

APPLYING LESSONS LEARNED FROM A NOVEL EISB STUDY TO DEVELOP THE NEW ASTM STANDARD ON MOLECULAR BIOLOGICAL TOOLS

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Background/Objectives:

A comprehensive biogeochemical assessment was performed at an historical refinery active for almost a century before transitioning to its current role as a petroleum products terminal. The primary objective was to determine if enhanced in situ bioremediation (EISB) would be successful at reducing benzene concentrations under the anaerobic conditions at the site, and if so, how to maximize its effectiveness. This biogeochemical assessment merged traditional geochemical parameters with a unique consortium of innovative molecular biological tools (MBTs). This project also influenced a new ASTM Standard.

This project is significant for four reasons. First, it demonstrates a modern method to evaluate EISB at a site impacted by legacy constituents of concern (COCs). Second, the information gleaned from these assessments was then used to design and implement a field-scale EISB pilot study that was the first of its kind, globally. Third, the approach practiced at this location, and lessons learned, influenced the development of, and content within, the 2022 “ASTM Standard Guide for Application of Molecular Biological Tools (MBTs) to Assess Biological Processes at Contaminated Sites”. Fourth, in addition to the pilot study being a model during the inception of the ASTM Standard, this project also demonstrates the simultaneous influence of the ASTM Standard on the project during its subsequent monitoring and reporting stages.

Approach/Activities:

In addition to examining a traditional suite of site geochemistry and COC data, stable isotope analyses were used to confirm and track benzene biodegradation. Furthermore, a novel series of next-generation molecular sequencing arrays and other quantitative molecular analyses were performed to directly monitor the entire indigenous microbial population as well as the full suite of metabolic functions being performed by this community. Together, these laboratory studies resulted in a site-specific profile of the current status of indigenous benzene biodegradation. Information from these studies was used to then develop the first known EISB pilot study of its kind, using the in situ enhancement of a specific benzene-biodegrading microbial population at a highly anaerobic location such as this. The lessons learned from this process were used during the development of the ASTM Standard and went on to exemplify the monitoring and reporting guidelines outlined in the Standard.

Results/Lessons Learned:

This presentation will discuss the ASTM Standard from the perspective of one of the real-world projects conceptually used during the document’s development. The presentation will also show how the protocols outlined in the Standard helped facilitate remedial decisions during this pilot study. This project has reported up to a 99% reduction of a legacy contaminant as a result of the cutting-edge MBTs employed prior to the novel EISB injections. This project demonstrates that the strategic combination of traditional site monitoring methods and cutting-edge molecular technologies can provide invaluable information about indigenous microbial activities, maximizing the potential for successful EISB of targeted and recalcitrant COCs. This presentation will outline the unique symbiotic relationship between this first-of-its-kind EISB pilot study and the new ASTM Standard that has filled a critical literature gap.

About The Author

Dr. Eleanor M Jennings Principal Environmental Microbiologist and Forensic Biogeochemist Parsons' Fellow and Subject Matter Expert Dr. Jennings has both a Master's Degree and a PhD in microbiology, with both degrees focused on the biodegradation of contaminants. She then went on to perform post-docs in Geosciences and Chemical Engineering before going into consulting. To date she has over 150 publications and presentations on the topics of environmental microbiology, biogeochemistry, bioremediation, and molecular and stable-isotope monitoring technologies. She has led bioremediation projects

across the US and Canada as well as on multiple continents. She recently completed a 9-year tenure as a National Board Member and National Chairperson for the American Society for Microbiology, and she continues to serve as a US Science Advisor for the Natural Science and Engineering Council (NSERC) of Canada. Finally, Dr. Jennings co-authored the 2022 ASTM Standard published on the use of molecular biological tools during environmental remediation.

