Comparing Microbial to Physical-Chemical Remediation Technologies and Associated Water Chemistry Amendments in GSR Assessments

Paul Brandt Butler (brandt.butler@aecom.com) (AECOM, Conshohocken, PA, USA)
Maureen McBride (maureen.mcbride@aecom.com) (AECOM, Newark, DE, USA)
Gerlinde Wolf (gerlinde.wolf@aecom.com) (AECOM, Latham NY, USA)
Emily Ghedia (emily.gehdia@aecom.com) (AECOM, Birmingham, United Kingdom, UK)

Background. In support of a RCRA Corrective Measures Study and Technical Impracticability Assessment (CMS-TI) for a chemical manufacturing facility in Pennsylvania, sustainable technologies were identified to remedy potential future discharges of an ammonium sulfate plume to the adjacent river. A green and sustainable remediation (GSR) assessment compared the merits of microbial bioreactor-based processes to physical-chemistry-based alternatives. Both approaches required chemical addition to amend water chemistry.

Approach. Two treatment approaches were evaluated. The first was microbial-based nitrification and denitrification to convert ammonia to nitrogen gas and sulfate to sulfide followed by sulfide precipitation. Nitrification required amendment with caustic to neutralize the acidic conditions produced by nitrification, and the microbial production of sulfide required the use of zero-valent iron (ZVI) that precipitated iron sulfide. The second alternative was physical-chemical air stripping of ammonia gas and precipitation of sulfate with barium. The air stripping required caustic to remove ammonia by air stripping, acid neutralization following stripping to return the treated water to a neutral pH, and barium chloride addition to precipitate barium sulfate.

Process flow diagrams were created to quantify the amount of caustic, acid, ZVI, and barium chloride required to treat impacted groundwater.

The Battelle SiteWise tool was used to quantify the GSR footprint, and the AECOM qualitative Sustainable Remediation Tool (AqSRT) was used to include client-specific social and corporate metrics into the GSR assessment.

Results/Lessons Learned. Technologies that are biologically-based and mimic natural processes are often more sustainable with lower footprints than technologies that employ physical-chemical technologies. An unexpected finding was that the footprint of the physical-chemical treatment option was on par with the microbial bioreactor option. In this case, the bioreactor footprint was elevated by pH control required by nitrification. As a value engineering alternative, a limestone bed was recommended as an alternative to liquid caustic addition. In addition, mulch for the bioreactor contributed significantly to the emissions and energy consumption metrics.

Overall, several key lessons can be drawn from this project including the following:

- Evaluation of sustainability metrics during the remedial decision-making process gives project stakeholders an opportunity to understand the environmental, social, and economic tradeoffs associated with various remedial alternatives.
- The consideration of sustainability metrics should ideally be considered early in the remediation process so that well informed, feasible alternatives can be presented and evaluated. This process will allow for more transparency and greater opportunity for stakeholders to participate in the process.

- The unexpected results found in the SiteWise analysis enabled identification of high-impact materials and project components. This process allows early value-engineered footprint reductions that are not readily apparent.