>• The four-step approach will take longer than ETTP has available. ETTP is to issue a record of decision in 2008, requiring field data collection over 18 months in 2004-2005. The ETTP project will include demonstrations of MNA and phytoremediation.</li> </ul>

**Question: During characterization, would additional technically based logic/guidance to support the multiple lines of evidence be useful?**

- Why measure the list of parameters?
- In what order?
- Which optional parameters are needed?
- Would technical guidance to assist in this graded approach be useful?
- How to responsibly implement using less documentation for less complex sites and more for more complex sites....

<b>Regulatory &amp; Stakeholder Breakout Session</b>	<b>End User Breakout Session</b>
<ul style="list-style-type: none"> <li>• The flow chart concept was perceived as useful to avoid investing a lot of money in characterization when more aggressive remediation is actually what is needed.</li> <li>• The concept of technically based guidance is fine, but the key is determining what needs to be done to support the decision. A decision matrix would be useful.</li> <li>• Stakeholders are uncomfortable with RODs describing “no action” when contamination remains and monitoring is needed.</li> <li>• MNA should not be called “no action.”</li> </ul>	<ul style="list-style-type: none"> <li>• More development of the guidance is needed before its usefulness can be judged.</li> <li>• The taxonomy approach can go only to a certain level based on commonalities and then site-specific conditions must be considered. There are no “cookie cutter” answers. The taxonomy approach would be useful for getting to a certain level.</li> <li>• The presence of karst at Oak Ridge makes characterization and modeling very difficult.</li> <li>• Is the HAZWRAP database still available? It would provide a good source of data for projections of MNA at a wide variety of sites.</li> <li>• It would help to include the decision logic.</li> <li>• Priorities for characterization should be included as well.</li> <li>• Characterization of flow systems as well as biological and chemical characterization should be included.</li> <li>• Using a set of screening parameters that lead to the path for in-depth characterization would help save money.</li> </ul>

Question: Does the general idea of “enhanced passive remediation” make sense? Should it be linked to MNA in guidance and protocols?	
Regulatory & Stakeholder Breakout Session	End User Breakout Session
<ul style="list-style-type: none"> <li>• It must be clear that the description and concept of EPR were developed in response to the “no human intervention” language in the EPA protocol. It would also help to explain EPR in comparison to MNA, including how exactly the two processes differ.</li> <li>• Success relies on quantifying attenuation capacity.</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainability is the key.</li> <li>• How can enhance “doing nothing,” which is what the term passive remediation implies. The EPR terminology needs work.</li> <li>• It is important to emphasize that this is not adding any harm to the environment. An integrated team will be needed to assure that enhancement in one area does not impact another negatively.</li> <li>• Invasive species or species that could plug the system should be avoided.</li> <li>• Thermal enhancements may be possible if they can be sustained (e.g., solar heating).</li> <li>• The question for enhancements that would change the water balance to reduce contaminant loading is whether or not the site is willing to commit the land to this purpose for an extended period of time.</li> <li>• At sites with karst and connected systems, there needs to be consideration of the impacts of other land uses on the water balance (e.g., development of a nearby golf course).</li> <li>• The guidance should indicate when EPR will work and incorporate this in the taxonomy.</li> <li>• Success stories for passive remediation will be hard to find.</li> </ul>
Specifically, what are the potential issues/acceptability for the following types of EPR:	
<ul style="list-style-type: none"> <li>• <b>Enhancing or expanding the groundwater surface water discharge zone processes (phytoextraction, phytoremediation, increasing size of hyporheic and wetland zone)....</b></li> </ul>	
<ul style="list-style-type: none"> <li>• At Union Valley the remediation strategy is to use pump and treat and air sparging. Further downstream “natural air sparging” occurs when the plume crops out.</li> <li>• “Manufactured” or “engineered” wetlands are okay, but if the plume goes right into surface water, it may be a problem (unless the ARAR is met) as water exits the wetland. Discussion with the regulators would be needed.</li> <li>• Using phytoremediation for springs may be okay with sufficient controls.</li> <li>• An expanded wetland at the toe of a dam for metals has been done at the coal ash site (FCAP).</li> <li>• Permits will be needed to impact wetlands.</li> </ul>	<ul style="list-style-type: none"> <li>• TDEC favors using riparian zones. This approach is being used at the ash pond at Oak Ridge.</li> <li>• The focus should be on degradation processes so the wetland does not become a source later.</li> <li>• Consideration should be given to whether or not creation/expansion of a wetland would cause a site to become a Corps of Engineers or State jurisdictional wetland, requiring permits.</li> <li>• Use of this kind of approach (e.g., creation of wetlands) could give the site restoration credits to apply as mitigation for other projects.</li> <li>• Do no harm (e.g., consider whether this would create a location for disease-laden mosquitoes).</li> </ul>
Specifically, what are the potential issues/acceptability for the following types of EPR:	
<ul style="list-style-type: none"> <li>• <b>Emplacement of long-term treatment zones in the system (such as permeable treatment beds based on pet wood chips and the like)....</b></li> </ul>	

<ul style="list-style-type: none"> <li>• Zero-valent iron is being used at the S pond in a NABIR project.</li> <li>• If sustainability can be <u>documented</u>, then emplacement of long-term treatment zones would be okay.</li> <li>• The key element is the time-frame. For the next 100 years, the U.S. government will control the site. It is vital to look at the end use, even short-term, to guide decisions.</li> </ul>	<ul style="list-style-type: none"> <li>• Where would these be placed (e.g., depth and location along the plume). It might be desirable to place these near the discharge zone.</li> <li>• Does this qualify as MNA (i.e., does it meet the requirement for sustainability)? How often would replacement of reactive materials be necessary?</li> <li>• This constitutes <i>in-situ</i> treatment rather than MNA, regardless of the time-scale over which it would require replacement of reactive materials.</li> </ul>
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**Specifically, what are the potential issues/acceptability for the following types of EPR:**

**• Addition of missing classes of microorganisms (such as halorespiring organisms)....**

<ul style="list-style-type: none"> <li>• Would addition of such microorganisms cause unforeseen problems to the ecosystem?</li> <li>• NABIR is working on a similar topic right now. NABIR has support from regulators and stakeholders.</li> <li>• Communication and precautions are essential for this type of remediation strategy.</li> <li>• Concerns about microorganisms not being natural to the area need to be addressed head on. Implications should be explained clearly.</li> <li>• More potential issues exist with genetically engineered microorganisms but the University of Tennessee and ORNL are working on this for specific remediation situations.</li> <li>• Regarding phytoremediation, genetic understanding and manipulation may be easier to explain and use than microorganisms. However, it is still necessary to address unforeseen problems and use good communication and precautions.</li> </ul>	<ul style="list-style-type: none"> <li>• A strong case would have to be made that these organisms were here before versus introducing “foreign” species.</li> <li>• Proving the safety of this will be a significant public issue (e.g., no pathogens allowed).</li> <li>• How would the introduced species be contained in the intended location?</li> <li>• Regulatory and stakeholder acceptability will be higher for enhancing existing microorganisms than for introducing new species.</li> </ul>
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**Specifically, what are the potential issues/acceptability for the following types of EPR:**

**• Including volatilization from surface water in the natural attenuation capacity....**

<ul style="list-style-type: none"> <li>• This may be an acceptable approach. However, the current rule does not permit relying on volatilization when the plume reaches the stream.</li> <li>• Points of compliance should be set on a site-specific basis.</li> <li>• This approach requires working and agreeing on points of compliance and the end state.</li> <li>• Volatilization must be documentable and measurable.</li> <li>• Consider that there is very little difference between volatilization from a stream versus volatilization from an area immediately adjacent to a stream.</li> </ul>	<ul style="list-style-type: none"> <li>• “Dilution is the solution” is not acceptable.</li> <li>• The State of Tennessee does not want the contamination entering surface water in the first place.</li> <li>• If discharge was to something (e.g., a holding pond) before going to a stream and volatilization occurred in that intermediate surface water, this might be acceptable. However, it would be better if air stripping or a similar approach was taken.</li> </ul>
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**Question: What is your general assessment of the line of inquiry, issue identification and prioritization process performed by the technical working group?**

<p><b>Regulatory &amp; Stakeholder Breakout Session</b></p>	<p><b>End User Breakout Session</b></p>
<ul style="list-style-type: none"> <li>• There was general support for this process.</li> </ul>	<ul style="list-style-type: none"> <li>• The concepts are good (e.g., the balance between</li> </ul>

	contaminant loading and attenuation capacity).
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<b>Question: Are the highest priority items appropriate?</b>	
<ul style="list-style-type: none"> <li>• Direct measurement of key microbial capabilities in the system, and examining the potential to enhance these capabilities in a sustainable fashion?</li> <li>• What are your general impressions and comments on the prioritization?</li> </ul>	
<b>Regulatory &amp; Stakeholder Breakout Session</b>	<b>End User Breakout Session</b>
<ul style="list-style-type: none"> <li>• Consideration should be given to placing sensors higher on the priority list.</li> <li>• Participants expressed reluctance to embrace modifications to large-scale hydrology as a long-term solution. Specific issues are:             <ul style="list-style-type: none"> <li>▪ Questions exist about the sustainability and impacts of this approach.</li> <li>▪ How can one ensure how well it would work over long periods of time?</li> <li>▪ Scale is a challenge.</li> <li>▪ Example at Y-12: a creek and pond were modified then ended up as a contaminant source</li> <li>▪ Example at Melton Valley: barriers are not always effective at blocking water transport</li> <li>▪ There is a need to be aware of geological features and link any planning to site-specific structures.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Abiotic and physical processes may be more important at Oak Ridge.</li> <li>• There is skepticism about progress in the area of modeling. Biochemical modeling is a good thing to address but physical modeling in heterogeneous karst is a big challenge.</li> </ul>

