NABIR Field Research Center
Oak Ridge, Tennessee

March 18, 2002 NABIR PI Meeting

David Watson (865-241-4749) - FRC Manager
Environmental Sciences Division
Oak Ridge National Laboratory
E-Mail: watsondb@ornl.gov

http://www.esd.ornl.gov/nabirfrc/

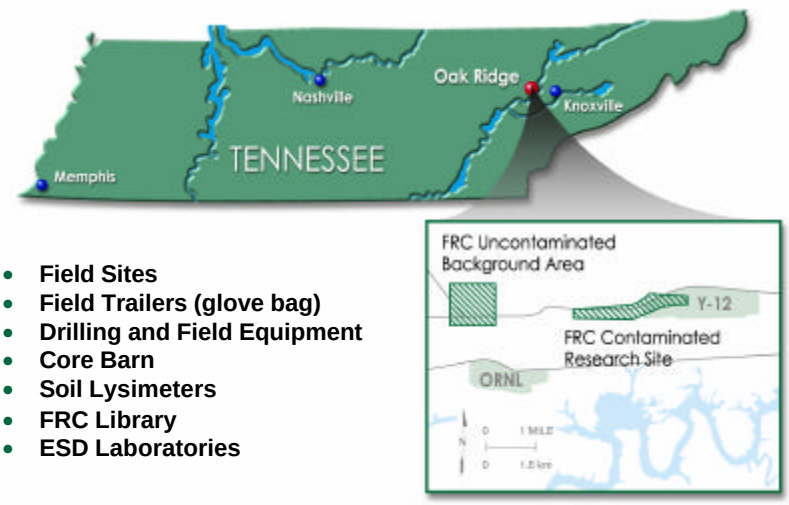
Presentation Outline

- **Objectives**
- **Summary of Site Setting**
- **What's New**
  - **Administrative**
  - **Organic Anion Analytical Method**
  - **Field Plots and Samples**
- **Update on Characterization Results**
- **Summary of Upcoming Field work**

FRC Objectives

- **Objective - Understand fundamental biogeochemical processes that would allow for the use of bioremediation approaches for cleaning up DOE's contaminated legacy waste sites.**
  - **Source of subsurface samples for NABIR investigators**
  - **Evaluation of new characterization and monitoring methods**
  - **Intrinsic bioremediation analyses**
  - **In situ accelerated bioremediation research**
- **Advantages – Promote coordination and efficient use of resources, and facilitate comparison and integration of data**

NABIR FRC Facilities



- **Field Sites**
- **Field Trailers (glove bag)**
- **Drilling and Field Equipment**
- **Core Barn**
- **Soil Lysimeters**
- **FRC Library**
- **ESD Laboratories**

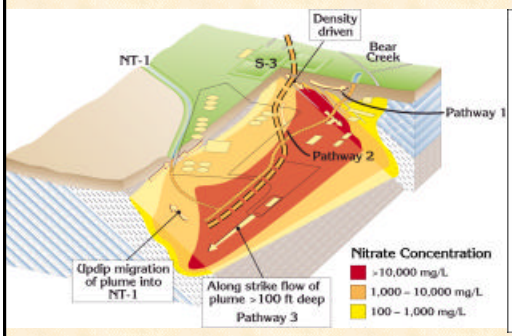
Field Research Center

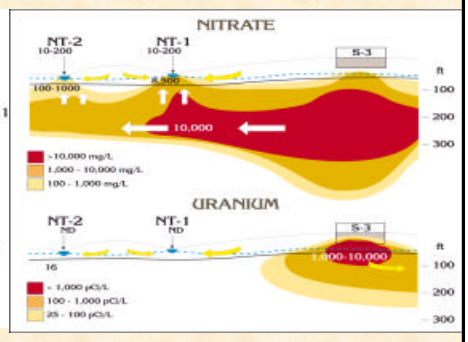
- Operated from 1951 to 1983
- 400 ft x 400 ft x 17 ft deep
- Over 2.5 million gallons waste/year
- Wastes contained nitrate, uranium, Tc-99, metals, VOCs, high TDS, and low pH (<2.0)
- Neutralized in 1984 capped in 1988

