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CASE STUDY #15 | Ferox[SM] Application – Former Industrial Facility, – Central New Jersey

Project Summary

A pilot test of the Ferox[SM] technology was conducted at a former industrial site in central New Jersey. Historical operations at the site had led to significant TCE contamination in the shallow shale bedrock aquifer. TCE concentrations were as high as 170 mg/liter in the early 1990's when the contamination was identified. Pneumatic fracturing was subsequently performed within the source area to enable the TCE removal by a dual-phase extraction system (DPE). The DPE was successful in removing the bulk mass of TCE and bringing the dissolved TCE concentrations down to single-digit ppm levels. At this point, the system was considered an inefficient and costly process as the mass removal rate had asymptoted. The objectives of the pilot test were to demonstrate the effectiveness of the technology for the cleanup of the entire site and to allow for the cessation of the DPE system.

The pilot test consisted of applying a patented Ferox[SM] technology, which is based on a specialty ZVI powder integrated with a gas-based injection method. The ZVI powder was injected into three existing open-rock wells using nitrogen gas as the carrier fluid.

Fractures previously created during the initial application 6 years earlier were isolated in 3-foot intervals using straddled pneumatic packers during the injections. Using minimal pressures, these fractures were re-dilated immediately prior to the introduction of an iron-water slurry in conjunction with the nitrogen gas. The volume flow rate and velocity of the nitrogen gas "atomized" the ZVI slurry and dispersed it uniformly throughout each injection interval. The iron was injected into depths of 12 feet bgs to approximately 27 feet bgs. Figure 1 is a layout of the pilot test area showing the locations of the injection and monitoring wells.

Approximately 2,275 kg of the ZVI powder were introduced into the fracture network during a 3-day field event.

Outcome

Based on field observation and pressure monitoring, the injection process was a success in effectively dispersing the Ferox[SM] powder into the targeted zones that led to significant decrease in the TCE concentrations. Table 1 on the following page shows the most up-to-date sampling results. Two rounds of pre-injection sampling and four rounds of post-injection sampling have been conducted in selected wells. Note that PF-4A was re-sampled during the fourth round of post-injection sampling as the laboratory analysis was questioned.

Results show that significant TCE reduction was observed in most of the monitored wells, with the exception of MW-5S, which is sidegradient to the treatment zone. TCE concentrations have decreased from as high as 3,700 ug/liter before the Ferox^{SM} injection to less than 10 ug/liter and non-detect in some wells.

Note the changes in the TCE-to-cis-1,2-DCE ratio in some of the wells, particularly PF-2A, PF-4A and to a certain extent, MW-6. The pre-injection TCE concentrations were significantly higher than those of the cis-1,2-DCE. Subsequent to the injection, the TCE-to-DCE ratio began to change as the cis-1,2-DCE concentrations increase to approach those of TCE and in some cases surpass them. This reversal in the TCE and DCE concentrations is indicative of the effective dechlorination of the TCE.

Based on long-term observations, downgradient TCE concentrations have been gradually decreasing since the Pilot Test in more than three years ago. Although the initial objective of the Pilot Test was to assess the remedial effectiveness of the technology and to provide field parameters for the design of a full-scale site-wide implementation, the positive impact of the test appeared to have gone beyond the test area and provided discernable remedial effects downgradient and even off-site. A full-scale implementation may not be necessary while a monitoring strategy may be more appropriate.

