BASELINE SAMPLING AND PERFORMANCE MONITORING GUIDELINES

Following the addition of Provect-IR or Provect-IRM (or their conventional Provect-IR® counterparts with no active methane control technology) to an aquifer environment, several physical, chemical and microbiological processes combine to create an extremely reduced environment that stimulates dehalogenation and ultimately mineralization of otherwise persistent compounds. As outlined below, a combination of field measurements and laboratory analyses can be used to determine effectiveness of the ISCR processes.

Field Parameters: Sampled Frequently

Field parameters are comparatively inexpensive measurements that can be collected on a frequent basis to monitor general progress of the ISCR process. They are also useful in assessing general zone of influence of the added amendments.

Field Parameter	Analytical Method	Desired Range	Data Use
pH	Field probe	6 to 8	Excessive fermentation can acidify aquifer and impede microbiological activity and yield secondary plumes
Turbidity (nephelometric)	Field probe	Generally <1 NTU, or site specific standards	Excessive turbidity compromises data; indicates need for filtration; Gas bubbles (CH_4) can cause high readings
Water level / temperature	Field probe	+/- 10% baseline readings	Notable variations can indicate change in contaminant loading rates and are useful in interpreting COI data
DO/ORP or Eh (see note below)	Field probe (corrected for SHE, if required)	< -200 mV (be mindful of recording values as Eh or ORP; ORP + 200 mV = Eh)	Rapid reductions in redox should be observed in the zone influenced by the ISCR reagent; Field ORP values as low as -400 mV have been observed
Well head gases CH_4, CO_2, H_2S, O_2 [N_2]	GEM2000, GEM 5000, biogas5000, TVA2020 Total gas analyzers	< 5% CH_4	Excessive methane production represents inefficient use of H donor and potential health and safety problems

http://www.ysi.com/media/pdfs/T608-Measuring-ORP-on-YSI-6-Series-Sondes-Tips-Cautions-and-Limitations.pdf

Thermo/Foxboro TVA-1000B PID/FID Analyzer (PID sensitive to 2,000 ppm CH4; FID sensitive to 50,000 ppm CH4) and a LandTec GEM5000 Landfill Gas (LFG) Meter (infrared detector calibrated to 15% methane). Equipment purchase see http://diamondsci.com Equipment rental options see http://www.fieldenvironmental.com

Critical Parameters: Sampled Quarterly

Critical parameters are initially used to assess the general applicability of an ISCR approach, and they establish an important baseline for subsequently measuring technology effectiveness. Groundwater samples should be collected according to standard protocols (trip blanks, field blanks) and shipped under proper conditions (preservatives, proper containers, chain-of-custody) to an analytical laboratory for timely analysis.

Critical Parameter	Analytical Method	Data Use
RCRA Metals - DISSOLVED (include iron, calcium, magnesium, manganese. Hg optional)	SW846 6010B 0.45 micron filtered, no preservatives	Baseline values help determine reagent requirements. Changes over time indicate presence of ISCR reagents and help document effectiveness.
RCRA Metals - TOTAL (include iron, calcium, magnesium, manganese. Hg optional)	SW846 6010B	Baseline values help determine reagent requirements. Changes over time indicate presence of ISCR reagents and help document effectiveness.
Total Iron	US EPA 200.7	Indicates presence of ISCR reagents and microbiological activity
Other heavy metals – DISSOLVED AND TOTAL	Arsenic 200.9/200.8 Cyanide 335.4/9010 Lead 200.9/200.8 Mercury 7470A Nickel 200.9/200.8	As determined necessary based on site-specific conditions
CVOCs	SW846 8260	Baseline values help determine reagent requirements. Changes over time indicate presence of ISCR reagents and help document effectiveness.
Anion Scan – chloride, sulfate, nitrate, nitrite	US EPA 300	Competing electron acceptors will affect the loading requirements
Total Organic Carbon, TOC	SW846 9060 US EPA 415.1 / 415.2	Indicates presence of ISCR reagents and microbiological activity
Dissolved gasses (CH_4, CO_2, ethane, ethene)	SW846 3810 (See link below)	Document effectiveness; helps determine presence of ISCR reagents

http://www.clu-in.org/download/contaminantfocus/dnapl/Treatment_Technologies/Ethene-ethane-methane-analysis.pdf

Baseline TOC, DOC, VFAs and Fe data could be compared to post-injection levels to determine that the groundwater is influenced by Provect-IRM. Elevated levels of these parameters would indicate effective product placement. Elevated levels of TOC, DOC and Fe would be expected almost immediately following the Provect-IRM emplacement.

NOTE: purging at least three well volumes is recommended in order to ensure collection of formation water when sampling. Monitoring wells must be free of sediment or other deposits which may contain precipitated heavy metals.

Non-Critical Parameters: Sampled Quarterly, or as Needed

Various non-critical parameters are optional, but they provide general information about the soil and water chemistry that may be useful when analyzing and interpreting performance monitoring data. However, baseline measurements are needed in order to make best use of these complementary data.

Non- Critical Parameter	Analytical Method	Data Use
VFAs	Specialty – see link below	
Biological Oxygen Demand, BOD 5 day	SW 846 5210B	Indicator of microbiological activity
Chemical Oxygen Demand, COD	US EPA 410.4	Indicator of redox and oxygen demand
Cation Scan - Calcium, Magnesium, Potassium, Sodium	US EPA 200.7	Indicates presence of ISCR reagents and microbiological activity
Bicarbonate 2310B	Bicarbonate 2310B	Indicates presence of ISCR reagents and microbiological activity – buffering capacity
Total Dissolved Solids (TDS)	SW846 2540C	Indicates presence of ISCR reagents and microbiological activity
Hardness	US EPA 2340B	Indicates presence of ISCR reagents and microbiological activity
Alkalinity	SW846 2310B US EPA 310.1	Indicates presence of ISCR reagents and microbiological activity

As the organic carbon moieties of Provect-IR and Provect-IRM degrade, elevated levels of VFAs would be observed. In addition, as the bacteria grow on the organic particles, they ferment carbon and release a variety of volatile fatty acids (acetic, propionic, butyric, pyruvic, lactic, pentanoic and hexanoic). These are useful forms of hydrogen donors for desired microorganisms.

CONTACT US FOR A COMPLIMENTARY SITE EVALUATION

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