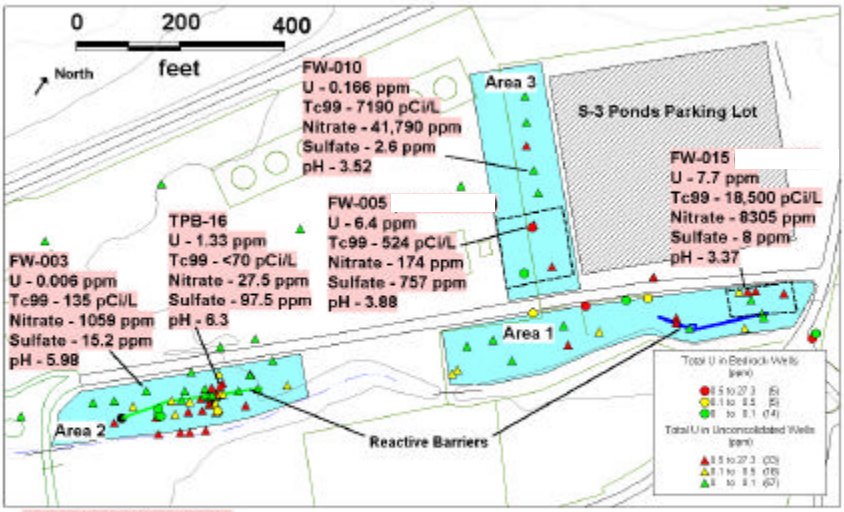
Currently a parking lot

S-3 Disposal Ponds During Denitrification

Conceptual Model of Contaminant Transport at the S-3 Ponds Site







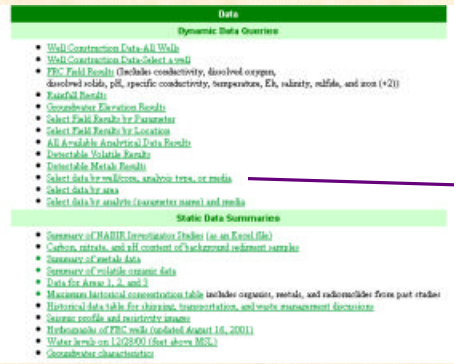
FW-300 (Background Site)
U - 0.0007 ppm
Tc99 - <72 pCi/L
Nitrate - 1.2 ppm
Sulfate - 6.2 ppm
pH - 6.1

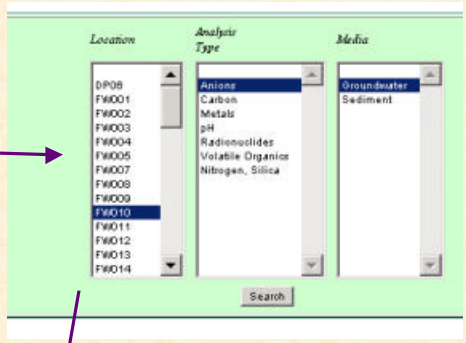
Groundwater Characteristic at the NABIR FRC

What's New - Administrative

- **FRC Brochure**
- **Users Guide available**
- **Summary of PI research on the FRC**
- **Website revised to include data querying and online sample request form**

Data Querying on the NABIR FRC Website





Lab Test	Type	Media	Location	Sampling Date	Sample Type	Parameter	Result	Units	Qualifier	Detection Limit	Uncertainty
IC	ANION	GW	FW010	13-Dec-00	REG	Sulfate	2.55	mg/L			
IC	ANION	GW	FW010	13-Dec-00	REG	Phosphate	4.73	mg/L	<		
IC	ANION	GW	FW010	13-Dec-00	REG	Nitrate	44241.18	mg/L			
IC	ANION	GW	FW010	13-Dec-00	REG	Bromide	0.153	mg/L	<		
IC	ANION	GW	FW010	13-Dec-00	REG	Chloride	497.78	mg/L			
IC	ANION	GW	FW010	18-Oct-00	REG	Bromide	0.01	mg/L	<		
IC	ANION	GW	FW010	18-Oct-00	REG	Chloride	871.0	mg/L			
IC	ANION	GW	FW010	18-Oct-00	REG	Sulfate	14.0	mg/L			
IC	ANION	GW	FW010	18-Oct-00	REG	Nitrate	41790.0	mg/L			