<b>Question: Did you or people you know receive the historical survey?</b>	
<ul style="list-style-type: none"> <li>• What is your initial impression of the results?</li> <li>• Are they similar to TN experiences?</li> </ul>	
<b>Regulatory &amp; Stakeholder Breakout Session</b>	<b>End User Breakout Session</b>
<ul style="list-style-type: none"> <li>• No one in the breakout session had received the survey or knew anyone who had received it.</li> <li>• There is a tremendous amount of information on the successes and failures of MNA projects, particularly from the Air Force (Department of Defense).</li> </ul>	[Question not addressed]

**Action Items:**

- The MNA project staff should include Oak Ridge and Tennessee Department of Environmental Control representatives in the September 10 meeting with EPA Region IV staff.
- The MNA project staff should utilize the large amount of data from EPA sites.
- Copies of the Oak Ridge meeting summary should be sent to the meeting participants.
- The results of meetings with regulators, stakeholders and end users should be combined with those from the Oak Ridge meeting and provided to all participants.

*Attachment A***MNA/EPR Workshop – Oak Ridge  
Attendees**

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*Attachment B*

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration  
Agenda**

**Date: August 12, 2003****Time: 8:30 am – 12:30 pm****Location: Tennessee Department of Environment and Conservation, Emory Valley Road****Objectives:**

- To provide information about the project to regulators, stakeholders and end users.
- To elicit feedback and gather input on a) the direction of the project, b) its usefulness, and c) applicability to the issues with which the respective sites, states and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

<b>Time</b>	<b>Topic</b>	<b>Lead</b>
8:30 am – 9:10 am	<b>Welcome</b> <ul style="list-style-type: none"> <li>• Gerald Boyd, US DOE, Manager, Oak Ridge Operations Office</li> <li>• Steve McCracken, US DOE, Assistant Manager, Environmental Management</li> <li>• Paul Clay, Bechtel Jacobs Company LLC, Vice President and Deputy General Manager</li> <li>• Claire Sink, US DOE, MNA/EPR for Chlorinated Solvents, DOE Alternative Project for Technology Acceleration, Project Manager</li> </ul>	Tom Early, ORNL
9:10 am – 9:20 am	<i>Introductions and Review of Agenda</i>	Tom Early, ORNL
9:20 am – 9:40 am	<b>Definition of MNA and History of MNA Protocols/Introduction of Project</b> <ul style="list-style-type: none"> <li>• Overview of MNA Project <ul style="list-style-type: none"> <li>– Why this project was funded</li> <li>– Purpose of project, product and desired outcome</li> <li>– Project structure</li> <li>– Project timeline</li> <li>– Snapshot of: <ul style="list-style-type: none"> <li>- Areas identified for improvements to existing MNA approach</li> <li>- New way of expressing problem</li> <li>- Enhanced passive remediation and how it complements MNA</li> <li>- Strategy for long-term monitoring; transition from active to passive systems</li> </ul> </li> </ul> </li> </ul>	Karen Vangelas, SRTC
9:40 am – 9:50 am	<b>Break</b>	
9:50 am – 10:50 am	<i>Technical Presentations/Discussions</i> <ul style="list-style-type: none"> <li>• Overview of ground rules and lines of inquiry</li> <li>• Natural Attenuation Capacity</li> <li>• Characterization/Monitoring Strategy</li> <li>• Bioassessment Tools</li> </ul>	Brian Looney, SRTC

	<ul style="list-style-type: none"><li>• Results of Prioritization of Technical, Policy and Implementation Topics</li><li>• General Discussion, Questions and Answers</li></ul>	Participants
10:50 am – 12:30 pm	<i>Concurrent Breakout Discussion Groups</i> <ul style="list-style-type: none"><li>• Breakout Group 1 - Regulatory Policy – Regional/National Perspective; Community Needs</li><li>• Breakout Group 2 - End User Implementation Needs</li></ul>	Facilitated discussion
12:30 pm	<i>Adjourn</i>	

## **Appendix C**

### **Savannah River Site – Soil and Groundwater Closure Project (SGCP)**

#### **Meeting Summary**

**August 21, 2003**

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration**

**SGCP ERE Tech Talk  
Savannah River Site  
August 21, 2003**

**Meeting Summary**

Representatives of DOE's alternative project on monitored natural attenuation and enhanced passive remediation (MNA/EPR) for chlorinated solvents met with technical staff of the Savannah River Site, Soils and Groundwater Closures Project (SGCP) on August 21, 2003, at SGCP's offices. An attendance list is provided in Attachment A and the agenda for the meeting is presented in Attachment B. The objectives of the meeting were to:

- Provide information about the project to end users.
- Elicit feedback and gather input on the direction of the project, its usefulness, and its applicability to the issues with which the respective sites, states, and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

Welcoming remarks and introductions were made by Rich Borgatti, Deputy Manager, Engineering and Technology, Soils and Groundwater Closures Project. Following the introduction, Karen Vangelas, SRTC presented an overview of the project and a description of the technical activities and strategies for the MNA/EPR project.

During the overview, Karen outlined the purpose of the project, project structure, and schedules. She also summarized areas for improvements to existing MNA approaches, a new way of expressing the problem, enhanced passive remediation and how it complements MNA, and the strategy for long-term monitoring and the transition from active to passive systems. During the description of the technical activities and strategy for the MNA/EPR project, Karen outlined the ground rules developed by the technical working group and the lines of inquiry identified by this group. She discussed the concept of balancing contaminant loading with natural attenuation capacity and outlined a four-step strategy for characterization and monitoring to support MNA/EPR. She presented an overview of the prioritization of technical, policy, and implementation activities developed by the technical working group and then opened the floor for questions and discussion.

Upon completion of the general questions and discussions, Karen put forth to the participants several questions to elicit feedback on some of the key concepts of the project. The results of discussion are summarized on the following pages.

### Main Themes

- Mass balance concept is sound, but putting into practice will be difficult.

**Question: Would the idea of using a balance between contaminant loading and attenuation capacity as the conceptual basis for MNA and EPR be useful/acceptable?**

- How is it different than the existing protocol?
- What are the potential pitfalls or problems with the approach?
- Regulatory requirements are concentration based.
- Mass balance is difficult on natural systems. Large sites may be problematic.
- Fundamentally a sound approach, but hard for regulators to appreciate. (concentration versus mass)
- May have mechanisms for mass increase.
- Current guidance tends to exclude dispersion type mechanisms (those that don't destroy mass).
- Flies in the face of existing guidance.

**Question: Are the ground rules used by the Technical working group in evaluating the lines of inquiry appropriate?**

- Are there any that should be eliminated?
- Are there other important issues that need to be addressed through new or modified ground rules?
- Do any of these ground rules move in an undesirable direction?
- "agreed" risk-based end state- technical and regulatory input/based
- transition from active to passive – wouldn't enhanced passive fall between active and passive?
- Discussion on pushing the envelope. (e.g. EPR, volatilization in streams)
- Characterization and Monitoring ground rules are good. Cannot afford to follow existing template.
- Mass balance concept difficult to measure accurately in natural system.
- Supplement the traditional requirement of "plume stability". Difficult concept for regulators.
- Understanding of source area is important; data gaps frequently creates problems for projects
- Cost balance is important. Characterization/monitoring exceeding active remediation is a negative.
- Direct measurements up front to prove concept; indirect measurements to monitor progress.
- Process monitoring indicator parameters should be identified upfront.

**Question: Would the proposed four-phase characterization and monitoring sequence improve MNA/EPR?**

- Is it consistent with decision-making processes?
- Are any of the phases unnecessary?
- What should be done to avoid increasing costs?
- What are the potential problems and pitfalls with the idea?
- Indicator parameters need to be identified in the characterization phase.
- What is the difference between Process and System Performance Monitoring? Need to define clearly.
- For EPR need to address where in process to establish a new baseline.
- A model may be useful to capture critical items, such as attenuation rates, in the Decisions Characterization phase.
- These four phases may be iterative or performed in parallel, in some situations.

**Question: During characterization, would additional technically based logic/guidance to support the multiple lines of evidence be useful?**

- Why measure the list of parameters?
  - In what order?
  - Which optional parameters are needed?
  - Would technical guidance to assist in this graded approach be useful?
  - How to responsibly implement using less documentation for less complex sites and more for more complex sites....
- Yes.
  - Setting up scenarios for different situations would be useful.
  - Matching monitoring with attenuating mechanisms would be useful.

**Question: Does the general idea of “enhanced passive remediation” make sense? Should it be linked to MNA in guidance and protocols?**

- Why should we link MNA and EPR? They are closely linked naturally.

