

Services and Technologies

BioRemedial Technologies, Incorporated
Hermitage, Pennsylvania

724-981-1994

www.bioremedial.com



BioRemedial Technologies, Incorporated

BioRemedial Technologies, Inc.

“Biological Solutions for Environmental Problems”



- Founded in 1993
- Fully equipped microbiological laboratory with analytical capabilities
- Well Rounded Staff with Ph.D. Microbiologists, Professional Geologist and Environmental Scientists



BioRemedial Technologies, Incorporated

Office and Laboratories

Hermitage, Pennsylvania

(~50-miles north of Pittsburgh)



BioRemedial Technologies, Incorporated

Company Overview

- Soil and groundwater remediation
 - Aerobic and Anaerobic Processes
 - Selenium and other metals
 - Acid Mine Drainage (AMD)
 - Petroleum Hydrocarbons (oils, gasoline/diesel, MTBE)
 - Chlorinated Solvents (PCE, trichloroethylene)
 - Polyaromatic Hydrocarbons (PAHs)
 - Lagoon Sludge



Bioremediation



- The use of amendments to enhance growth and activities of ***intrinsic beneficial bacteria*** to perform a desired process
- The indigenous microbes used by BRT are harvested from a given site and are 100% site specific
- Key is to focus on Beneficial Bacteria



Beneficial Bacteria

- Heterotrophic Bacteria
 - Over a million organisms on the head of a pin,
 - Not all carry out the desired process
- Beneficial bacteria acclimate to new site conditions
 - Out compete foreign organisms – enhance the activity of the of the beneficial
 - Palm tree in West Virginia?
- Harvest and enhance the power of mother nature
 - **Site specific approach; Bacteria, Nutrients and Carbon Source**



Site Specific Approach Bacteria

- Bacteria
 - Identify beneficial bacteria
 - In some instances, desired bacteria degrade contaminant, producing carbon dioxide while others reduce contaminant to an alternative electron state to precipitate out of solution
 - Determine what is needed for the given site
 - Harvested from intrinsic beneficial bacteria grown en masse then re-inject (biological seeding)



Site Specific Approach

Nutrients

- Biological testing performed with in-house lab to monitor nutrient needs, loading and consumption
- Site Specific formula
- 13 different compounds for optimal efficiency
 - nitrate and phosphate
 - cofactors for enzyme reactions, growth stimulants, metabolic enhancers
 - water soluble
 - slow released
 - facilitates faster, better and stronger contaminant degrading microorganisms
- Introduced to site below EPA drinking water standards



Site Specific Approach

Carbon Source

- Carbon Source
 - BRT's proprietary blend targets the intrinsic beneficial bacteria and make for more efficient biological activity
 - Without enough carbon source, conversion will stall. Too much and precious time and money will be wasted. Need to find the correct balance.
 - Different bacteria require different carbon sources



Field Application

- Identify contaminant of concern and determine what bacteria to analyze
 - Selenium – Selenium reducers
 - AMD and metals – Sulfate Reducing Bacteria (SRB)
- Site Characteristics
 - Flow (gpm), concentrations, lagoon/outfall size
- Sample of media (soil or water)



AMD Origin

- Chemical Process
 - Oxidation of pyrite and other sulfide minerals results in groundwater that has high concentrations of sulfate, ferrous iron and other metals.
 - Ferrous iron in groundwater then oxidize to create ferric iron
 - Precipitation of these ferric irons produce acidic conditions
- Oxidation of Pyrite
 - $\text{FeS}_2 + 7/2 \text{O}_2 + \text{H}_2\text{O} \rightarrow \text{Fe}^{2+} + 2\text{SO}_4^{2-} + 2\text{H}^+$
- Oxidation of ferrous iron to ferric irons
 - $\text{Fe}^{2+} + 1/4\text{O}_2 + 5/2 \text{H}_2\text{O} \rightarrow \text{Fe}(\text{OH})_3 + 2\text{H}^+$



BRT's Approach

- Biological solution for chemical reaction
 - Sulfate reducing bacteria (SRB)
 - SRB's use organic compounds as carbon and energy sources and sulfate as an electron acceptor for respiration (breathing)
 - Byproducts of this respiration is hydrogen sulfide and alkalinity
 - Hydrogen sulfide precipitates metals out of water in the form of metal sulfides
- SRB's production of hydrogen sulfide and alkalinity
 - $\text{SO}_4^{2-} + 2(\text{CH}_2\text{O})_n \rightarrow \text{H}_2\text{S} + 2\text{HCO}_3^-$
- Metal Precipitation
 - $\text{Me}^{2+} + \text{HS}^- \rightarrow \text{MeS} + \text{H}^+$