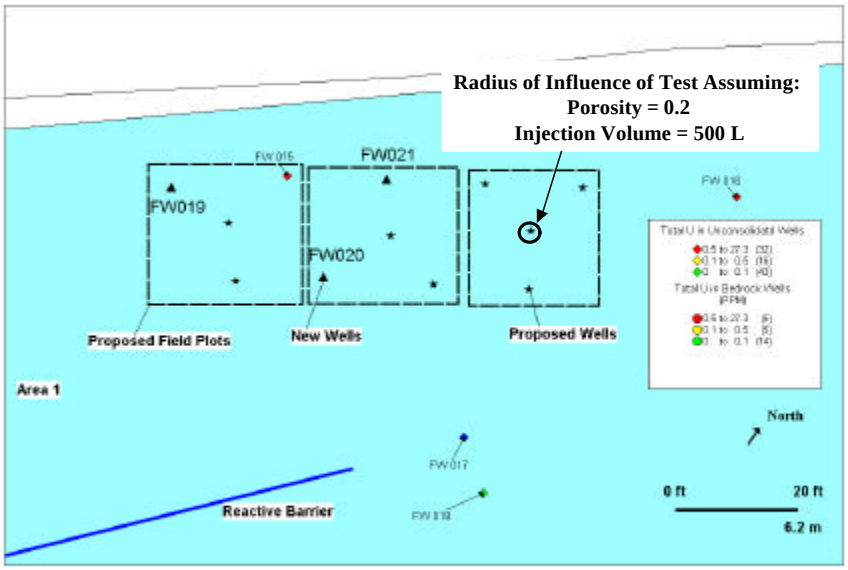
What's New – Analytical Methods

- **Organic anion IC analysis method developed - Isocratic elution by ion chromatography**
  - **Analytical column: Dionex IonPac ICE-AS6 Analytical Column**
  - **Eluant: 0.4 mM Heptafluorobutyric acid**
  - **Detection: Suppressed conductivity**
  - **Suppressor: Dionex Anion-ICE MicroMembrane Suppressor**
  - **Regenerant: 5 mN Tetrabutylammonium hydroxide**
- **Acetate and Citrate detected in Area 1 and 3 wells at a maximum concentration of 1821 mM/L and 110 mM/L**

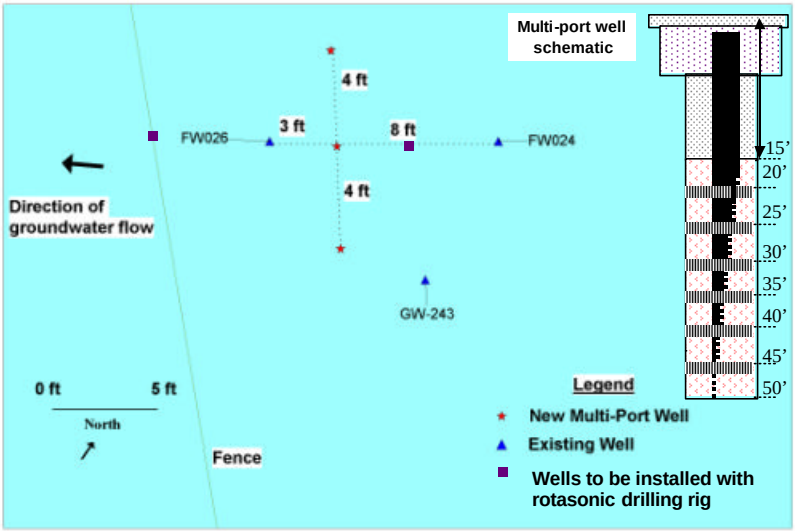
What's New – Field plots and Samples

- **Over 400 Groundwater and sediment samples (cores and composites) have been collected and shipped from the background and contaminated site for use by 7 National Labs and 15 Universities**
- **Humics available**
- **Site selection and initiation of 2 NABIR Investigator field studies**
  - **OSU/OU team – Area 1**
  - **Stanford/ORNL team – Area 3**