**Question: What is your general assessment of the line of inquiry, issue identification and prioritization process performed by the technical working group?**

- Need to push back on how much evidence is actually necessary.

**Action Items:**

- The results of meetings with regulators, stakeholders and end users from the three sites will be combined and provided to all participants.

*Attachment A*

**SGCP - ERE Tech Talk - MNA/EPR for Chlorinated Solvent – Technology Alternative Project  
Attendees**

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*Attachment B*

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration  
Agenda**

**Date:** September 21, 2003

**Time:** 11:30 am – 1:00 pm

**Location:** SGCP ERE Tech Talk, SRS, Bldg. 730-2B, Aiken, SC

**Objectives:**

- To provide information about the project to end users.
- To elicit feedback and gather input on a) the direction of the project, b) its usefulness, and c) applicability to the issues with which the respective sites, states and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

<b>Time</b>	<b>Topic</b>	<b>Lead</b>
11:30 am – 11:35 am	<i>Welcome</i> • Rich Borgatti	
11:35 am – 12:15 pm	Definition of MNA History of MNA Protocols Introduction of Project Technical Presentation	Karen Vangelas, SRTC
12:15 pm – 1:00 pm	<i>Discussion Session</i>	
1:00 pm	<i>Adjourn</i>	

## **Appendix D**

### **Savannah River Site – SC Department of Health and Environmental Control**

#### **Meeting Summary**

**September 11, 2003**

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration  
Columbia, SC  
September 11, 2003  
Meeting Summary**

Representatives of DOE's alternative project on monitored natural attenuation and enhanced passive remediation (MNA/EPR) for chlorinated solvents met with staff of the South Carolina Department of Health and Environmental Control (SCDHEC) on September 11, 2003, at the SCDHEC Offices in Columbia, SC. An attendance list is provided in Attachment A and the agenda for the meeting is presented in Attachment B. Due to the level of interest in this project, two sessions were conducted, one in the morning and one in the afternoon. The objectives of the meeting were to:

- Provide information about the project to regulators, stakeholders, and end users.
- Elicit feedback and gather input on the direction of the project, its usefulness, and its applicability to the issues with which the respective sites, states, and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

Don Siron, SCDHEC, called the meeting to order and welcomed the participants. Ken Taylor, SCDHEC, and Bob Aylward, SRTC, welcomed participants to the workshop and briefly described the meeting goals.

Karen Vangelas, SRTC project manager, presented an overview of the project. She outlined the purpose of the project, project structure, and schedules. She also summarized areas for improvements to existing MNA approaches, a new way of expressing the problem, enhanced passive remediation and how it complements MNA, and the strategy for long-term monitoring and the transition from active to passive systems.

Brian Looney, SRTC, provided a description of the technical activities and strategy for the MNA/EPR project. He outlined the ground rules developed by the technical working group and the lines of inquiry identified by this group. He discussed the concept of balancing contaminant loading with natural attenuation capacity and then outlined a four-step strategy for characterization and monitoring to support MNA/EPR. Finally, Brian provided examples of the results of an historic survey on the use of MNA and presented an overview of the prioritization of technical, policy, and implementation activities developed by the technical working group. He then opened the floor for questions and discussion. Questions included the following:

A discussion session with the participants was held at the end of the morning and afternoon presentations. Both discussion sessions addressed the same set of questions. The results of discussions in the two sessions are summarized below.

### Main Themes

- Need to couple MNA with source remediation.
- Cost and time need to be considered when evaluating MNA as a remedy.
- MNA is a part of almost every remedy.
- Sustainability and performing act one time is key to EPR.

### Question: What are the general experiences in South Carolina implementing and utilizing MNA for chlorinated solvents?

- Is MNA feasible, is it encouraged or discouraged for these plumes and why?
- What are the key implementation and cost issues?
- Barrier to implementation is the need of “longterm” data to determine plume stability.
- Air Force Center for Environmental Excellence Screening Protocol is useful. More detail/understanding of use for screening protocol would be valuable. Where to use in the plume.
- Proposed for many sites. Is a part of all remedies.
- Cost prohibitive/cost positive (view of “owner”). Inconsistencies in how costs are assessed when evaluating MNA as a remedy.
- Need to identify key time periods for monitoring. Need to understand the basis/theory.
- Dissolved oxygen (DO) measurements are not reliable.
- MNA is included in assessments of remedial options.
- Mixing zones are seen by some as MNA.
- Becoming the default remedy.
- Where it is working is obvious.
- Is there a middle ground? Marry active treatment with MNA.
- There is a wide range in the complexity of contaminated sites and in the knowledge of the persons involved in the characterization and remedial option processes.

### Question: Would the idea of using a balance between contaminant loading and attenuation capacity as the conceptual basis for MNA and EPR be useful/acceptable?

- How is it different than the existing protocol?
- What are the potential pitfalls or problems with the approach?
- Need to consider end use of land and time as factors.
- See collection of data as being no additional cost, as it is already being collected.
- Identification of which mechanisms are predominant is important.
- Need to identify which mechanism(s) can be manipulated for “biggest bang for the buck”.
- Time is an important issue.
- Idea is good. Natural attenuation capacity must be greater than the loading.
- Allows you look at entire scope of “problem”.
- Need to go after the source.
- Comfortable with the idea if you couple it with source remediation.
- Caution: Those who want to use the idea of the natural attenuation capacity of a system to justify construction of something like a landfill where contaminants may be introduced into the subsurface system.

**Question: Are the ground rules used by the Technical working group in evaluating the lines of inquiry appropriate?**

- Are there any that should be eliminated?
- Are there other important issues that need to be addressed through new or modified ground rules?
- Do any of these ground rules move in an undesirable direction?

- 2<sup>nd</sup> bullet under Scientific Basis. What is the meaning of “closure”. Closure is synonymous with no further action in regulatory space. A more appropriate term may be “transition”.
- Need to keep in mind cost as a factor.
- 2<sup>nd</sup> and 6<sup>th</sup> bullets under Scientific Basis have the same meaning.
- 6<sup>th</sup> bullet under Scientific Basis. “Agreed risk-based end state” is not really open for discussion for groundwater unit. MCLs are standard end state.
- Need to have a contingency to go from passive to active system.
- Cost and effectiveness have been seen as bases for going to MNA. Need to think about what is best for the environment.
- Time equivalency as per original guidance is important.
- Like the rule (4<sup>th</sup> bullet in scientific basis) for building on past knowledge.

**Question: Would the proposed four-phase characterization and monitoring sequence improve MNA/EPR?**

- Is it consistent with decision-making processes?
- Are any of the phases unnecessary?
- What should be done to avoid increasing costs?
- What are the potential problems and pitfalls with the idea?

- Modeling is iterative. It is based on gathering data. Thus, is on-going through all 4 phases.
- Don't need a perfect model the first time.
- It is important to have an accurate conceptual model.
- Start monitoring early. (Once wells are installed, start monitoring quarterly. Many times decisions are made with one set of data when there has been sufficient time to collect several rounds of data.)
- Decision characterization should be aligned with modeling.
- The 2 stages of characterization may add a lot of cost.
- The 2 monitoring stage concept is liked. It may minimize costs.
- Approach should be based on the complexity of scenario (site).
- Phase 1 is similar to the Air Force screening.

**Question: During characterization, would additional technically based logic/guidance to support the multiple lines of evidence be useful?**

- Why measure the list of parameters?
- In what order?
- Which optional parameters are needed?
- Would technical guidance to assist in this graded approach be useful?
- How to responsibly implement using less documentation for less complex sites and more for more complex sites.

- Yes.

**Question: Does the general idea of “enhanced passive remediation” make sense? Should it be linked to MNA in guidance and protocols?**

- Yes. Need to look at entire package.
- May be applicable to site-specific conditions.
- If sustainable, consistent with existing MNA guidance.
- The 2 components (MNA and EPR) may be coupled for a final remedy.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- **Enhancing or expanding the groundwater surface water discharge zone processes (phytoextraction, phytoremediation, increasing size of hyporheic and wetland zone)....**

- The end state of the site would effect implementation.
- Need to couple with “source” remediation.
- Need to ensure the types and levels of breakdown products are not toxic to the system.
- Constructed wetlands are viable as remediation. Seen as a polishing step.
- Similarity to mining.
- There are subtle issues of water of state versus an active remedial action.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- **Emplacement of long-term treatment zones in the system (such as permeable treatment beds based on pet wood chips and the like)....**

- “What is life?” Good if you can do once and then it is sustainable.
- Consider as intervention.
- Energy intensive to install.
- May need to be repeated.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- **Addition of missing classes of microorganisms (such as halo-respiring organisms)....**

- Need to understand why they are not present.
- Need to know if they would remain and thrive is introduced. Will they be sustainable? How effectively can you populate an area?
- Less comfort with genetically engineered microbes than with indigenous organisms.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- **Including volatilization from surface water in the natural attenuation capacity....**

- Early mixing zone guidance took credit for dilution and some volatilization.
- Later guidance became more conservative.
- Recognition that some of the VOCs will reach the surface water at some point in time.
- The eco-risk must be tolerable.
- May be an option as VOCs don’t bio-accumulate.
- Some discomfort. Depends on the level of discharge to the surface water and the use of the water.
- Preference is for a remedy before the VOCs reach the discharge to surface water. ( meet standards in groundwater)

**Question: What is your general assessment of the line of inquiry, issue identification and prioritization process performed by the technical working group?**

- Like the process. Need to balance cost and land use.
- What do you get from the biomolecular tools/science?
- Passive samplers should be incorporated into the tools.