BRT's Approach

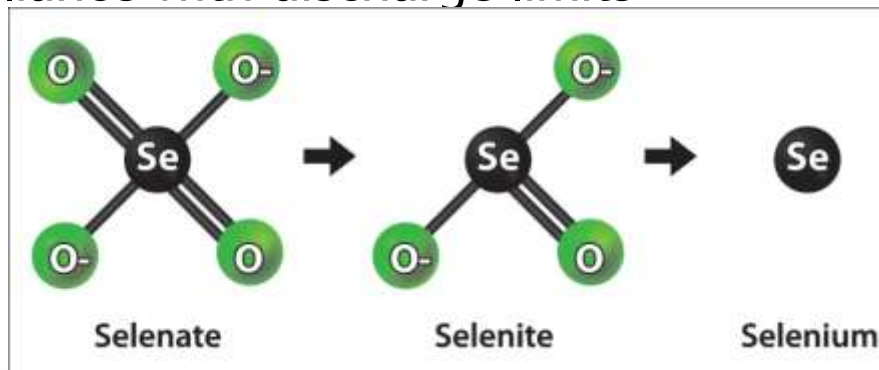
- Promote and maintain SRB activity
 - Addition of organic compounds (carbon and energy source)
 - Addition of site specific nutrients (enhanced bacterial activity)
 - This will lead to increase of SRB's *in situ*
- Biological bench scale studies performed in-house to determine viability of technology.



Selenium

Bioremediation of Selenium

- Selenate and selenite are oxidized forms of selenium that stay in solution and carried in discharge waters
- Through biological activities, certain natural occurring beneficial bacteria have the potential to respire selenate and selenite
- Respiration of selenate and selenite produces insoluble elemental selenium which drops out of solution enabling compliance with discharge limits



Selenium

- Culture being prepared for delivery



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Selenium

Site Specific Approach

- All activities are site specific. Design and formulation of all materials are done in BRT's in-house lab and production facility



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Selenium

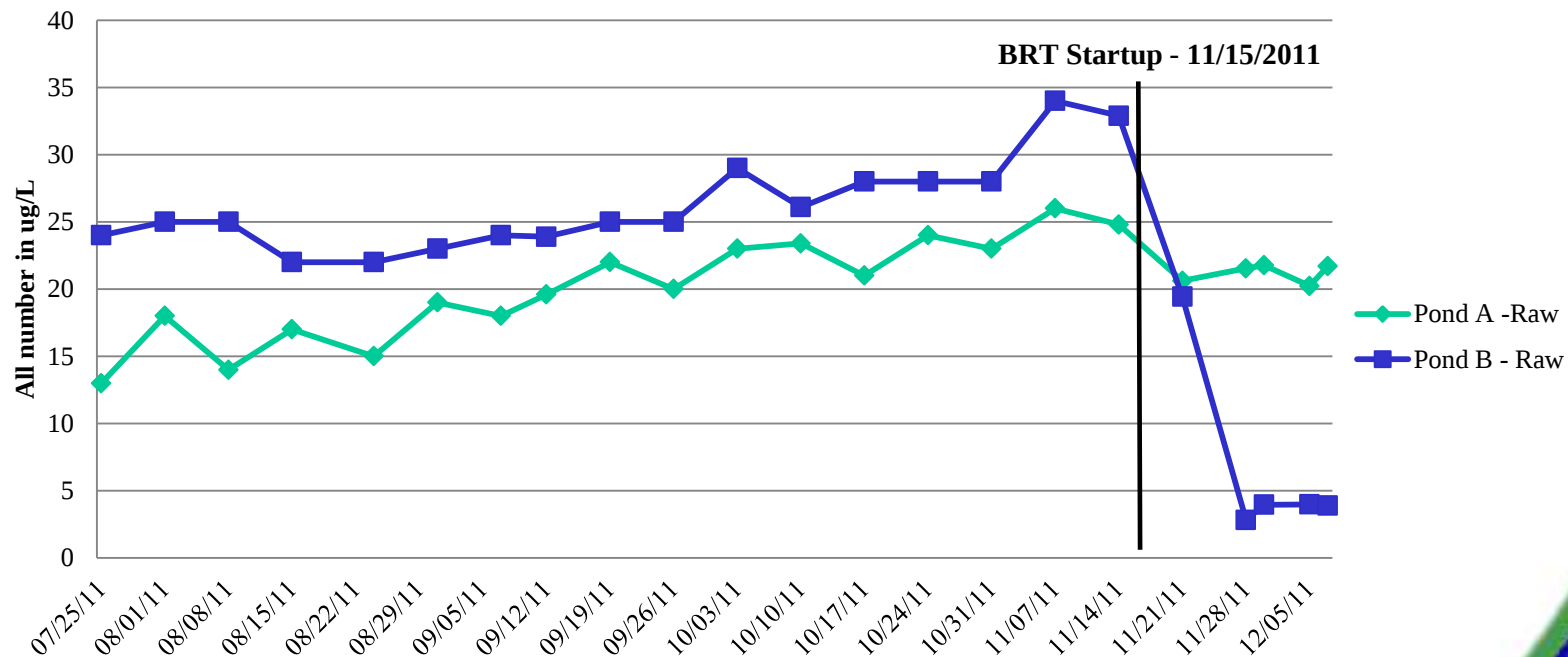
Site Specific Approach

- No power or infrastructure needed
- No sludge generated



Selenium Project Overview

Selenium Concentrations Over Time



Questions?

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