Location of Wells at OSU/OU Area 1 Site

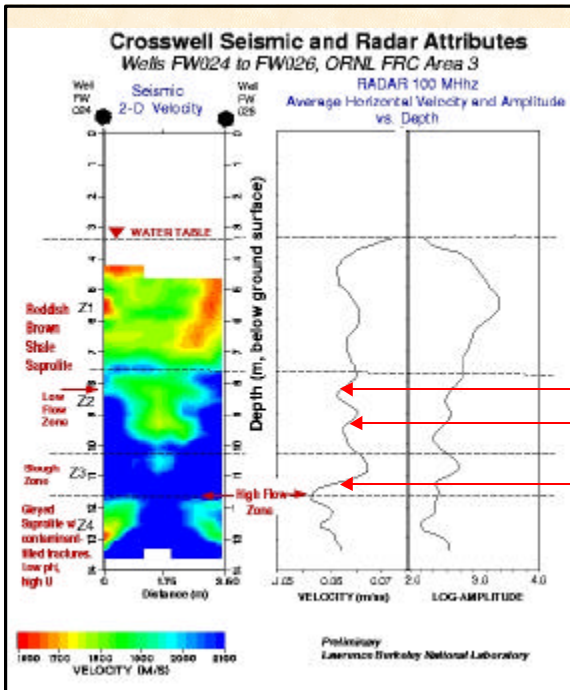


Stanford/ORNL Field Plot in Area 3



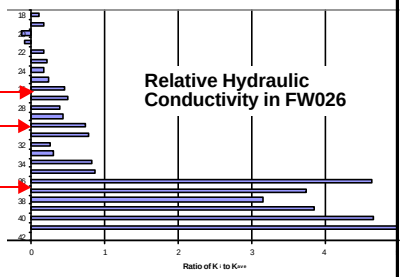
Update on Characterization Results

- **Geophysics**
  - **ORNL seismic and resistivity surface tomography at Area 2 and NT-1 (down gradient of Area 3)**
  - **LBNL crosswell seismic and radar tomography**
- **Geochemical characterization of groundwater in Area 3 Field Plot**
- **Storm event monitoring at Area 3 Field Plot (FW100)**
  - **Four ports in FW100 monitored during 6.24" rainfall event**
  - **Field parameters, anions, cations, and DOC**
- **Mineralogical evaluations (thin sections, SEM, EDX, XRD, XPS, XAS)**
  - **Background Area (FRC/UT collaboration)**
  - **Areas 1 and 3**
- **Bug traps – PLFA and rDNA (FRC/UT collaboration)**

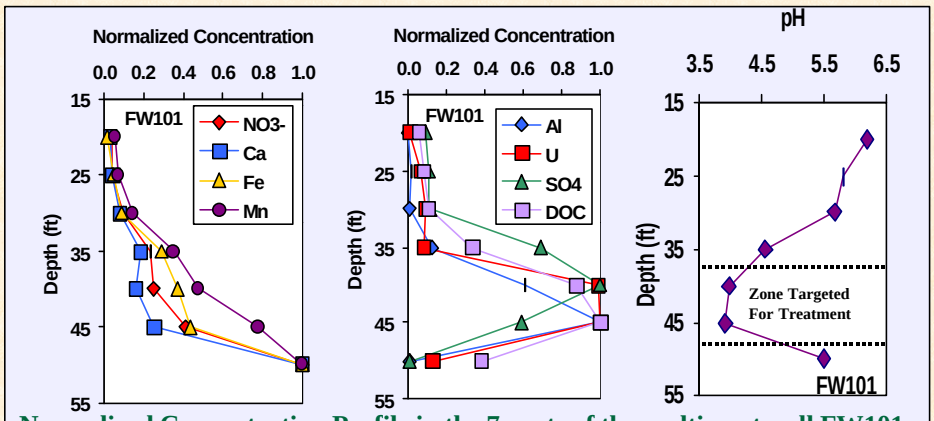


Comparison of stratigraphy and borehole flow meter data with LBNL (Susan Hubbard, Ernie Majer, and Ken Williams) crosswell seismic and radar study