FIGURE 1 – FEROX^{SM} PILOT TEST LAYOUT

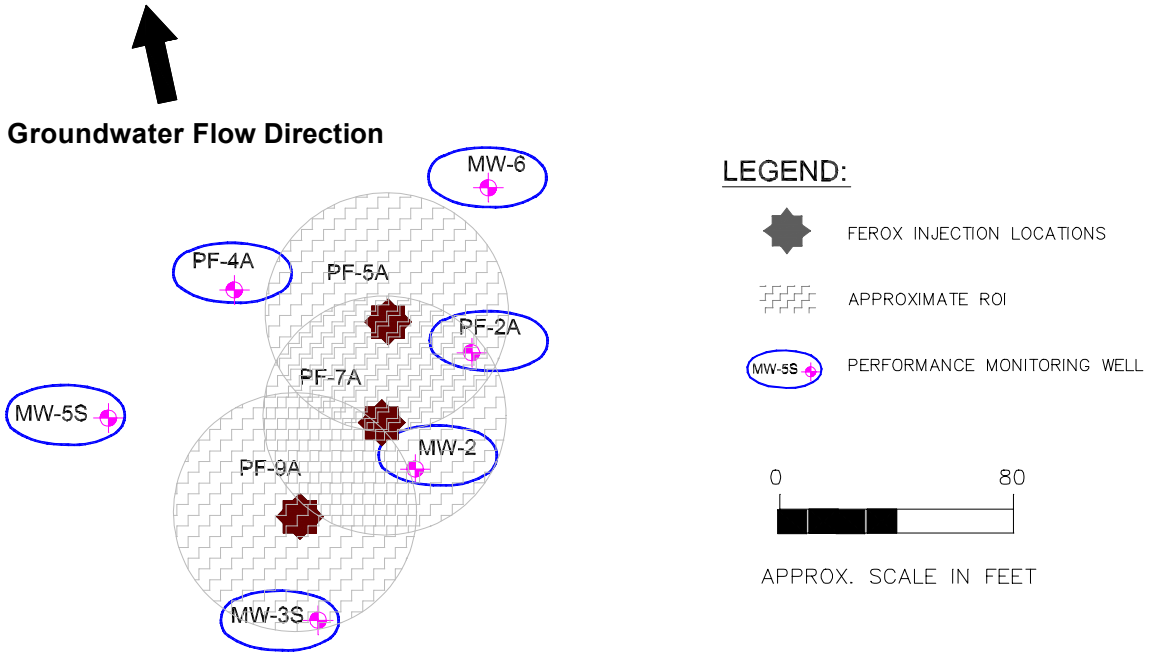

TABLE 1 - FEROX Performance Verification Sampling Results

Monitoring Wells	Sampling Events	TCE (ug/liter)	*cis* -1,2-DCE (ug/liter)	*trans* -1,2-DCE (ug/liter)	VC (ug/liter)
PF-2A	5/3/01	1100	110	0.9	U
	5/14/01	730	44	U	U
	5/24/01	27	7	U	U
	6/14/01	U	25	U	U
	7/5/01	42	42	U	1.96
	8/9/01	99	170	U	U
	12/4/01	210	280	U	U
	3/8/02	140	45	U	U
	8/17/02	NS	NS	NS	NS
PF-4A	5/3/01	2800	380	9	U
	5/14/01	980	300	U	U
	5/24/01	200	69	U	U
	6/14/01	360	250	U	24
	7/5/01	49	61	2.98	10.53
	8/9/01	830	800	16	71
	8/21/01	290	480	U	42
	12/4/01	330	600	U	18
	3/8/02	640	430	U	51
	8/17/02	NS	NS	NS	NS
PF-7A	5/3/01	NS	NS	NS	NS
	5/14/01	770	180	U	U
	5/24/01	10	23	U	U
	6/14/01	3	3	U	U
	7/5/01	9	9	U	U
	8/9/01	47	39	U	U
	12/4/01	13	58	U	2
	3/8/02	4	40	U	2
	8/17/02	NS	NS	NS	NS
MW-2	5/3/01	3700	68	0.7	U
	5/14/01	610	65	U	U
	5/24/01	8	17	U	U
	6/14/01	2	2	U	U
	7/5/01	5	7	U	U
	8/9/01	5	5	U	U
	12/4/01	3	15	U	U
	3/8/02	5	20	U	U
	8/17/02	10	24	U	U
MW-3S	5/3/01	140	3	U	U
	5/14/01	130	U	U	U
	5/24/01	53	2	U	U
	6/14/01	74	4	U	U
	7/5/01	37	1.7J	U	U
	8/9/01	16	1.7J	U	U
	12/4/01	5	2	U	U
	3/8/02	4	1	U	U
	8/17/02	3	1	U	U
MW-5S	5/3/01	990	160	U	U
	5/14/01	1200	210	U	U
	5/24/01	900	130	U	U
	6/14/01	930	190	U	U
	7/5/01	879	142	U	U
	8/9/01	1000	170	U	U
	12/4/01	530	150	U	U
	3/8/02	370	290	U	U
	8/17/02	500	250	U	U
MW-6	5/3/01	560	300	0.9	0.7
	5/14/01	930	360	U	U
	5/24/01	130	71	U	U
	6/14/01	26	10	U	U
	7/5/01	32	13	U	U
	8/9/01	41	28	U	U
	12/4/01	72	49	U	U
	3/8/02	33	53	U	U
	8/17/02	34	57	1	U

Notes: U - Compound not detected at method detection limit

NS - Well not sampled