

## **Mark A. Widdowson, Ph.D., P.E.**

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### **EDUCATION**

Ph.D., Civil Engineering, Auburn University, 1987.  
MS, Water Resources Engineering, University of Kansas, 1984.  
BSCE, Civil Engineering, University of Cincinnati, 1982.

### **PROFESSIONAL EXPERIENCE AND REGISTRATION**

Professor of Civil Engineering, Virginia Tech, 1993-present  
Assistant Department Head, 2009-present  
Program Coordinator, Environmental and Water Resources Engineering Program, 2003-2008  
Professional Engineer Registration, #14257, South Carolina, 1991-present.  
Assistant Professor, Department of Civil Engineering, University of South Carolina, 1988-92.  
Post-Doctoral Fellow/Instructor, Department of Civil Engineering, Auburn University, 1988.  
Graduate Research Assistant, Department of Civil Engineering, Auburn University, 1984-87.  
Graduate Teaching Assistant, Department of Civil Engineering, University of Kansas, 1982-84.  
Engineering Technician, Shaw, Weiss & DeNaples, Consulting Engineers, Dayton, Ohio, 1980-81.  
Undergraduate Research Assistant, Department of Civil Engineering, University of Cincinnati, 1979-80.

### **PROFESSIONAL ACTIVITIES, HONORS AND NOTABLE RECOGNITIONS**

American Society of Civil Engineers  
National Ground Water Association  
Outstanding Civil Engineering Faculty, 1996  
Graduate Summer Fellowship, University of Kansas, 1983

### **PATENTS AND SOFTWARE PUBLISHED**

U.S. Patent (No. 5,293,931) entitled "Modular Multi-Level Sampling Device".  
SEAM3D: A Code for Simulating 3-D Transport and Biodegradation in Groundwater (with Dan W. Waddill), Virginia Polytechnic Institute and State University, 1997.  
NAS: Natural Attenuation Software (with F.H. Chapelle, E. Mendez, J.S. Brauner, C. Casey), Virginia Polytechnic Institute and State University, 2002.

### **RESEARCH AND PROFESSIONAL INTERESTS**

Mathematical modeling and experimental studies of the fate and transport of contaminants in soil, sediments and groundwater, including

- Chlorinated solvents (PCE, TCE, Vinyl chloride); Chlorinated compounds (PCB, perchlorate)
- Petroleum hydrocarbons (Benzene, BTEX, MTBE), Creosote (PAH compounds)

Groundwater resource development and management

Natural attenuation and engineered remediation of contaminants in groundwater and soil, including:

- Phytoremediation, bioremediation
- Computational modeling
- Laboratory and field studies

Software development (computational models and interface tools) for modeling contaminant fate and transport in groundwater systems, surface-groundwater interface, and river/streambed sediments.

