Report of NABIR Subcommittee of BERAC
October 8-9, 2001 meeting at AGU, Washington D.C.

NABIR Field Research Center

The NABIR Field Research Center (FRC) serves as the centerpiece for NABIR field research, providing an infrastructure at ORNL for sample acquisition and distribution to NABIR investigators and for hypothesis-driven research on contaminant transport and remediation. The committee's responses to questions poised by DOE (bold) on the future role of the FRC in NABIR are outlined below.

How can the FRC better support NABIR?

FRC Infrastructure

Exceptional progress has been made by ORNL in establishing the FRC infrastructure: Sediment and groundwater samples have been distributed to NABIR investigators throughout the program. Experimental programs have been initiated with strong support from ORNL, which has provided available site characterization data integral to experimental design and site selection. Critical support has also been provided to NABIR investigators to ensure that sample deliveries to off-site locations and experimental activities on-site meet all (and often formidable) regulatory requirements.

Site Characterization and Research Focus

On-going efforts at the FRC include (1) an advanced characterization program that augments characterization conducted in support of clean up activities and will aid in experimental site selection and interpretation and (2) initiation of two interdisciplinary projects to develop and test concepts for in situ immobilization of oxyanions.

ORNL is located on an extremely complex site with a high degree of heterogeneity in hydrologic and biogeochemical properties. Detailed understanding of these properties is essential for selection of locations on the site for field experimental efforts because of the strong need to define and account for a number of (often confounding) variables that may influence contaminant transport and the ability to evaluate the effects of in situ treatment methodologies. Unfortunately, advanced characterization and initial experimental studies have proceed somewhat concurrently, rather than sequentially and unanticipated issues have surfaced during the experimental campaigns including, e.g., elevated soluble Al and the discovery of marked heterogeneity in hydrologic and geochemical properties at sites selected on the basis of preliminary characterization efforts. This has resulted in some inefficiency in implementation of the field experiments by requiring, in certain cases, major adjustments in the research approaches. Although midcourse adjustments are an inherent part of any field experimental effort, several

actions might be taken to improve implementation in the future. The committee recommends the following:

- A brief scientific strategy should be developed for the FRC that builds on the unique properties of the site and aids in establishing research priorities and directions consistant with the NABIR Strategic Plan

- The next FRC RFA should build on the rapidly developing knowledge of site characteristics and be directed, at least in part, toward key information gaps identified in the current experimental research

- A phased approach to field experimentation should be encouraged that progressively assesses the site features and other factors governing the feasibility of proposed field experimentation, including preliminary laboratory and pilot field studies as appropriate. The research should be hypothesis-driven and designed to be incrementally publishable as research progresses through the various stages leading to full field experimentation.

- Detailed site characterization data need to be made available on the NABIR web site to assist the scientific community in developing well-rationalized proposals and in assessing the likelihood of success at this complex site. The RFA should encourage investigators to take full advantage of this data in proposal preparation and identify the most appropriate location on the site where proposed experimentation would be conducted.

Given the Results To-Date, What Next?

Although challenging, the waste disposal and subsurface characteristics of the site have opened the door to new research opportunities. Examples include investigations of:

- The behavior of U, Tc, and Cr in strata differing markedly in pH

- The microbiology and geochemistry of highly acidic, high nitrate environments and the effects of solubilized Al and Mn on the behavior of U, Cr and other metals

- The role of organic carbon in complexation reactions occurring in different pH environments (e.g., identification of functional groups participating in complexation and the effects of proton competition)

- Biogeochemical processes in systems dominated by preferential flow and matrix diffusion

- Changes in permeability, microbial succession and solute transport with neutralization of acidic Al species

- Methods to achieve spatially uniform delivery of electron donors and nutrients in spatially heterogeneous environments

- Combined use and optimization of coupled processes (e.g., chemical-microbiological, mobilization-immobilization, in situ-ex situ) to achieve multiple remediation objectives

Given DOE Needs, What Next?

Balance

The FRC is a critical component of NABIR that provides focus and direction for laboratory and field research. However, the site is not fully representative of other DOE locations in site characteristics (e.g., fracture dominated vs. porous media flow) and problems (e.g., acidic vs. neutral nitrate plumes). Thus, there are risks associated with over-emphasis on one site. NABIR should attempt to maintain a balance in the program encouraging (within resource limits) use of samples from other sites. The UMTRA studies are a good example of field sampling/experimentation that broadens the applicability of research to different environments. This issue can be effectively addressed during the RFA process with encouragement of investigations of basic processes at other sites if appropriate to experimental objectives and consistent with the NABIR Strategic Plan.

In situ Research

It is highly recommended that the program continue to pursue fundamental, interdisciplinary research focused on in situ immobilization processes. While it is recognized that development of ex situ methods may at times be necessitated to meet experimental objectives, emphasis should be on in situ processes even if there is a risk of failure. The research reported by Jack Istok is an example of a high risk attempt to test situ remediation concepts that provided unique insight into the subsurface system and raised a number of important research questions that, when refined, might help in developing the next FRC RFA. However, the research is also an example of an effort that may have benefited from better coordination and use of NABIR capabilities in design and interpretation. Possible mechanisms to address this general issue at the FRC are given below.

Scientific Leadership

The committee recommends a stronger emphasis on scientific leadership and coordination at the FRC. Experiments currently underway at the site could be improved by early access to a broader range of capabilities (e.g., in biogeochemistry and geochemical/hydrologic modeling). As new field experiments are contemplated, it is extremely important to consider (1) the site characteristics, including strengths and limitations for achieving project objectives, (2) the range and strength of capabilities that may be applicable and available elsewhere in NABIR and the scientific community and

(3) how (1) and (2) can be integrated effectively into experimental efforts to optimize the opportunities for success.

A possible mechanism to address the scientific leadership issue is to identify an FRC scientific leader (perhaps on a rotating basis as the focus of experiments on the FRC evolves and changes). This person should have the breadth of knowledge and experience required to (1) identify and resolve problems before they become real obstacles to success, (2) help ensure that the full capabilities of the scientific community are brought to bear on field experimental efforts, and (3) help eliminate redundancies in the NABIR program by recommending common samples, methods, and approaches that would contribute to the success of field efforts while satisfying the objectives of other projects in the NABIR program.

Signed for the Committee

James M. Tiedje, Chair November 6, 2001

Members present:

Linda Abriola
Margaret Cavanaugh
Linda Chrisey
Stephen Lien
Derek Lovley
David White
Ray Wildung
Amy Wolfe
John Zachara