

Michaye L. McMaster
Senior Principal

project delivery
full-scale technology application
technology development/demonstration
bioremediation, bioaugmentation & natural attenuation

EDUCATION

M.Sc., Earth Science (Hydrogeology Option), University of Waterloo, Waterloo, Ontario, Canada, 1996

B.Sc., Biology, University of Waterloo, Waterloo, Ontario, Canada, 1991

CAREER SUMMARY

Ms. McMaster is a Senior Principal Scientist with over 20 years of experience in groundwater remediation. She is currently managing director of Canadian and Australian consulting operations. Ms. McMaster is a member of Geosyntec's Board of Directors (2018-2020) and sits on several committees within Geosyntec. Ms. McMaster is the project director for several large multi-disciplinary teams for the design and implementation of full-scale soil and groundwater remediation projects for multinational clients in North America, Latin America and Australia. Her area of expertise includes source zone remediation of DNAPLs, monitored natural attenuation (MNA) and enhanced in situ bioremediation (EISB) of chlorinated solvents and other recalcitrant compounds. She is a technical lead for complex emerging contaminant investigation for confidential clients. She is the project director for first full-scale applications of innovative technologies for challenging sites, including partitioning electron donors for TCE source treatment and self-sustaining treatment for active remediation (STAR) for coal-tar impacted sites.

Full-Scale Technology Applications

Confidential Client Project Director for detailed site investigation for emerging contaminants in soil and groundwater. Conceptual site model development including fate and transport assessment.

E.I du Pont Nemours Technical Expert for two sites in Brazil. Provide technical support and oversight for in-country consultants for bioremediation and assessing degradation potential for a range of compounds in soil and groundwater.

E.I du Pont Nemours Project Director for a full scale soil and groundwater remediation program is being implemented at a former coal tar manufacturing facility that produced road

tars, phenols, cresol (methyl phenol), and cresylic acid. Detailed site investigation and development of a 3D EVS model allowed for a targeted remediation approach. Soil remedy selected is Self-Sustaining Treatment for Active Remediation (STAR) which is an innovative in situ smoldering method which is cost-competitive to conventional technologies (ISS and excavation). First full-scale field application of STAR. In addition to the soil remediation and design, Geosyntec is completing the long term groundwater remediation strategy for this site. Including, an evaluated and interpreted sustainability of eight different remedial alternatives for this large coal tar contaminated site, using SimaPro, a specialized Life Cycle Assessment software package. This site is under New Jersey's Licensed State Remediation Professional (LSRP) program.

Former Manufacturing Facility, Confidential Client, Los Angeles, CA. This project involved serving as Project Director for a full-scale application of EISB, to treat TCE and 1, 2-DCA in a multi-layer aquifer. Pilot results and comprehensive modeling assessments were used to develop the full scale design for the site. This remedy also includes a natural attenuation component for parts of the site where remediation is sufficient to contain the 1, 2-DCA.

Former Manufacturing Facility, Confidential Client, NJ. In this multi-disciplinary team Ms. McMaster serves as a technical specialist for full-scale applications of remedial options for a large dispersed PCE plume. The operating extraction, treatment and re-injection system is ineffective at controlling vapor intrusion issues. Alternative strategies are being evaluated as well as detailed off-site characterizations to understand site conditions. A pilot test will be completed to evaluate EISB for an isolated hot spot.

Manufacturing Facility, DuPont, Deep Water, NJ. Development and application of a novel remedial options selection tool for ranking remedial alternatives. This project involved the translating of the 14-Compartment Model into a spreadsheet tool to evaluate a complex site for a corrective measures study. This work is being expanded to develop a tool that can be used by the DOD as a web-based evaluation tool for RPMs.

Manufacturing Facility, DuPont, Brazil. In this multi-disciplinary team Ms. McMaster serves as a technical specialist for evaluating the performance success of a full-scale application of EISB to treat a complex plume of chlorinated ethanes. Activities include review, technical oversight and providing guidance to in country consultants and field staff. Additional site characterization is planned to further understand the current site conditions.

Former Industrial Facility, Confidential Client, CA. This project involves developing a combined remedy approach to treat a mixed VOC source zone. Ms. McMaster serves as the Senior Scientist and is responsible for groundwater remediation activities. The

adaptive management strategy will involve sequential application of technologies including enhanced in situ bioremediation and conventional containment. This project involves working with a large multi-group team.