## RESEARCH AND SCHOLARLY PUBLICATIONS

### *Papers in refereed journals:*

- Parker, J.C., Kim, E., Widdowson, M., Kitanidis P., and Gentry, P. "Effects of model formulation and calibration data on uncertainty in predictions of DNAPL source dissolution rate", *Water Resources Research* 46, W12517, doi:10.1029/2010WR009361, 2010
- Chaplin, B.P., Schnobrich, M.R., Widdowson, M.A., Semmens, M.J., and Novak, P.J. "Stimulating in situ hydrogenotrophic denitrification with membrane-delivered hydrogen under passive and pumped groundwater conditions", *ASCE Journal of Environmental Engineering* 135(8), 666-676, 2009.
- Rectanus, H.V., M. Widdowson, F. Chapelle, C. Kelly, and J. Novak. "Investigation of reductive dechlorination supported by natural organic carbon", *Ground Water Monitoring and Remediation*, 27(4), 53-62, 2007.
- Marr, L.C., E.C. Booth, R.G. Andersen, M.A. Widdowson and J.T. Novak. "Direct volatilization of naphthalene to the atmosphere at a phytoremediation site". *Environmental Science & Technology*, 40(17), 5560-5566, 2006.
- Pitterle, M., R. Andersen, J. Novak and M. Widdowson. "Push-pull tests to quantify in-situ degradation rates at a phytoremediation site", *Environmental Science and Technology*, 39(23), 9317-9323, 2005.
- Widdowson, M.A., S. Shearer, R. Andersen, J.T. Novak. "Remediation of polycyclic aromatic hydrocarbon compounds in groundwater using poplar trees", *Environmental Science and Technology*, 39(6), 1598-1605, 2004.
- Widdowson, M.A. "Modeling natural attenuation of chlorinated ethenes under spatially-varying redox conditions". *Biodegradation*, 15, 435-451, 2004.
- Zoeckler, J.R., M.A. Widdowson and J.T. Novak. "Aerobic biodegradation of MTBE in gasoline-contaminated aquifer sediments". *ASCE Journal of Environmental Engineering*, 129(7), 642-650, 2003.
- Robinson, S.L., J.T. Novak, M.A. Widdowson, S.B. Crosswell, and G.J. Fetterolf. "Field and laboratory evaluation of the impact of tall fescue on PAH degradation in an aged creosote-contaminated surface soil". *ASCE Journal of Environmental Engineering*, 129(3), 232-240, 2003.
- Brauner, J.S., M.A. Widdowson, J.T. Novak, and N.G. Love. "Biodegradation of a PAH Mixture by Native Subsurface Microbiota". *Bioremediation Journal*, 6(1), 9-24, 2002.
- Killingstad, M.W., M.A. Widdowson, and R.L. Smith. "Modeling enhanced *in situ* denitrification in ground water". *ASCE Journal of Environmental Engineering*, 128(6), 491-504, 2002.
- Brauner, J.S. and M.A. Widdowson. "Numerical simulation of a natural attenuation experiment with a petroleum hydrocarbon NAPL source". *Ground Water*, 39(6), 939-952, 2001.
- Filz, G.M., M.A. Widdowson, and J.C. Little. "Barrier-controlled monitored natural attenuation". *Environmental Science and Technology*, 35(15), 3225-3230, 2001.
- Smith, R.L., D.N. Miller, M.H. Brooks, M.A. Widdowson, and M.W. Killingstad. "In situ stimulation of groundwater denitrification with formate to remediate nitrate contamination". *Environmental Science and Technology*, 35(1), 196-203, 2001.
- Kirtland, B.C., C.M. Aelion, and M.A. Widdowson. "Pilot testing of air sparging/soil vapor extraction and bioremediation at a petroleum-contaminated site in the Piedmont region". *ASCE Journal of Environmental Engineering*, 127(2), 134-144, 2001.
- Waddill, D.W. and M.A. Widdowson. "A three-dimensional model for subsurface transport and biodegradation", *ASCE Journal of Environmental Engineering*, 124(4), 336-344, 1998.
- Scaturro, D.M. and M.A. Widdowson. "Experimental evaluation of a drive-point groundwater sampler for hydraulic conductivity measurement", *Ground Water*, vol. 35(4), 713-720, 1997.
- Widdowson, M.A., O. Haney, H.W. Reeves, C.M. Aelion, and R.P. Ray. "Multilevel soil-vapor extraction test for heterogeneous soil", *ASCE Journal of Environmental Engineering*, vol. 123(2), 160-168, 1997.

