



# Field-scale Demonstration of *in situ* Bioremediation of Uranium Contaminated Sediments

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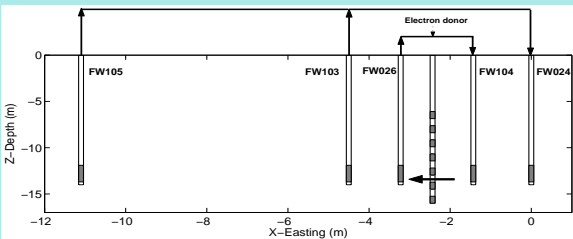
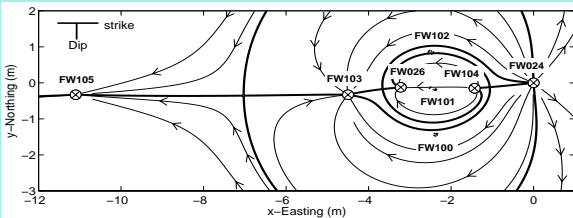
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## Objectives

- Establish hydraulic and chemical control over a highly contaminated region within the subsurface of Area 3 of the DoE NABIR FRC for microbial uranium reduction and immobilization
- Pre-condition the target region for biostimulation.
- Biostimulation to create a microbial community capable of reducing residual nitrate to N<sub>2</sub> and mobile U(VI) to insoluble U(V)
- Characterize the remediation of U(VI).
- Investigate the extent U(VI) reduction and factors influencing remediation performance.

## Field Treatment System



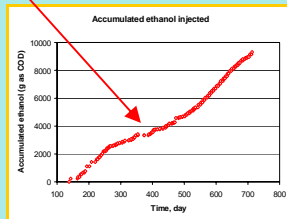
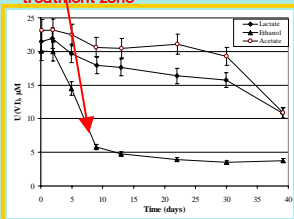
## Remediation Phases

The field test started on August 24, 2003 and has continued for two years, with the following steps:

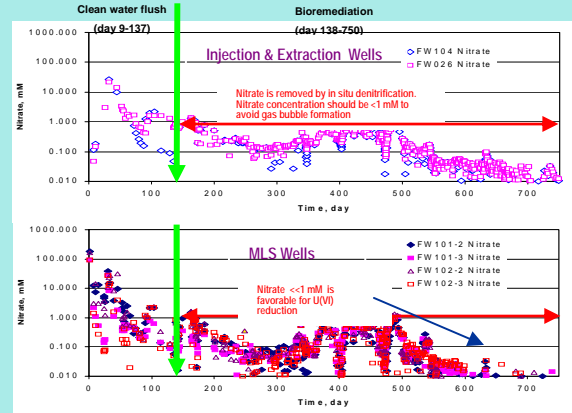
- Clean water flush (day 9-136) to remove bulk nitrate and Al
- In-situ* denitrification (day 137-184) for further remove nitrate
- In-situ* U(VI) reduction (day 185-present) to test remediation performance.

Ethanol was selected as the sole electron donor for the field test and delivered intermittently

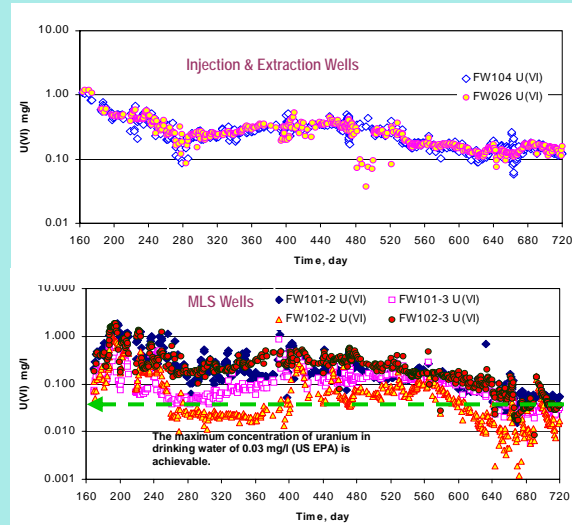
Microcosm tests with FRC sediments indicated that ethanol was a good electron donor (left). Cumulative mass of ethanol injected to the treatment zone



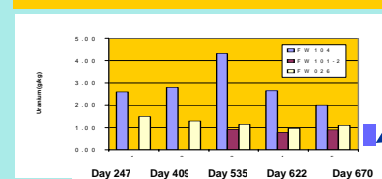
## Nitrate removal in each stage of remediation



## Long-term removal of soluble U(VI) *In situ*



## Uranium Content in Sediments from Injection, MLS and Extraction Wells

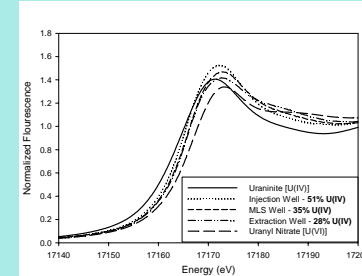


Accumulation of U around injection well was due to reduction and immobilization of U.

Variability in U content of injection well is likely due to removal of U through frequent surging

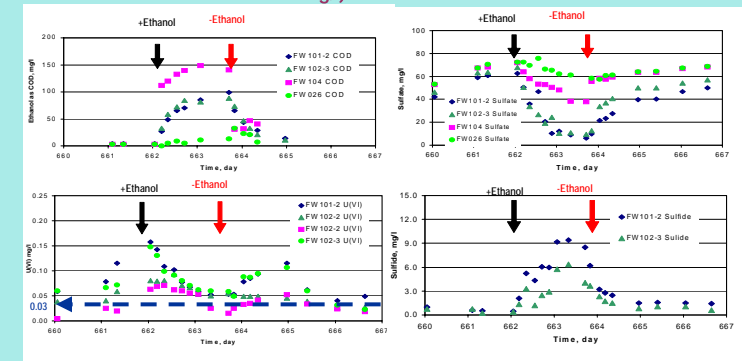
Uranium content in core samples from FW104 was in the range of 0.03-0.8 g/kg before bioremediation

## Confirmation of U(VI) Reduction In Sediments by XANES Analysis

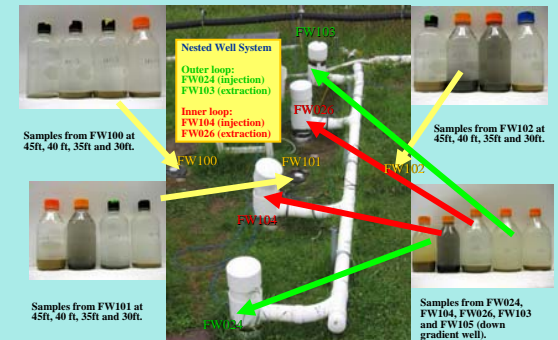


Day	Well	U (g/kg solids)	% U(V)
258	FW 104	2.60	39
271	FW 104	1.03	54
333	FW 104	ND	51
409	FW 026	1.29	0
409	FW 104	2.79	53
535	FW 026	1.14	28
535	FW101-2	0.91	35
535	FW 104	4.32	51

U(VI) reduction was associated with sulfate reduction (day 660-667). The recent U(VI) reduction pattern indicates that the EPA MLC (0.03 mg/l) is achievable



Sediment samples from the treatment zone indicate the reduction status of the subsurface and an expansion of the reduction zone after 22 months



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