Former Industrial Facility, Confidential Client, CA. Project Manager for an enhanced in situ bioaugmentation. This included using a passive in situ biobarrier (injection of emulsified vegetable oil) to treat TCE and other chlorinated VOCs in several groundwater plumes. The tests were one of the first successful applications of emulsified oil and bioaugmentation. Pre-design evaluations required integration of redevelopment. At one of the plumes a “No Further Remediation” approval was obtained less than three years after amendment of edible oil. The other two sites were expanded to full scale (over more than 17,000 square feet of treatment area) and are currently in progress. These applications were completed in a low permeability layer and effectively demonstrated that the emulsified vegetable oil could be injected and sustained in the area for more than 18 months. This project involved working with a large multi-group team.

Former Industrial Facility, Confidential Client, Greater Los Angeles, CA. Project Manager for an enhanced in situ bioaugmentation using a passive in situ biobarrier (injection of emulsified vegetable oil) to treat TCE in groundwater. An in situ biobarrier was created using subsurface well vaults for access due to site redevelopment. The barrier will be monitored for a three year period. The design allows for repeat applications of electron donor if necessary.

Former Industrial Facility, North Eastern US. Project Scientist for the evaluation of treatment of both hexavalent chromium and chromium ore process residue in soils and groundwater using innovative remedial approaches. Tasks included developing a white paper on speciation and developing remedial designs and treatability tests using biological and chemical treatment approaches.

Aerospace Manufacturing Facility, Ontario, Canada. Project Director for installation and operation of a large EISB (> 100 gpm) recirculation system in fractured bedrock. Including, ongoing site investigation, regulatory and public consultation support. The EISB system aims to limit off-site migration of chlorinated solvents and reduce system operation by promoting source reduction through the application of electron donors in suspected source areas.

Active Manufacturing Facility, Confidential Client, Bulle, Switzerland. Project Scientist for the design and operation of an in situ passive EISB system to treat TCE and associated dechlorination products.

Technology Development/Demonstration

E.I du Pont Nemours Technical Expert for two sites in Brazil. Provide technical support and oversight for in-country consultants for bioremediation and assessing degradation potential for a range of compounds in soil and groundwater.

Confidential Client. Project Manager to conduct extensive laboratory treatability tests to assess threshold minimum degradation for ethylene dibromide and dichloride (anti-knock agents) in residual petroleum hydrocarbon plumes. Research will investigate if there is inhibition of degradation of the anti-knock agents with and without BTEX compounds, electron donors, electron acceptors and bioaugmentation cultures.

Navy Facilities Engineering Service Center (NFESC), Port Hueneme, CA. Project Director for a pilot test to evaluate novel electron donors as a means to enhance the dissolution of DNAPLs by using targeted electron donors tailored to partition into a DNAPL. This pilot test demonstration is funded by ESTCP and is being completed at the NAS North Island, San Diego, CA.

Navy Facilities Engineering Service Center (NFESC), Port Hueneme, CA. Project Manager for a pilot test of in situ bioaugmentation, as a means to enhance the dissolution of a PCE DNAPL. This pilot test demonstration was funded by ESTCP and was being completed at the Dover National Test Site at Dover AFB, DE. The demonstration validated that source areas can be treated with bioaugmentation.

Kelly Air Force Base, Science Applications International Corporation, San Antonio, TX. Project Manager for a pilot test of in situ bioaugmentation of PCE and related degradation products in groundwater. This site was one of the first sites to be bioaugmented with an anaerobic dechlorinating consortium (KB-1).

Groundwater Remediation Demonstration, University of Waterloo, Waterloo, ON, Canada. This project involved serving as Project Manager for a demonstration of innovative passive and semi-passive techniques for groundwater remediation. It evaluated anaerobic-aerobic treatment trains to remove selected chlorinated solvents and petroleum hydrocarbons from groundwater. Funding for this research is from the U.S. Department of Defense to the University of Waterloo through the non-profit Advanced Alternative Treatment Design Facilities (AATDF) of Rice University in Texas.

Bioremediation, Bioaugmentation & Natural Attenuation

Technical Guidance/Review, USGS and AFCEE. The USGS requested review and support for application of bioaugmentation into wetlands and seeps. The AFCEE requested review of technical protocols for application of emulsified oils.