- Aelion, C.M., J.N. Shaw, R.P. Ray, M.A. Widdowson, H.W. Reeves. "Simplified methods for monitoring petroleum-contaminated ground water and soil vapor", *Journal of Soil Contamination*. vol. 5(3), 225-241, 1996.
- Widdowson, M.A., C.K. Suddeth, and D.M. Scaturro. "Cost-effective contaminant plume delineation using multi-level drive point samplers", *Remediation*, vol. 4(1), 59-76, Winter 1993/94.
- Melville, J.G., F.J. Molz, O. Guven and M.A. Widdowson. "Multi-level slug testing with comparison to tracer test data", *Ground Water*, vol. 29(6), 897-907, 1991.
- Widdowson, M.A., F.J. Molz and J.G. Melville. "An analysis technique for multi-level and partially penetrating slug test data", *Ground Water*, vol. 28(6), 937-945, 1990.
- Widdowson, M.A., F.J. Molz and L.D. Benefield. "A numerical transport model for oxygen- and nitrate-based respiration linked to substrate and nutrient availability in porous media", *Water Resources Research*, 24(9), 1553-1565, 1988.
- Molz, F.J. and M.A. Widdowson. "Internal inconsistencies in dispersion-dominated models that incorporate chemical and microbial kinetics", *Water Resources Research*, 24(4), 615-619, 1988.
- Molz, F.J., M.A. Widdowson and L.D. Benefield. "Simulation of microbial growth dynamics coupled to nutrient and oxygen transport in porous media", *Water Resources Research*, 22(8), 1207-1216, 1986.

#### *Peer-Reviewed Published Reports*

- Widdowson, M., Chapelle, F., Casey, C. and Kram, M.A. "Estimating cleanup times associated with combining source-area remediation with monitored natural attenuation", NAVFAC Technical Report TR-2288-ENV, February 2008.
- Chapelle, F.H., J.T. Novak, J.C. Parker, B.B. Campbell and M.A. Widdowson. "A framework for assessing the sustainability of monitored natural attenuation", U.S. Geological Survey Circular 1303, Feb. 2007.
- Chapelle, F.H., M.A. Widdowson, J.S. Brauner, E. Mendez\*, and C.C. Casey. "Methodology for estimating times of remediation associated with monitored natural attenuation", USGS Water Resource Investigation Report 03-4057, 51 pp., 2004.
- Dortch, M.S., C.J. McGrath, J.J. Nitao, M.A. Widdowson, and S. Yabusaki. "Development of simulators for in situ remediation evaluation, design, and operation: final report", ERDC/EL TR-01-33, U.S. Army Engineer Research and Development Center, Vicksburg, MS, 75 pp., 2001
- Waddill, D.W. and M.A. Widdowson. "SEAM3D: A numerical model for three-dimensional solute transport and sequential electron acceptor-based bioremediation in groundwater", ERDC/EL TR-00-X, U.S. Army Engineer Research and Development Center, Vicksburg, MS, 89 pp., 2000

#### *Book chapters*

- Harvey, R.W. and M.A. Widdowson. "Microbial distributions, activities and movement in the terrestrial subsurface: Experimental and theoretical studies", in *Advances in Soil Science*, R.J. Wagenet, P. Baveye and B.A. Stewart (eds.), Lewis Publishers, Boca Raton, FL, 185-225, 1992.

#### *Papers in refereed conference proceedings:*

- Rectanus, H.V., M.A. Widdowson, J.T. Novak, and F.H. Chapelle. 2005. "Method development for quantifying potential bioavailable organic carbon in sediments", *Proceedings of the Third European Bioremediation Conference*, Chania, Crete, Greece, July 4-7, 2005.
- Mendez, E., M. Widdowson, S. Brauner, F. Chapelle and C. Casey. "Natural Attenuation Software (NAS): A computer program for estimating remediation times of contaminated groundwater", In: G. Latini, G. Passerini, and C. Brebbia (eds.), *Development and Application of Computer Techniques to Environmental Studies X (ENVIROSOFT 2004)*, Proceedings of Envirosoft 2004 – The Tenth International Conference on Development and Application of Computer Techniques to Environmental Studies, Ancona, Italy, June 2-4, 2004.