**Question: Are the highest priority items appropriate?**

- Direct measurement of key microbial capabilities in the system, and examining the potential to enhance these capabilities in a sustainable fashion?
- What are your general impressions and comments on the prioritization?
- Overall, they are appropriate.
- Need training to understand flux. How to measure it and how to interpret the data obtained.

**Question: Did you or people you know receive the historical survey?**

- What is your initial impression of the results?
- Are they similar to Hanford experiences?
- One person received the survey.

**Action Items:**

- The MNA/EPR team will combine the results of meetings with regulators, stakeholders and end users at Hanford, Oak Ridge, and Savannah River and provide these results to all participants.

Attachment A

MNA/EPR Workshop – SCDHEC  
 Attendees

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*Attachment B*

**Monitored Natural Attenuation and Enhanced  
 Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
 DOE Alternative Project for Technology Acceleration  
 Agenda**

**Date:** September 11, 2003  
**Time:** 9:30 am – 11:00 am (first mtg.), 2:00 pm – 3:30 pm (second mtg.)  
**Location:** South Carolina Department of Health and Environmental Control,  
 Columbia, SC

**Objectives:**

- To provide information about the project to regulators, stakeholders and end users.
- To elicit feedback and gather input on a) the direction of the project, b) its usefulness, and c) applicability to the issues with which the respective sites, states and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

Time	Topic	Lead
Morning 9:30 am – 9:45 am  Afternoon 2:00 pm – 2:15 pm	<b>Welcome</b> <ul style="list-style-type: none"> <li>• Ken Taylor, Director, Division of Hydrogeology, South Carolina Department of Health and Environmental Control</li> <li>• <b><i>Bob Aylward, Savannah River Technology Center, Manager, Environmental Restoration Technology Section</i></b></li> </ul>	Don Siron, SCDHEC
Morning 9:45 am – 10:05 am  Afternoon 2:15 pm – 2:35 pm	Definition of MNA and History of MNA Protocols/Introduction of Project <ul style="list-style-type: none"> <li>• Overview of MNA Project               <ul style="list-style-type: none"> <li>– Why this project was funded</li> <li>– Purpose of project, product and desired outcome</li> <li>– Project structure</li> <li>– Project timeline</li> <li>– Snapshot of:                   <ul style="list-style-type: none"> <li>- Areas identified for improvements to existing MNA approach</li> <li>- New way of expressing problem</li> <li>- Enhanced passive remediation and how it complements MNA</li> <li>- Strategy for long-term monitoring; transition from active to passive systems</li> </ul> </li> </ul> </li> </ul>	Karen Vangelas, SRTC
Morning 10:05 am – 10:45 am  Afternoon 2:35 pm – 3:15 pm	<i>Technical Presentations/Discussions</i> <ul style="list-style-type: none"> <li>• Overview of ground rules and lines of inquiry</li> <li>• Natural Attenuation Capacity</li> <li>• Characterization/Monitoring Strategy</li> <li>• Bioassessment Tools</li> <li>• Results of Prioritization of Technical, Policy and Implementation Topics</li> </ul>	Brian Looney, SRTC

<p>Morning 10:45 am – 11:00 am</p> <p>Afternoon 3:15 pm – 3:30 pm</p>	<p><i>General Discussion, Questions and Answers</i></p>	<p>Participants</p>
<p>Morning 11:00 am</p> <p>Afternoon 3:30 pm</p>	<p><i>Adjourn Meeting,</i> Meet with smaller group for detailed discussions</p>	

## **Appendix E**

### **EPA Region IV Meeting Summary**

**September 18, 2003**

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration**

**EPA Region IV  
Atlanta, GA  
September 18, 2003**

**Meeting Summary**

Representatives of DOE's alternative project on monitored natural attenuation and enhanced passive remediation (MNA/EPR) for chlorinated solvents met with staff of the U.S. Environmental Protection Agency (EPA), Region IV, on September 18, 2003, at EPA's office in Atlanta, GA. An attendance list is provided in Attachment A and the agenda for the meeting is presented in Attachment B. The objectives of the meeting were to:

- Provide information about the project to regulators.
- Elicit feedback and gather input on the direction of the project, its usefulness, and its applicability to the issues with which the respective sites, states, and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

Karen Adams, DOE-SR project manager for the MNA/EPR project, and Jeff Crane, EPA Region IV, welcomed participants to the meeting. Carl Froede, EPA, asked the MNA/EPR team to meet with Paducah and Pinellas regulators and stakeholders as well. He noted that the Pinellas site has a TCE plume that DOE is responsible for cleaning up.

Following introductions, Karen Vangelas, SRTC project manager, provided an overview of the project. She outlined the purpose of the project, project structure, and schedules. She also summarized areas for improvements to existing MNA approaches, a new way of expressing the problem, enhanced passive remediation and how it complements MNA, and the strategy for long-term monitoring and the transition from active to passive systems. In response to a question on whether the project will look at the cost-benefit in relation to other technologies, Karen said that cost-benefit will be considered but a formal cost-benefit analysis will not be conducted. The key will be to look at what point MNA will no longer be cost-effective. With respect to the historical survey results, she explained that the reasons why MNA failed at some sites included (1) the plume had already reached surface water and (2) MNA was attempted at aerobic sites where the mechanisms were not strong enough.

Brian Looney, SRTC project technical director, provided a description of the technical activities and strategy for the MNA/EPR project. He outlined the ground rules developed by the technical working group and the lines of inquiry identified by this group. He discussed the concept of balancing contaminant loading with natural attenuation capacity and outlined a four-step strategy for characterization and monitoring to support MNA/EPR. He presented an overview of the prioritization of technical, policy, and implementation activities developed by the technical working group and then opened the floor for questions and discussion. Questions and comments raised by the participants included the following:

- Determination of whether or not a plume is stable needs to factor in potential changes over time (i.e., is it stable over the long term?)
- Will the project compare active and passive remediation?
- Where will the effects of daughters be considered in evaluating enhancements to MNA?
- What is the end point for MNA? It should be when the remedial goals are met.
- Characterization of the plume to support decisions on whether or not to use MNA could cost more than just doing pump and treat.

The meeting participants then went into a discussion session to address specific questions on which the MNA/EPR team requested feedback. The results of discussions are summarized below.

**Question: What are the general experiences in EPA Region IV implementing and utilizing MNA for chlorinated solvents?**

- Is MNA feasible, is it encouraged or discouraged for these plumes and why?
  - What are the key implementation and cost issues?
- MNA is used in almost every remedy somewhere along the line.
  - Where the plume is diving, the monitoring system gets out of date.
  - Long-term monitoring data are needed by the feasibility study stage and should be included in characterization plans (e.g., quarterly monitoring of characterization wells). The cost of this would be small compared to the cost of well installation.
  - One pitfall is application of MNA at sites where the volume of microbes is too small. It is important to identify the presence and volume of biological forms needed to deal with TCE before making the MNA decision.
  - MNA needs to be coupled with source destruction or removal. MNA should be used as a polishing step.
  - Characterization is critical. Undiscovered DNAPL will be a major problem for MNA. A clear definition of the magnitude and vertical and horizontal extent of the source and plume is critical.
  - MNA may take too much time due to either the concentration and/or flow rate of the contaminant.

**Question: Would the idea of using a balance between contaminant loading and attenuation capacity as the conceptual basis for MNA and EPR be useful/acceptable?**

- How is it different than the existing protocol?
  - What are the potential pitfalls or problems with the approach?
- Yes
  - The challenge will be to determine the attenuation capacity, which will require both characterization and modeling.
  - The existing protocol focuses on point determinations over time rather than a systems analysis, which the mass balance approach would provide.
  - It is important to recognize that the balance is not the cleanup standard. The mass balance will need to be used to determine what, if anything, more needs to be done to reach the cleanup standard.
  - The mass balance equation needs to also factor in time and changes in the factors over time.
  - The mass balance approach could show where MNA alone would work.

**Question: Are the ground rules used by the Technical working group in evaluating the lines of inquiry appropriate?**

- Are there any that should be eliminated?
- Are there other important issues that need to be addressed through new or modified ground rules?
- Do any of these ground rules move in an undesirable direction?

**Scientific Basis Ground Rules**

- The changing nature of “sustainability” needs to be addressed.
- The ground rule regarding linking to past MNA protocols should be clarified to say that the new approaches will not change existing protocols that are working and will focus on where the existing protocols can be improved.
- Working toward an “agreed risk-based end state” will be a challenge. Cleanup for groundwater is usually driven by aquifer protection ARARs.

**Characterization and Monitoring Ground Rules**

- The cost-benefit for MNA, especially considering long-term monitoring, needs to be addressed. This is particularly important for non-federal sites.

**Question: Would the proposed four-phase characterization and monitoring sequence improve MNA/EPR?**

- Is it consistent with decision-making processes?
- Are any of the phases unnecessary?
- What should be done to avoid increasing costs?
- What are the potential problems and pitfalls with the idea?