Superfund Site, PRP Group, CT. Project Scientist for a PRP Group to evaluate remedial options at a former solvent recycling facility. Working in a multidisciplinary team to evaluate remedial options with a focus on enhanced bioremediation following DNAPL treatment.

Aerojet Superfund Site, Sacramento, CA. Project Manager for a pilot test of in situ biodegradation (using bioaugmentation) of perchlorate and chlorinated solvents in groundwater and also for a pilot test of in situ biodegradation of perchlorate in recharge water. Project Scientist for a pilot test of cometabolic bioventing of chlorinated solvents in the vadose zone at a former septic waste lagoon. Project Scientist for an investigation of intrinsic bioremediation of 1, 2-dichloroethane and chloroform.

Laboratory Treatability Testing, New Jersey, New Hampshire, Colorado, Florida, Tennessee, and Botany Bay, Australia. Project Scientist for laboratory treatability tests of enhanced bioremediation, ISCO, and microscale/nanoscale zero valent iron of chlorinated solvents (ethenes, methanes, ethanes) in porous media and fractured bedrock groundwater at various industrial sites.

Former Manufacturing Facility, Confidential Client, WV. Project Scientist for a laboratory treatability test of natural and/or enhanced bioremediation of chlorinated solvents (carbon tetrachloride, chloroform, dichloromethane and chloromethane) and other recalcitrant compounds (nitrobenzene, aniline, 2,4-dinitrotoluene, dichlorobenzenes).

PROFESSIONAL EXPERIENCE

Geosyntec Consultants, Guelph, Ontario, 1998 - Present

BEAK International, Guelph, Ontario, 1996 - 1998

University of Waterloo, Research Hydrogeologist, Department of Earth Science, 1995-1996

University of Waterloo, Microbiologist, Department of Earth Science, 1991-1993

AFFILIATIONS

National Groundwater Association (1996 to present)

International Association of Hydrogeologists (2011 to present)

Sustainable Remediation Forum (SURF) – (2011 to present)

SELECTED RECENT PUBLICATIONS/PRESENTATION

- 14-01 Perez-de-Mora, A. A. Zila, M.L. McMaster and E. A. Edwards. 2014. Bioremediation of Chlorinated Ethenes in Fractured Bedrock and Associated Changed in Dechlorinating and Nondechlorinating Microbial Populations. *Environ. Sci. Technol.* 48: 5770-5779
- 14-02 Vanderkooy, M., McMaster, M., Wealthall, G., Vidumsky, J. Sustainability Helps Tip the Balance for Selecting Novel Technologies: A Case Study Selecting STAR for a Coal Tar DNAPL Site. Battelle Ninth International Conference on Remediation of Chlorinated and Recalcitrant Compounds. May 2014. Platform Presentation.
- 14-03 McMaster, M.L. Short Course on Enhanced In Situ Bioremediation. Ekos Brazil. Sao Paulo. October 5 2014.
- 14-04 McMaster, M.L. Short Course on Enhanced In Situ Bioremediation. Ecoforum. Gold Coast. October 24 2014.
- 13-01 Wealthall, G. P., M. Ford, M. McMaster, M. Vanderkooy and J. Vidumsky. Including Probability and Optimization to Enhance Sustainability Evaluations. NICOLE Lisbon, Portugal, 15 June 2013.
- 13-02 Vanderkooy, M., McMaster, M. Evaluating Remediation Sustainability: Does it Matter Which Tool You Choose? Sustainable Remediation Forum Meeting 24. November 2013.
- 13-03 Vanderkooy, M., McMaster, M., Wealthall, G., Vidumsky, J. Generating Meaningful and Easy-To-Interpret Sustainability Data to Support Decision Making: A Method and A Case Study. GeoMontreal 2013, Geoscience for Sustainability. September 2013. Platform Presentation.
- 13-04 Vanderkooy, M., McMaster, M., Wealthall, W., Daprato, R., Bartlett, J. Evaluating Remediation Sustainability: Does it Matter Which Tool You Choose? Battelle Symposium on Bioremediation and Sustainable Environmental Technologies. June 2013. Platform Presentation.
- 13-05 Vanderkooy, M. G. Wealthall, M. McMaster and J. Vidumsky. 2013. Generating Meaningful and Easy to Interpret Sustainability Data to Support Decision

- Making: A Method and A Case Study. GeoMontreal Paper Proceedings September 29 to October 3 2013 Montreal Canada.
- 12-01 Mundle, S. O.C., T. Johnson, G. Lacrampe-Couloume, A. Perez-de-Mora, M. Duhamel, E.A. Edwards, M.L McMaster, E. Cox, K. Revesz, and B. S. Lollar. 2012. Monitoring biodegradation of chlorinated ethenes at a contaminated site using CSIA. *Environ. Sci. Technol.* 46(3): 1731-1738
- 11-01 Capiro, N.L, E.K. Granbery, C. A. Lebron, D. W. Major, M. L. McMaster, M. J. Pound, F. E. Loffler, and K. D. Pennell. Liquid-Liquid Mass Transfer of Partitioning Electron Donors in Chlorinated Solvent Source Zones *Environ. Sci. Technol.*, 2011, 45 (4), pp 1547-1554
- 09-01 Morrill, P.L, B.E. Sleep, D.J. Seepersad, M.L. McMaster, E.D. Hood, C. LeBron, D. W. Major, E. A. Edwards and B. Sherwood Lollar, 2009. Variations in expression of carbon isotope fractionation of chlorinated ethenes during biologically enhanced PCE dissolution close to a source zone. *J. Contam. Hydrology.* 110(1-2):60-71
- 06-01 Sleep, B.E., D.J. Seepersad, K. Mo, C. M. Heidorn, L. Hrapovic, P. Morrill, M. L. McMaster, E. D. Hood, C. LeBron, B. Sherwood Lollar. D. W. Major and E. A. Edwards, 2006, "Biological Enhancement of Tetrachloroethene Dissolution and Associated Microbial Community Changes," *Environ. Sci. Technol.* 40(11):3623-3633
- 05-01 Morrill, P., G. Lacrampe-Couloume, G. F. Slater, B. E. Sleep, E. A. Edwards, M. L. McMaster, D. W. Major, B. Sherwood Lollar (2005), "Quantifying Chlorinated Ethene Degradation during Reductive Dechlorination at Kelly AFB using Stable Carbon Isotopes," *Journal of Contaminant Hydrology.* 76:279-293.
- 04-01 McMaster, M.L., C. LeBron, D. Major, E. Hood and J. Quinn, "Bioremediation of DNAPL Source areas: Summary of Two Field Scale Applications," Invited Speaker. Partners in Environmental Technology Symposium and Workshop. SERDP/ESTCP. Washington, D.C., 30 November- 2 December 2004.
- 09-01 Morrill, P., G., B.E. Sleep, D.J. Seepersad, M. McMaster, E.D. Hood, C. LeBron, D.W. Major, E.A. Edwards, B. Sherwood Lollar (2009), "Variations in Expression of Carbon Isotope Fractionation of Chlorinated Ethenes During Biologically Enhanced PCE Dissolution Close to a Source Zone," *Journal of Contaminant Hydrology.* 110:60-71.
- 04-01 Morrill, P.L., D.J. Seepersad, G. Lacrampe-Couloume, M. Kaiguo, E.A. Edwards, B.E. Sleep, M.L. McMaster, D.W. Major, and B. Sherwood Lollar,

- “Biologically Enhanced Dissolution of Tetrachloroethene: A Stable Carbon Isotope Investigation,” In: A.R. Gavaskar and A.S.C. Chen (Eds.), Remediation of Chlorinated and Recalcitrant Compounds— 2004. Proceedings of the Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 2004. Abstract 2E-16
- 02-01 Major, D. W., M. McMaster, E. Cox, E. A. Edwards, S. Dworatzek, E. E. Hendrickson, M. G. Starr, J. Payne, and L. Buonamici, (2002) “Successful Bioaugmentation to Achieve Complete Dechlorination of Chlorinated Ethenes and Validation through Molecular Monitoring,” Environ. Sci. & Technol. 36(23): 5106-5116.
- 02-02 Devlin, J.F., McMaster, M., Barker, J.F.,(2002) “Hydrogeologic Assessment of In Situ Natural Attenuation in a Controlled Field Experiment,” Water Resources Research 38 (1), 3-1– 3-11.
- 01-01 Devlin, J.F., McMaster, M., Katic, D., Barker, J.F., “Evaluating Natural Attenuation in a Controlled Field Experiment by Mass Balances, Flux Fences and Snapshots: A Comparison of Results,” Papers from the Third International Conference on Groundwater Quality, IAHS, University of Sheffield, UK, June 18– 21 2001.