- Widdowson, M.A., F.H. Chapelle, and J.S. Brauner. "Analytical method for optimizing monitored natural attenuation in contaminated aquifers", ASCE World Water and Environmental Resources Congress, Philadelphia, PA, June 23-26, 2003.
- Cooney, M.F., Widdowson, M.A., and M. Schreiber. "Effects of solubility-enhancing agent on reductive dechlorination", Paper A-11. Seventh International Symposium on In Situ and On-Site Bioremediation, Orlando, FL, June 2-5, 2003.
- Waddill, D.W., C.C. Casey and M.A. Widdowson. "Modeling vegetable oil injection for enhanced biodegradation of chlorinated solvents", In A.R. Gavaskar and A.S.C. Chen (eds.), Remediation of Chlorinated and Recalcitrant Compounds – 2002, Paper 1A-08. Proceedings of the Third International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 20-23, 2002.
- Robinson, S.L., Novak, J.T., Widdowson, M.A., and M. Elliot. "Microbial degradation of PAHs under various redox conditions at a creosote contaminated site", In: A. Leeson, E.A. Foote, M.K. Banks, and V.S. Magar (Eds.), *Natural Attenuation of Environmental Contaminants*, Sixth International Symposium on In Situ and On-Site Bioremediation, San Diego, CA, June 4-7, 6(5), 1-8, 2001.
- Widdowson, M.A., H.V. Rectanus, J.T. Novak and D.F. Berry. "Integrated assessment of monitored natural attenuation at a PCE contaminated site", In: A. Leeson, M.E. Kelley, H.S. Rifai, and V.S. Magar (Eds.), *Natural Attenuation of Environmental Contaminants*, Sixth International Symposium on In Situ and On-Site Bioremediation, San Diego, CA, June 4-7, 6(2), 105-112, 2001.
- Widdowson, M.A., D.W. Waddill, and C.E. Ruiz. "SEAM3D: A numerical model for three-dimensional solute transport and sequential electron acceptor-based bioremediation in groundwater." In A.N. Findikakis and F. Stauffer (eds.), *Proceedings of Groundwater: An Endangered Resources*, ASCE, New York, NY, 83-88, 1997. 27th Congress of the International Association of Hydraulic Research, San Francisco, CA, August 11-15, 1997.
- Brauner, J.S. and M.A. Widdowson. "Sequential electron acceptor model for evaluation of in situ bioremediation of petroleum hydrocarbon contaminants in groundwater." In *Annals of the New York Academy of Sciences*, vol. 829, 399-419, 1997. Engineering Foundation Conference on Bioremediation, Palm Coast, FL, January 21-26, 1996.
- Waddill, D.W., M.A. Widdowson and J.S. Brauner. "SEAM2D: A numerical model for two-dimensional solute transport and sequential electron acceptor-based bioremediation of LNAPL-contaminated aquifers." In L.N. Reddi (ed.), *Proceedings of the ASCE Conference*, ASCE, New York, NY, 466-477, 1996. ASCE Environmental Engineering Division Conference on Non-Aqueous Phase Liquids (NAPLs) in the Subsurface Environment: Assessment and Remediation, Washington, DC, November 21-25, 1996.
- Widdowson, M.A., C. M. Aelion, R. P. Ray, and H. W. Reeves. "Soil vapor extraction pilot study at a piedmont UST site." In R. E. Hinchee, R. N. Miller, and P. C. Johnson (eds.), *In Situ Aeration: Air Sparging, Bioventing, and Related Remediation Processes*, Battelle Press, Columbus, OH, 3(2), 455-461, 1995. The Third International In Situ and On-Site Bioreclamation Symposium, San Diego, CA, April 24 - 27, 1995.
- Aelion, C. M., M. A. Widdowson, R. P. Ray, H. W. Reeves, and J. N. Shaw. "Soil vapor and off-gas monitoring during soil venting and air sparging." In R. E. Hinchee, R. N. Miller, and P. C. Johnson (eds.), *In Situ Aeration: Air Sparging, Bioventing, and Related Remediation Processes*, Battelle Press, Columbus, OH, 3(2), 127-134, 1995. The Third International In Situ and On-Site Bioreclamation Symposium, San Diego, CA, April 24 - 27, 1995.
- Widdowson, M. A., R. P. Ray, H. W. Reeves, and C. M. Aelion. "Integrated site characterization for soil vapor extraction design." In Y. B. Acar and D. E. Daniel (eds.), *Proceedings of The Geoenvironment 2000*, ASCE, Vol. 2, pp. 1291-1305, 1995. The Geoenvironment 2000 Specialty Conference, New Orleans, LA, February 23 - 25, 1995.
- Widdowson, M.A., R.P. Ray, H.W. Reeves, C.M. Aelion, and K.W. Holbrooks. "Investigation of soil venting-based remediation at a UST site in the Appalachian Piedmont", in *Bioremediation of Pollutants in*

Soil and Water, Brian S. Schepart (ed.), ASTM STP 1235, 135-148, 1994. Symposium on Bioremediation of Pollutants in Soil and Water, Ft. Worth, TX, Oct. 20-22, 1993.