- The screening phase should include an evaluation of existing alternatives such as pump-and-treat to see if MNA might work better. This might also be done as part of 5-year reviews.
- The concept of a phase for long-term systems performance monitoring at a lower cost is attractive.
- The four-phase approach appears consistent with regulatory processes.
- At the end of the decision characterization phase, the graphic should clarify that this is where a decision would be made on selection of MNA or enhanced passive remediation.
- Data collection to characterize the flux will be costly.
- Phase 2, decision characterization, often happens after the decision has already been made.
- PUSH technology could be used instead of wells for monitoring.
- The Scoping Summary process used by the tri-parties at SRS in working from the characterization through to the ROD may provide a concise process to work through and document the four phases suggested for MNA/EPR. This process forces the parties to think critically about the site conditions and what is or is not needed for cleanup.

**Question: During characterization, would additional technically based logic/guidance to support the multiple lines of evidence be useful?**

- Why measure the list of parameters?
- In what order?
- Which optional parameters are needed?
- Would technical guidance to assist in this graded approach be useful?
- How to responsibly implement using less documentation for less complex sites and more for more complex sites....

- Such guidance would be especially helpful for private sites; DOE has more resources available to it.
- The guidance would help with time pressures to finish fast.
- The guidance would help balance between screening and very detailed work to be done.
- It will be important to think who is the audience for the guidance.
- This should be guidance for less-informed users to identify where more detailed work needs to be done.
- Being site-specific is key to the guidance. The guidance should focus on what is applicable for each type of site.
- Addition of a sampling technique scorecard would be helpful.

**Question: Does the general idea of “enhanced passive remediation” make sense? Should it be linked to MNA in guidance and protocols?**

- Yes.
- The cost of the delivery/access systems needs to be considered.
- EPR needs to be tied to sustainability (one-time) versus periodic injections, which would be active treatment.
- EPR should look at both accelerating the processes and improving performance.
- Would baro-balls work as a form of EPR for the vadose zone?
- EPR needs to be separated from MNA in the guidance (e.g., as Volume 2).

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- Enhancing or expanding the groundwater surface water discharge zone processes (phytoextraction, phytoremediation, increasing size of hyporheic and wetland zone)....

Yes if the following questions can be answered satisfactorily:

- If the discharge zone is located onsite, this may be acceptable. However, if the zone is offsite, it may not be.
- What mechanism is occurring in this method (dispersion or destruction)?
- Does the zone need to be separated from the waters of the state?
- Where the processes are occurring needs to be understood.
- The acceptability hinges on whether or not the plume is stable.
- When does this become an active remediation (e.g., building a wetland versus expanding an existing wetland)?

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- Emplacement of long-term treatment zones in the system (such as permeable treatment beds based on pet wood chips and the like)....

- This may be “active” remediation.
- The use of peat or similar materials would have a long life and could be considered EPR after they are installed.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- Addition of missing classes of microorganisms (such as halorespiring organisms)....

- There is a public sensitivity that this is not “natural,” especially for genetically modified organisms.
- Acceptance will be higher for use of natural organisms. These are unmodified organisms that may not be indigenous or that are present in low quantities.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- Including volatilization from surface water in the natural attenuation capacity....

- The concept of “risk-based end state” would come into consideration here.
- Acceptability of this approach depends on state regulations regarding whether discharge into surface water is allowed in the first place.
- Vaporization through the vadose zone also occurs; is this a threat to receptors?
- If the flow path is long, this approach may be acceptable.

**Question: What is your general assessment of the line of inquiry, issue identification and prioritization process performed by the technical working group?**

- The process and results are impressive.
- The results will be useful, especially the taxonomic approach.

**Question: Are the highest priority items appropriate?**

- Direct measurement of key microbial capabilities in the system, and examining the potential to enhance these capabilities in a sustainable fashion?
- What are your general impressions and comments on the prioritization?
- A scorecard for sampling techniques, especially for new technologies, would be great.
- A faulty evaluation of the flow path can overstate the attenuation capacity, so characterization components are key to this effort.
- What about passive diffusion samplers for monitoring (e.g., for key daughters)?

**Question: Did you or people you know receive the historical survey?**

- What is your initial impression of the results?
- Are they similar to TN experiences?
- One person knew someone who received the survey. None of the meeting participants received it.
- The meeting participants would like to see the results of the survey.

#### Action Items:

- Carl Froede, EPA, will provide contacts at the Paducah and Pinellas sites to Karen Adams, DOE-SR, for follow-up to determine if they would like to meet with the MNA/EPA team.
- The MNA/EPR team will provide copies of the EPA meeting summary to the meeting participants.
- The MNA/EPR team will combine the results of EPA meeting with those from the other meetings with regulators, stakeholders, and end users and provide this to all participants.

*Attachment A*

**MNA/EPR Workshop – EPA Region IV  
Attendees**

<b>Name</b>	<b>Organization</b>	<b>Phone</b>	<b>Email</b>
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*Attachment B*

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration  
Agenda**

**Date: September 18, 2003**

**Time: 1:00 pm – 3:10 pm**

**Location: EPA Region IV, Federal Building, Atlanta, GA**

**Objectives:**

- To provide information about the project to regulators.
- To elicit feedback and gather input on a) the direction of the project, b) its usefulness, and c) applicability to the issues with which the respective sites, states and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

<b>Time</b>	<b>Topic</b>	<b>Lead</b>
1:00 pm – 1:05 am	<i>Welcome</i> <ul style="list-style-type: none"> <li>• <b><i>Karen Adams, DOE-SR</i></b></li> <li>• Jeff Crane, EPA Region</li> </ul>	
1:05 pm – 1:10 pm	<i>Introductions</i>	
1:10 pm – 1:30 pm	Definition of MNA History of MNA Protocols Introduction of Project	Karen Vangelas, SRTC
1:30 pm – 2:10 pm	<i>Technical Presentations</i> <i>General Discussion/Q&amp;A</i>	Brian Looney, SRTC
2:10 pm – 3:10 pm	<i>Discussion Session</i>	Facilitated discussion
3:10 pm	<i>Adjourn</i>	

## **Appendix F**

### **Hanford Meeting Summary**

**September 23, 2003**

**Monitored Natural Attenuation and Enhanced  
Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
DOE Alternative Project for Technology Acceleration**

*Richland, WA*

**September 23, 2003**

**Meeting Summary**

Representatives of DOE's alternative project on monitored natural attenuation and enhanced passive remediation (MNA/EPR) for chlorinated solvents met with staff of the U.S. Environmental Protection Agency (EPA) Region X, Washington State Department of Ecology (Ecology), the Nez Perce Tribe, a member of the Hanford Advisory Board, and representatives of DOE-Richland, and Hanford site contractors on September 23, 2003, at the Washington State University Consolidated Information Center in Richland, WA. An attendance list is provided in Attachment A and the agenda for the meeting is presented in Attachment B. The objectives of the meeting were to:

- Provide information about the project to regulators, stakeholders, and end users.
- Elicit feedback and gather input on the direction of the project, its usefulness, and its applicability to the issues with which the respective sites, states, and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

Matt McCormick, DOE-RL, Bruce Ford, Fluor Hanford, and Rod Quinn, Pacific Northwest National Laboratory (PNNL), welcomed participants to the workshop and described potential applications of MNA at the Hanford site. Tyler Gilmore, PNNL, summarized the purpose of the workshop and provided an overview of the workshop agenda. Claire Sink, DOE-EM, provided a background on the creation of the MNA/EPR alternative project and introduced the key members of the MNA/EPR project team, including the role of the ITRC.

Karen Vangelas, SRTC project manager, then presented an overview of the project. She outlined the purpose of the project, project structure, and schedules. She also summarized areas for improvements to existing MNA approaches, a new way of expressing the problem, enhanced passive remediation and how it complements MNA, and the strategy for long-term monitoring and the transition from active to passive systems.

Brian Looney, SRTC, provided a description of the technical activities and strategy for the MNA/EPR project. He outlined the ground rules developed by the technical working group and the lines of inquiry identified by this group. He discussed the concept of balancing contaminant loading with natural attenuation capacity. Tyler Gilmore then outlined a four-step strategy for characterization and monitoring to support MNA/EPR. Finally, Brian Looney provided examples of the results of an historic survey on the use of MNA and presented an overview of the prioritization of technical, policy, and implementation activities developed by the technical working group. He then opened the floor for questions and discussion. Questions included the following:

- Where in the four-step process would determination of the flow path occur? The issue is how much detail is needed to define the flow path.
- How was "success of MNA" defined for the historic survey? Was this based on acceptance by regulators or a finding that the mass balance works as predicted?
- Groundwater people tend think in terms of concentration now, so the mass balance would cause their thinking to shift.

The meeting participants then went into three parallel breakout groups that addressed the same set of questions. The results of discussions in the three breakout groups are summarized below.

### Main Themes

- MNA will have an inevitable role in every remediation. Five-year reviews should be used as an opportunity to look at potential application of new technologies, including MNA/EPR. MNA has been used at the Horn Rapids landfill, and it is suggested that the MNA committee look at the experience at that site.
- Use of the phrase “risk-based end states” already produces much angst for stakeholders; adding MNA to the mix will be an even more difficult sell. The emphasis at Hanford is on ecologic protection and source control versus a return to groundwater consumption.
- The mass balance approach is a good way to conceptually present the process, but it will be challenging to define the loading, especially at sites with poor inventory characterization or the natural processes.
- The CERCLA and RCRA processes need to be overlaid on the four-step process to show how they are wedded.
- If MNA is believed to be viable at a site, information to support a decision on its use needs to be included in the data collection programs. Guidance for characterization should not be a “cookbook.” The guidance should reflect forward thinking in characterization and remediation steps to not preclude later options in MNA/EPR and recognize that active efforts are performed during MNA.
- The boundaries between EPR and other active remediation are confusing. EPR should be passive, sustainable, and require only a one-time stimulus. MNA and EPR are part of a continuum. The remediation continuum should be approached from the passive side and focus on how much effort needs to be added to the natural processes to achieve remedial action objectives. But remember that regulators will require a clear definition because of the bias toward doing something now.
- Enhancements to MNA should do no harm. Use of EPR raises concerns about introduction of materials, generation of wastes, and other factors that will need to be addressed to satisfy stakeholders of process safety. Volatilization from the source should also be accounted for. This has a role in calculating attenuation capacity. At Hanford, volatilization from the source is more important than volatilization from surface water.
- Limitations on MNA/EPR for plumes with multiple contaminants need to be evaluated.
- Prioritization should focus on what is needed to support getting to remediation decisions.
- Hanford has a deep vadose zone that is a sink for contamination and can act as both a source and a receptor.
- Stakeholders and regulators need to continue to be informed about MNA committee progress to ensure buy-in and use of results.

**Question: What are the general experiences in the NW implementing and utilizing MNA for chlorinated solvents?**

- Is MNA feasible, is it encouraged or discouraged for these plumes and why?
- What are the key implementation and cost issues?
- MNA is a potential remedy for inorganics.
- Hanford is not yet at a decision point for chlorinated solvents. For the carbon tetrachloride plume in the 200-West Area, the interim action is active treatment. MNA will inevitably have a role but will be a challenge for the carbon tetrachloride plume because the plume is still expanding.
- The contaminants of concern for Hanford's interim RODs do not include contaminated solvents.
- MNA is being used for a uranium plume in the 300 Area but is not performing as expected. It appears to be sensitive to river levels and other factors.
- The site is unsure if this is because this is the wrong remedy or because the expectations were incorrect.
- The emphasis at Hanford is on ecologic protection and source control rather than returning groundwater to consumptive use or returning to MCLs.
- The Horn Rapids landfill has MNA specified in the ROD and is using it as part of the remedy (the MNA team needs to look at the experience at the Horn Rapids landfill; chronology, scientific results, evolution of thinking by the regulators, tribes, site staff, over time). The application of MNA in the 1100 Area was successful. At the next 5-year review, it is expected the remediation will be done.
- Fort Lewis has a plume that is traveling off the base. Pump and treat is in place now for the plume, but MNA is part of the remediation plan. The plume at Ft. Lewis is so large that it will continue to be a problem for years to come. High concentrations exist at the boundary.
- Other potential examples of where MNA may have been tried in the NW include a drinking water well and the Pasco landfill, but meeting participants did not have any detailed information on either of these.
- Ecology has sponsored a couple of two-day workshops on MNA across the state, and has used Hanford and a west-side Navy site as case study examples.
- Ecology has been involved in ITRC and has strongly encouraged tribal involvement.
- Ecology sees strong potential for application of MNA in dissolved plume areas, assuming treatment of source material.
- Any use of MNA at Hanford will need to be compatible with and be able to support the outcome of a NRDA lawsuit that has been filed.

**Question: Would the idea of using a balance between contaminant loading and attenuation capacity as the conceptual basis for MNA and EPR be useful/acceptable?**

- How is it different than the existing protocol?
  - What are the potential pitfalls or problems with the approach?
- The mass balance approach is a viable concept and addresses the basic question of how much load is there and how much will be attenuated. It may be necessary to add a margin of safety when considering the mass balance approach.
  - The mass balance is a dynamic concept. At what point will it be applied and how will the results be interpreted? The mass balance will be site and time dependent.
  - Public acceptance of MNA/EPR will be difficult until it can be shown scientifically that these will work. The stakeholders drive the regulators' view of MNA as an attempt to avoid taking action. The details of applying the equation will quickly get very technical and lose the audience.
  - Sites do not usually collect the data needed to evaluate the mass balance. Collection of such data would be useful for decision-making.
  - A key is the site needs to be able to define the flow path before it can use the mass balance approach.
  - Quantitative models will be needed to define the loading.
  - It will be a challenge to define the contaminant loading and the attenuation capacity of each of the natural processes. Flux through the vadose zone will be a major challenge. This is where monitoring will be important. If we cannot identify the source inventory well, how can MNA be an option if we cannot determine if source control has been attained?
  - Hanford does not have a complete inventory of the carbon tetrachloride source. Use of this concept may be difficult with this particular contaminant issue. Could flux measurements or estimates be useful in this case? Budget limitations at Hanford have made it difficult to place monitoring wells in all locations believed to be necessary for characterization of carbon tetrachloride inventory. Decades of legacy have created a very large secondary source of carbon tetrachloride (not simply the discharge from tanks and trenches originally envisioned).
  - Are the natural processes understood well enough to predict attenuation in a technically credible fashion?
  - Sustainability is the key.
  - The EPR concept will be especially important for the 200-West Area, where there is not much biologic activity.
  - Does MNA only apply to groundwater? What if flux back to the vadose zone occurs?
  - How is the conceptual model readjusted for new sources and assessments of flux?
  - Hanford has a deep vadose zone that is a sink for contamination (i.e., it can be either a source or a receptor).
  - It is critical to determine whether the mass is contained or moving. Contained mass is not an issue; mass that is on the loose, however, poses a much greater problem.
  - It seems like this approach takes contamination from the groundwater and puts it in the atmosphere.
  - The idea provides a conceptualization of what numerical models always have done.

**Question: Are the ground rules used by the Technical working group in evaluating the lines of inquiry appropriate?**

- Are there any that should be eliminated?
- Are there other important issues that need to be addressed through new or modified ground rules?
- Do any of these ground rules move in an undesirable direction?

- The ground rules represent good work.

*Scientific Basis*

- Some prioritization of work on what will yield the most information (e.g., characterization of flow versus sensors at the distal end of the plume) is needed.
- These rules should address the need to look at the entire system and future system needs (e.g., multiple contaminants are often present in plumes; also, you want to make sure you don't do things during active remediation that will limit MNA options).
- (#1) The term "natural mechanism" seems to imply that you do not do anything, when in fact, use of MNA involves some activities (such as monitoring). It should be clear that there are ongoing activities associated with MNA. The first two or three ground rules should be re-worded to reflect this.
- (#2) The key is that the problem does not get worse. Technologies will improve over time and DOE should not push for early "closure." What does this term really mean when used here? The concept of sustainability in this ground rule is okay.
- (#5) The ground rules need to recognize that sometimes active systems or a combination of an active system and MNA are preferred. What is the "trigger" where active remediation stops and MNA starts?
- (#6) The phrase "risk-based end state" should be avoided and may not be relevant to Hanford. The end states required by the NRDA process are perceived as "real" while the term "risk based end state" is considered jargon without specific meaning. Instead, the emphasis should be on working toward protection of receptors, including the ecosystem. Use of the phrase "risk-based end states" already produces much angst for stakeholders; adding MNA to the mix will be an even more difficult sell.

*Characterization and Monitoring*

- Model accuracy should also be verified as part of characterization and monitoring. This is an iterative process in which the model is refined as further characterization and monitoring data become available and the model, in turn, defines what more characterization and monitoring are needed.
- (#2) How decisions about the success of cleanup and the need for contingency planning will be made must be considered in designing the groundwater characterization and monitoring scheme (the original design for the 300 Area will be evaluated in the 5-year ROD review for these factors)
- (#3) It is fine to look at flux instead of a concentration at a specific point, but where do you "draw the circle" to look at receptors and risk?
- (#5) How the source is defined makes a big difference in the mass balance determination
- (#6) This is the most important rule. The concepts should always tie back to receptors.

**Question: Would the proposed four-phase characterization and monitoring sequence improve MNA/EPR?**

- Is it consistent with decision-making processes?
  - Are any of the phases unnecessary?
  - What should be done to avoid increasing costs?
  - What are the potential problems and pitfalls with the idea?
- Completion of the 4 phases would provide complete conceptual understanding of the site.
  - The processes described are self-evident, so they would not necessarily either improve or weaken the conceptual model
  - The graphic needs to depict the CERCLA RI/FS and RCRA CMS processes below the four-step process to show how these fit together. The processes have to be wedded. They do fit nicely together.
  - The point in the steps where a cost-benefit analysis is done and where the CERCLA criteria are evaluated is not apparent.
  - Should this process only be applied to CERCLA sites? What about RCRA sites?
  - For sites governed under CERCLA, the MNA evaluation should be conducted during the remedial investigation phase rather than the feasibility study phase.
  - The graphic needs to reflect that the decision is on the alternative action to be chosen among the set of alternatives, which include MNA. It is important to remember that MNA is only one choice among many. It can be an alternative or an integral part of other alternatives, but it is not the only choice.
  - It appears that this process goes directly from the RI/FS to MNA and skips the active remediation step. This would leap out at someone who is already skeptical of MNA. MNA will be a component of most active remediation choices and may be a contingency plan for some of these. MNA is an endpoint at Hanford, but the question is when and how it factors into the remediation. Although MNA is an endpoint now at Hanford, it could be part of remediation sooner and should be folded into the design at the feasibility stage. The question is when to make the investment.
  - This process needs to be part of the DQO process to define the data collection program.
  - Some activities called characterization are really monitoring. The characteristics are not really known until they are verified through monitoring.
  - Is the breakdown of the monitoring into phases unique to MNA? How is it different from the CERCLA process?
  - The key for monitoring is to write specific objectives and include these in the ROD. The ROD should also include contingency plans if the remedial action objectives are not met or if there are early indicators that the objectives will not be met.
  - The transition process between short and long-term monitoring needs to be clarified to show how and when the shift is made.
  - Would process monitoring be done before selection? The decision may need to occur after monitoring.
  - MNA involves processes that go beyond demonstration of compliance, and requires more than simple compliance monitoring; however, current budgets may not be able to accommodate these higher level needs.
  - Flexibility for new technologies should be built into contingency plans.

**Question: During characterization, would additional technically based logic/guidance to support the multiple lines of evidence be useful?**

- Why measure the list of parameters?
  - In what order?
  - Which optional parameters are needed?
  - Would technical guidance to assist in this graded approach be useful?
  - How to responsibly implement using less documentation for less complex sites and more for more complex sites....
- Yes, it is a fatal flaw to collect data without knowing why. The data collection program should include a description of why the data are being collected. These need to address site-specific characteristics. This guidance would support the DQO process. Explanations of how and why the characterization parameters are measured are critical to the defensibility of an MNA decision. It always makes the process more credible when stakeholders and regulators can understand the basis of the process and be shown that it has been proven.
  - Templates for design of sampling programs should be included in the guidance.
  - Templates for different scenarios will help to recognize the differences between sites. It is suggested that this additional information be done on the basis of “mini case studies” that would reflect experience over the last 5 years and provide “show-me” evidence.
  - It will be important to emphasize that this is guidance only and the site will still have to design for specific site characteristics. It is important to remember site-specific factors and not make the rules so strict that there is no room for flexibility. Responsibility for choosing remedial actions should lie with the people making decisions rather than the people writing the guidance.
  - The guidance should not be a “cookbook.”
  - The guidance needs to be tied to procedures and models; the templates to need to flow out of the models.
  - The guidance should emphasize multiple lines of evidence versus just more observational data.
  - The people writing the guidance need to be versed in degradation processes.
  - It will be difficult to avoid measuring unimportant things if the parameters are too rigid.
  - The guidance will be good for sustainability issues.
  - The additional information that would be provided in the guidance fits with what is called for in the EPA directive on MNA.

**Question: Does the general idea of “enhanced passive remediation” make sense? Should it be linked to MNA in guidance and protocols?**

- The EPR concept makes sense.
- The EPR concept is exciting and a good place to achieve a big “bang for your buck.”
- EPR may help with public acceptance.
- EPR has to be sustainable. Sustainability is a key issue in defining EPR. EPR should be passive, sustainable, and require only a one-time stimulus.
- An important aspect of “selling” MNA/EPR to regulators will be reminding them that monitoring will still be a key part of any plan and contingency plans will be in place if any of the processes fail.
- The differences between EPR and other active remediation are confusing and some examples would be helpful. Is the key difference whether the action is active or passive? Is EPR really different than active remediation? How so? EPR is not really passive because you are actively looking to change something to make it work better. Is it part of a transition stage to MNA (i.e., the system is not quite ready for MNA but needs a boost or a jump start to get it there)?
- The definition of MNA is not going to fundamentally change, so EPR may be a way to achieve the intent of MNA. The idea of EPR as enhancing MNA processes is a good one. It uses the same processes to get to the place where natural processes can take over.
- EPR should be linked with MNA guidance and protocols (e.g., Volume 2 of a two-volume guidance document).
- There should be recognition that there is a continuum from totally passive remediation (MNA) to augmentation (EPR) to active remediation. One should characterize the natural processes that are already occurring and then figure out what else needs to be added. The decision on remediation should be entered from the passive side of the continuum. But remember that regulators will require a clear definition because of the bias toward doing something now.
- Knowledge of potential solutions is always growing, so an understanding of the natural processes can buy time while new technologies for either remediation or monitoring are being developed.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- Enhancing or expanding the groundwater surface water discharge zone processes (phytoextraction, phytoremediation, increasing size of hyporheic and wetland zone)....

- This is not likely to be used at Hanford because of lack of wetlands, lack of sediment rich in organic material, and perception of potential impact to ecological receptors.
- Wetlands will not work at Hanford, so dilution in the River is the only option.
- The public could see this as “dilution is the solution.” It will be necessary to show that this is the best solution before it will be acceptable.
- It is possible to discharge so far from receptors that the natural processes will work before impacting on the receptors.
- There is a disconnect between stakeholder expectations of groundwater cleanup (i.e., meet drinking water standards by 2018) and what is actually going to happen at Hanford (i.e., meet minimum environmental protection standards).
- Is it appropriate to use phytoremediation for chlorinated solvents? This is a question of values.
- Phytoremediation has been considered for the disturbed discharge zone at Hanford.
- A groundwater-surface water interaction is not present in the 200 Area.
- There are potential land ban issues associated with carbon tetrachloride.

**Specifically, what are the potential issues/acceptability for the following types of EPR:**

- Emplacement of long-term treatment zones in the system (such as permeable treatment beds based on pet wood chips and the like)....

- This concept sounds much like a passive barrier.
- For acceptance of this approach, it would be necessary to show there would be no detrimental effects (e.g., concentrating the contaminants in a single area with the potential for a catastrophic breakthrough).
- This approach would be easier on the Central Plateau, where there would be time to respond to breakthrough) than at sites near the River.
- Would the barrier be removed eventually? What about potential problems in doing this with depth and proximity to the Columbia River?
- Degradation of by-products is a potential concern.
- Stakeholders are concerned about the need to deal with secondary waste streams.
- The effectiveness of barriers against multiple contaminants is not clear.
- Could this be used to drive aerobic processes to become anaerobic processes?
- How will the microorganisms behave?
- How will this type of system operate in conditions where lack of knowledge of inventory (e.g. carbon tetrachloride) is a problem with respect to predicting the time line of source contribution to the plume?
- The tribes are skeptical of the government's ability to maintain institutional controls over such areas for long periods of time.

#### Specifically, what are the potential issues/acceptability for the following types of EPR:

- **Addition of missing classes of microorganisms (such as halo-respiring organisms)...**

- First "do not harm." In other words, make absolutely sure the system is understood first.
- This approach would be more acceptable on the Central Plateau, where there is some distance from potential receptors, than along the River.
- There will be high sensitivity to "do no harm" at sites along the River.
- What is the definition of "missing"? If "missing" microorganisms refers to bio-engineered or non-indigenous organisms, this will not be acceptable. Organisms mutate quickly, so care should be taken to not bring in offsite organisms.
- Is introducing organisms in an area where they currently are not present a good idea? If they were supposed to be there, wouldn't they be there already?
- What about release and control of genetically engineered organisms relative to areas with specific types of land use such as farming?
- Addition of indigenous species that are not present in enough quantities to handle the contaminants would be okay (though it will be important to know why they are not present).
- How will these added organisms be monitored and controlled?
- The MNA team should look at the ITRC document that discusses stakeholder and regulator concerns relative to treatment of TPH and chlorinated hydrocarbons with microorganisms.

#### Specifically, what are the potential issues/acceptability for the following types of EPR:

- **Including volatilization from surface water in the natural attenuation capacity....**

- Volatilization is a natural process and is occurring, whether or not credit is taken for it. It is important not to say a process will be prevented if it is, in fact, inevitable. Instead, why not take credit toward cleanup for what is already occurring?
- The acceptability of this approach depends on whether or not sensitive receptors exist there.
- The acceptability will depend on how much and in what situation. The release will be regulated.
- The effects of other constituents besides the chlorinated solvents would need to be considered for this approach.
- Is this a dilution, dispersion or destruction process?
- This concept is analogous to mixing zones.
- This approach will not be acceptable for Hanford's carbon tetrachloride plume because the plume cannot be allowed off the Central Plateau. The plume is also too far from the river to use this.
- Volatilization from the source should also be accounted for, as it has a role in calculating attenuation capacity. At Hanford, volatilization from the source is more important than volatilization from surface water. Carbon tetrachloride is volatilizing from soil, and barometric check valves have been used to increase mass removed through this route.

**Question: What is your general assessment of the line of inquiry, issue identification and prioritization process performed by the technical working group?**

- This question is difficult to answer before reading the report; for that reason, the timing of the workshop may have been premature.
- Involvement of experts from outside the DOE complex provides greater credibility for the process and results.
- The process and results help provide equal treatment across all sites rather than unique approaches for each site.
- The work needs to emphasize, “one size does not fit all.”
- Cost avoidance should not be a major driver for MNA.
- How will the workshop results be incorporated? It is important for people to understand how their views have been and will be included.
- Information about application of the technology needs to be included in the Technical Working Group reports. The emphasis now is on science development and that is not enough. A commitment to go to the next step is needed.
- Regulators and stakeholders are somewhat in the dark on the progress of the technical working group. DOE should involve regulators and stakeholders in an “STCG-type” process.
- Continued commitment to communicating work process and outcomes to regulators and stakeholders is strongly recommended to make sure that the results of the work get used.

**Question: Are the highest priority items appropriate?**

- Direct measurement of key microbial capabilities in the system, and examining the potential to enhance these capabilities in a sustainable fashion?
- What are your general impressions and comments on the prioritization?
- The focus needs to be on determining if the natural processes are enough for each problem.
- For ease of presentation, it would help to split the list of high priorities into smaller categories (e.g., tools, strategies, etc.) and show a hierarchy (e.g., strategies first).
- The timing when the results are needed should also be factored into the prioritization.
- There appears to be a major focus on regulatory acceptance and little on field applicability.
- Flux measurements need to be a higher priority (at least as high as calculating degradation rates). These relate to loading and mass input.
- Some ranking of the priority items is needed.
- Some participants requested more time to review and provide feedback to the MNA team.
- Some of the listed priorities are not necessarily applicable to Hanford (e.g., remote sensing).
- A high priority item should be added to evaluate the issue of potential reversibility of processes – what are the factors that enhance retardation and remobilization?
- At Hanford, the MNA team should tie some of the identified high priorities to activities already going on at the site and involve people already involved in these activities (e.g. modification of large-scale hydrology).
- Regulators should be involved at some point in the future to keep lines of communication and feedback open; BUT, don't let communication get in the way of completing the work.

**Question: Did you or people you know receive the historical survey?**

- What is your initial impression of the results?
- Are they similar to Hanford experiences?
- No. (Few participants even knew what it was.)

Mike Thompson, DOE-RL, briefly talked about potential applications of MNA/EPR at Hanford, including the following points:

- Natural processes will be part of every remediation.
- Application of the mass balance approach will depend on how well one understands the conceptual model.
- Other potential applications for MNA at Hanford include metals, radionuclides, and uranium. This project should be expanded to include these contaminants.
- The regulators' bias toward action may argue against approaching remediation decisions from the passive side of the continuum.

Dennis Faulk, EPA, added that the ZP-1 RI/FS is coming up. The MNA/EPR project should follow how natural attenuation fits with this RI/FS and add a scientific basis to the decision process.

Each of the regulators, tribes, and stakeholders in attendance was given an opportunity to present perspectives on monitored natural attenuation and enhanced passive remediation. Dennis Faulk, EPA, Dib Goswami, Ecology, Sandra Lilligren, Nez Perce Tribe, and Maynard Plahuta, Hanford Advisory Board and City of Richland, offered perspectives and workshop participants added to the discussion. The following remarks were made during this discussion:

- Every remedy should consider MNA and build the data collection program to support assessments of its viability.
- The MNA/EPR project should prioritize work that is needed to support RODs.
- The MNA/EPR guidance should recognize and make use of the fact that natural attenuation has been going on for at least 10 years for existing plumes where the default has been to monitor. The project should also look at the 1100 Area model where MNA has been applied successfully.
- The MNA/EPR guidance should address the applicability of this technology outside DOE.
- To gain acceptance, MNA has to be demonstrated at Hanford rather than extrapolating the results from other sites.
- A real cost-benefit analysis for MNA and an explanation of MNA are needed so stakeholders will understand that MNA is not "do nothing."
- MNA is appropriate where protection of human health and the environment is achieved and the process is effective in a reasonable timeframe.
- Site characterization may be more expensive for MNA so MNA may not be as cost-effective as thought.
- MNA may not be reasonable if the inventory is not understood or there is not adequate source control.
- MNA must be able to deal with multiple co-contaminants.
- The Tribes are concerned about time frames far longer than those covered in any remedial action plans and about the potential for reversal of the processes at some point in the future after the cleanup is supposedly "done."
- The credibility gained by involving outside experts is key to acceptance of the work of the MNA/EPR project.
- Communication is key; the project needs to go to interested people rather than asking them to come to the project.

**Action Items:**

- The MNA/EPR team will send copies of the Hanford meeting summary to the meeting participants, hopefully in time for the Hanford Advisory Board's River and Plateau Committee meeting on October
- Maynard Plahuta will talk with the chair of the Hanford Advisory Board's River and Plateau Committee about including a brief outline of the workshop with the agenda item on the carbon tetrachloride plume at Hanford at the committee's October 8 meeting and explore interest in bringing information on the MNA/EPR project to the committee and the full Board.
- The MNA/EPR team will combine the results of meetings with regulators, stakeholders and end users at Hanford, Oak Ridge, and Savannah River and provide these results to all participants.

*Attachment A***MNA/EPR Workshop – Hanford  
Attendees**

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*Attachment B*

**Monitored Natural Attenuation and Enhanced  
 Passive Remediation (MNA/EPR) for Chlorinated Solvents,  
 DOE Alternative Project for Technology Acceleration  
 Agenda**

**Date: September 23, 2003**

**Time: 9:00 am – 4:00 pm**

**Location: Washington State University CIC, 2770 University Drive, Richland, WA**

**Objectives:**

- To provide information about the project to regulators, stakeholders and end users.
- To elicit feedback and gather input on a) the direction of the project, b) its usefulness, and c) applicability to the issues with which the respective sites, states and regions are dealing in relation to application of monitored natural attenuation of chlorinated solvent contamination.

Time	Topic	Lead
9:00 am	<b>Welcome</b> <ul style="list-style-type: none"> <li>• Mike McCormick, US DOE, Richland Operations Office</li> <li>• Bruce Ford, Fluor Hanford</li> <li>• Rod Quinn, PNNL</li> </ul>	Tyler Gilmore, PNNL
9:30 am	<i>Introductions and Review of Agenda</i>	Tyler Gilmore, PNNL
9:35 am	Project Introduction <ul style="list-style-type: none"> <li>• Background on MNA/EPR for Chlorinated Solvents, DOE Alternative Project for Technology Acceleration (10 min.)</li> </ul>	Claire Sink, DOE-EM
9:45 am	Definition of MNA and History of MNA Protocols/Introduction of Project <ul style="list-style-type: none"> <li>• Overview of MNA Project (15 min.)               <ul style="list-style-type: none"> <li>– Why this project was funded</li> <li>– Purpose of project, product and desired outcome</li> <li>– Project structure</li> <li>– Project timeline</li> <li>– Snapshot of:                   <ul style="list-style-type: none"> <li>- Areas identified for improvements to existing MNA approach</li> <li>- New way of expressing problem</li> <li>- Enhanced passive remediation and how it complements MNA</li> <li>- Strategy for long-term monitoring; transition from active to passive systems</li> </ul> </li> </ul> </li> <li>• Discussion (5 min.)</li> </ul>	Karen Vangelas, SRTC
10:05 am	<b>Break</b>	

10:20 am	<p><i>Technical Presentation/Discussion</i></p> <ul style="list-style-type: none"> <li>• Overview of technical working group development of technical targets for MNA/EPR project (30 min.) <ul style="list-style-type: none"> <li>– Overview of ground rules and lines of inquiry</li> <li>– Natural Attenuation Capacity</li> <li>– Characterization/Monitoring Strategy</li> <li>– Bioassessment Tools</li> <li>– Results of Prioritization of Technical, Policy and Implementation Topics</li> </ul> </li> <li>• General Discussion, Questions and Answers (15 min.)</li> </ul>	<p>Brian Looney, SRTC Tyler Gilmore, PNNL</p> <p>Participants</p>
11:00 am	<i>Concurrent Breakout Discussion Groups</i>	Facilitated discussion
12:00 pm	<i>Lunch</i>	
1:30 pm	<i>Concurrent Breakout Discussion Groups (cont.)</i>	Facilitated discussion
2:15 pm	<p><i>Plenary Session on Breakout Group Results</i></p> <ul style="list-style-type: none"> <li>• Summary of key issues and comments from each breakout group (15 min.)</li> <li>• Discussion (5 min.)</li> </ul>	Breakout group spokespeople
2:35 pm	<i>Application to Hanford</i>	Mike Thompson, DOE-RL
2:45 pm	<p><i>Regulatory, Tribal and Stakeholder Perspectives</i></p> <ul style="list-style-type: none"> <li>• EPA (10 min.)</li> <li>• Ecology (10 min.)</li> <li>• Confederated Tribes of the Umatilla Indian Reservation (10 min.)</li> <li>• Nez Perce Tribe (10 min.)</li> <li>• Wanapum Tribe (10 min.)</li> <li>• Yakama Indian Nation (10 min.)</li> <li>• State of Oregon (10 min.)</li> <li>• Other interested parties</li> </ul>	
4:00 pm	<i>Action Items and Next Steps</i>	Facilitator
4:15 pm	<i>Adjourn</i>	