Borehole flowmeter data



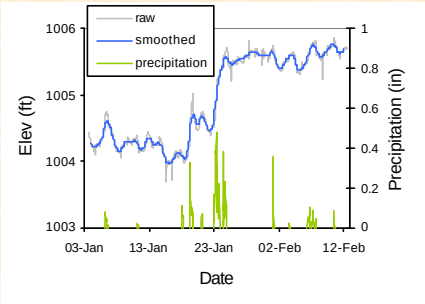
Characterization of Area 3 Field Plot Geochemistry



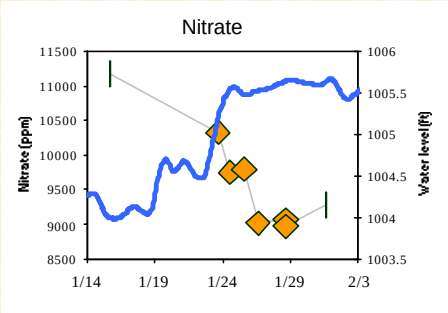
Normalized Concentration Profile in the 7 ports of the multi-port well FW101

Storm Response

Rainfall and Groundwater level in FW024

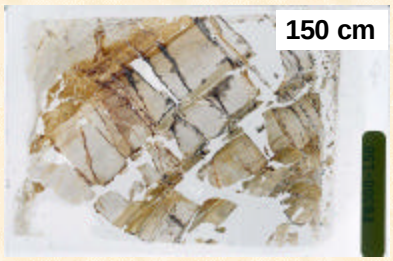


Change in Nitrate in 40' port during storm

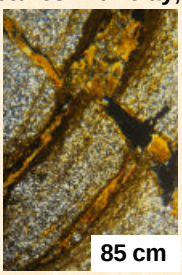


- **Groundwater levels increased 1.5' in response to 6.24" rainfall event**
- **Nitrate concentration decreased 20% in 40' deep port and 31% in 20' deep port**
- **Some ions had complex response to storm related to dilution and pH changes**

Example - Background Core Mineralogical Evaluation

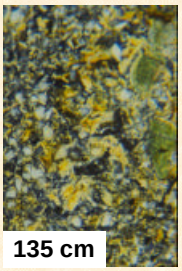


Shallow and deep thin sections showing bedding parallel and orthogonal fractures with clay, Fe and Mn infillings



Shallow - clay infilling with sand matrix

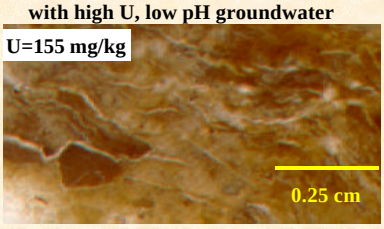
Deep - Fe/Mn lining with silt matrix



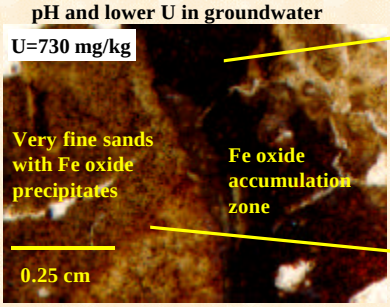
Sand matrix with clay and Fe/Mn

Example - Area 3 Core Mineralogical Evaluations

Overlying Gleyed leached flow zone with high U, low pH groundwater



Black precipitate Zone with higher pH and lower U in groundwater

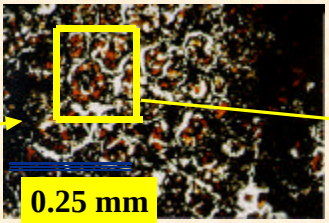


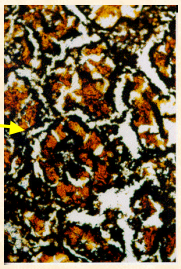
A high U zone was detected in FW100 (Area 3 field site) at a depth of 46'.

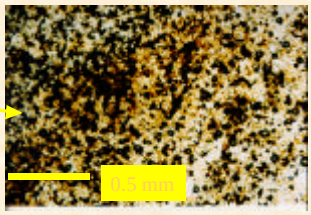
XRD results:

Gleyed Zone - Quartz, Vermiculite, Mica, HIV, Ca-feldspar

Black Zone - Quartz, Ca-feldspar, Vermiculite, Mica, Goethite







<u>XAS on black zone</u>

Ferrihydrite: 44%

Goethite: 47%

Hematite: 7%

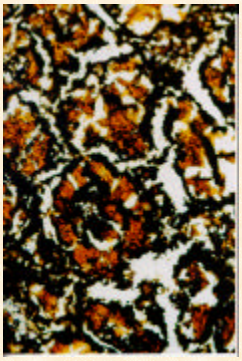
Hornblende: 22%

U identified as U^{+6}

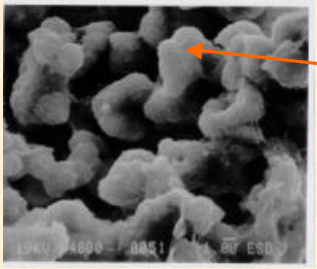
SEM-EDX Analysis of Black High Rad Zone

U detected with SEM/EDX in black zone in association with Fe, Mn, mica, sulfur and phosphorous.

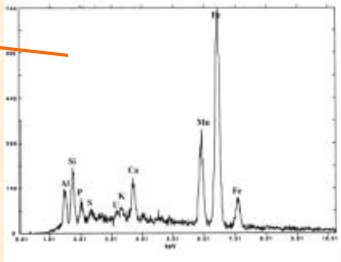
U^{+4}:U^{+6} detected at 64%:36% with XPS.



Thin Section



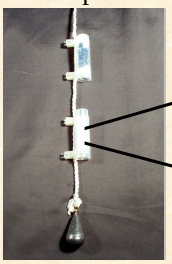
SEM



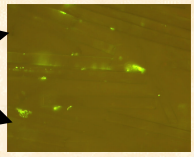
EDX

Example - Down-Well Coupons For Enhanced Microbial Monitoring FRC Area 2

Traps



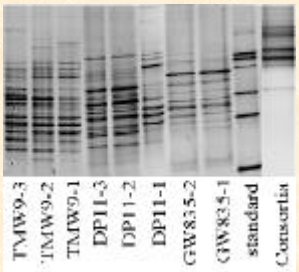
Colonized Surface



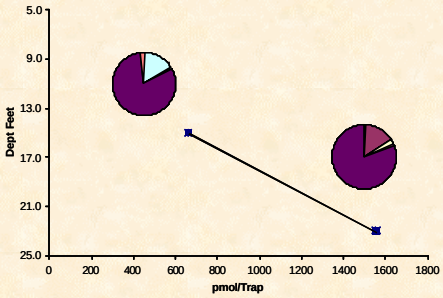
Areas deployed:

- **Areas 1, 2, and 3**
- **Background Area**
- **Maynardville Limestone**

DGGE Profiles of 16S rDNA



PLFA Biomass and Distribution with Depth in DP11



Upcoming Field Work

- **Coring and well installation at Area 3 Field Plot with rotasonic drilling methods**
- **Coring of Area 1 Field Plot after completion of Push-Pull manipulations**
- **Background cores**

FRC Contributors

- **Sample Collection, Processing, Shipping, Analysis**
  - **Barry Kinsall (Shipping)**
  - **Kenneth Lowe (Drilling and ICP/MS and Tc analysis)**
  - **Mary Anna Bogle (Health and Safety Officer)**
  - **George Houser (Radiological Safety)**
  - **Annett Sullivan and Gerry Moline (Storm monitoring and Water levels)**
  - **Steve Childs (Waste Management)**
- **Norman Farrow - Drilling Expert**
- **Bill Doll, Les Beard, and Jeff Gamey – Geophysics**
- **Debra Phillips and Yul Roh - Soil Characterization**
- **Brian Spalding – Developed use of NaI detector**
- **Craig Brandt – Database**
- **Susan Holladay – Data processing and webpage**
- **Lynda Campbell – Administrative assistance**
- **Harry Quarles and Monty Ross – Regulatory issues**
- **Scott Brooks – Geochemistry**
- **Susan Pfiffner and Tom Phelps - Microbiology**
- **Amy Wolfe –BASIC**
- **Phil Jardine and Tonia Mehlhorn**