Widdowson, M.A. and C.M. Aelion. "Application of a numerical model to the performance and analysis of an in situ bioremediation project", in R.E. Hinchee and R.F. Olfenbuttel (eds.), *In Situ Bioremediation: Application and Investigations for Hydrocarbon and Contaminated Site Remediation*, Butterworth-Heinemann, Boston, 227-244, 1991. The First International In Situ and On-Site Bioremediation Symposium, San Diego, CA, March 24 - 26, 1993.

Widdowson, M.A. and F.J. Molz. "Solution technique for a coupled system of equations describing advection-dominated Transport and biotransformations in the subsurface", in *Computational Mechanics*, S.N. Alturi and G. Yagawa (eds.), vol. 2, 58iv(1-4), 1988.

#### *Recent Papers Presented at Professional Meetings*

King, L. M., Widdowson, E. Mendez, R. Barton, J. Novak, F. Chapelle, J. Parker, M. Singletary and C. Lebron. "Bioavailable Organic Carbon and the Natural Attenuation of Chlorinated Solvents", Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2010.

Stewart, L., M. Widdowson, J. Nyman, R. Deeb, M. Kavanaugh, and J. Mercer. "Field Characterization of Mass Transfer at a NAPL Source Zone", Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2010.

Widdowson, M., M. Mobile, L. Stewart, J. Nyman, R. Deeb, M. Kavanaugh, and J. Mercer. "Modeling Plume Longevity Following Partial NAPL Source Remediation", Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2010.

Pruden, A. and M. Widdowson. 1053221 RAPID Response Research for the Gulf of Mexico Oil Spill: "Effect of Petroleum Deposit Geometry on Biodegradation Potential and Long-Term Persistence", JSOST Deepwater Horizon Oil Spill Principal Investigator (PI) Conference, St. Petersburg, FL, October 5-6, 2010.

Widdowson, M. and A. Pruden. "Effect of Petroleum Deposit Geometry on Biodegradation Potential and Long-Term Persistence", Gulf Oil Spill Conference, New Orleans, LA, November 1-2, 2010.

Lebron, C., F. Chapelle, J. Parker, M. Widdowson, and J. Novak. "Verification of Methods for Assessing the Sustainability of Monitored Natural Attenuation (MNA)", Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, November 30-December 2, 2010.

Nyman, J., M. Kavanaugh, R. Deeb, L. Stewart, M. Widdowson, and J. Mercer. "Improved Field Evaluation of NAPL Dissolution and Source Longevity", Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, November 30-December 2, 2010.

Parker, J., P. Kitanidis, X. Liu, M. Cardiff, U. Kim, and M. Widdowson. DNAPL Source Strength vs. Time – Model Formulation, Calibration and Uncertainty", Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, December 1-3, 2009.

Widdowson, M.A. "Predicting Remedial Time Frames – Models and Approaches" for publication in *Proceedings*, Monitored Natural Attenuation of Polycyclic Aromatic Hydrocarbons at Manufactured Gas Plant Sites, USEPA workshop, Irving, Texas, May 27-29, 2009 (invited).

Widdowson, M., H. Rectanus, and P. Taucher. "Natural attenuation of benzene in a coal seam aquifer", Ninth International *In Situ and On-Site Bioremediation* Symposium, Baltimore, MD, May 7-10, 2007.

Rectanus, H.V., M. Widdowson, J. Novak, and F. Chapelle. "Application of potentially bioavailable organic carbon at chlorinated solvent sites", Ninth International *In Situ and On-Site Bioremediation* Symposium, