



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

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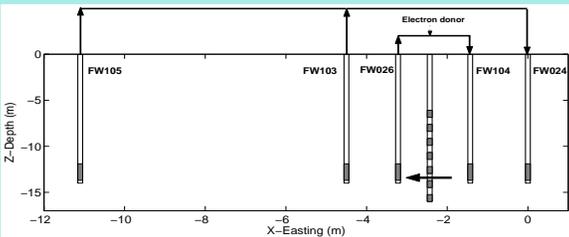
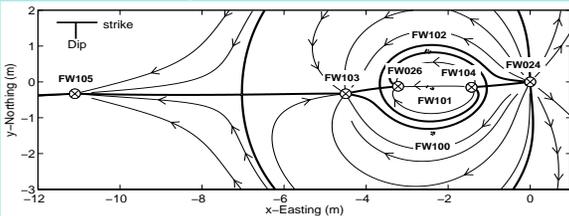
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Objectives

- 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 N₂ and mobile U(VI) to insoluble U(IV)
- Characterize the remediation of U(VI).
- Investigate the extent U(VI) reduction and factors influencing remediation performance.

Field Treatment System



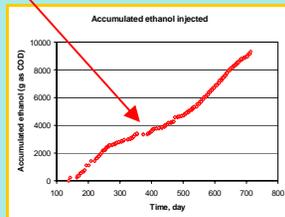
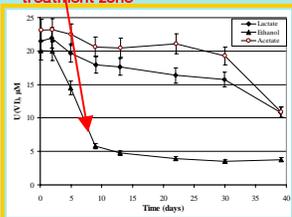
Remediation Phases

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

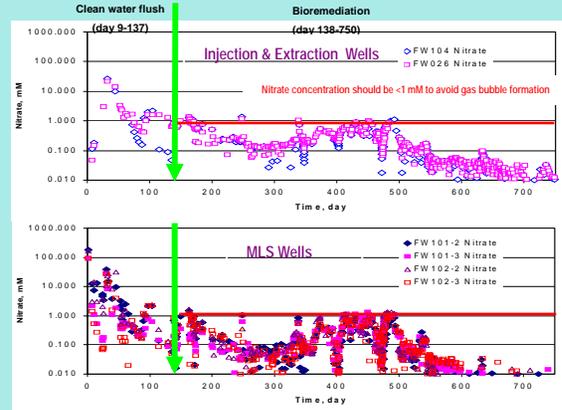
- Clean water flush (day 9-136) to remove bulk nitrate and Al
- In-situ* denitrification (day 137-184) for further remove nitrate
- In-situ* U(VI) reduction (day 185-present) to test remediation performance.

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

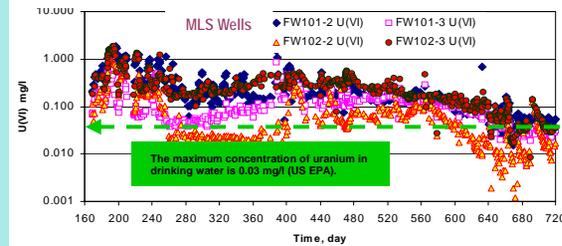
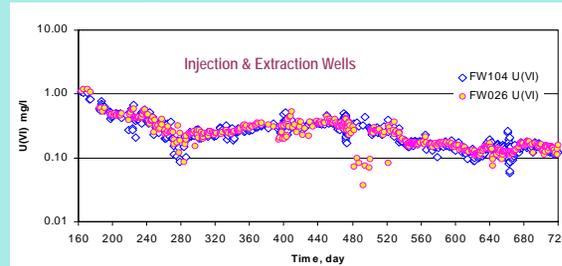
Microcosm tests with FRC sediments indicated that ethanol was a good electron donor (left). Cumulative mass of ethanol injected to the treatment zone



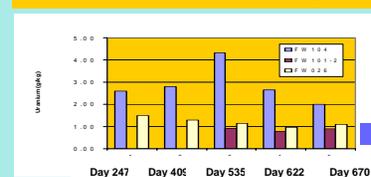
Nitrate removal in each stage of remediation



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



Uranium Content in Sediments from Injection, MLS and Extraction Wells

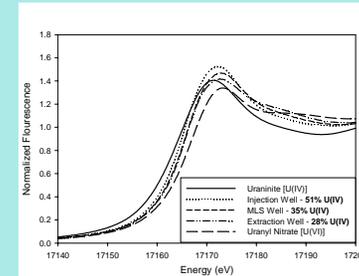


Accumulation of U around injection well was due to reduction and immobilization of U.

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

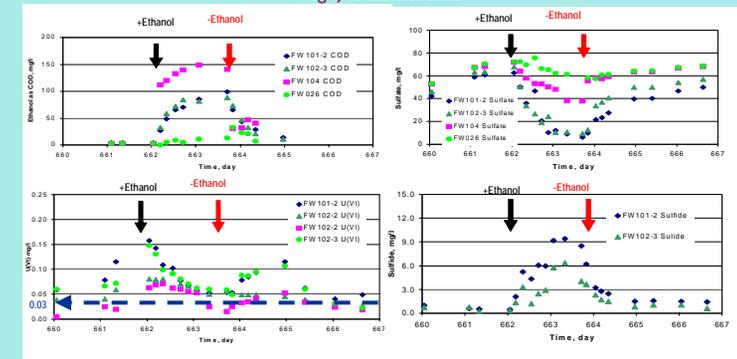
Uranium content in core samples from FW104 was in the range of 0.03-0.8 g/kg before bioremediation

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

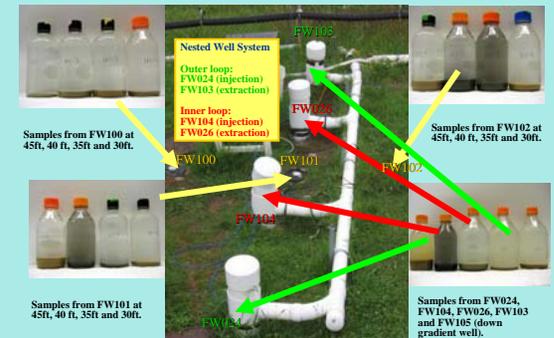


Day	Well	U (g/kg solids)	% U(IV)
258	FW 104	2.60	39
271	FW 104	1.03	54
333	FW 104	ND	51
409	FW 026	1.29	0
409	FW 104	2.79	53
535	FW 026	1.14	28
535	FW101-2	0.91	35
535	FW 104	4.32	51

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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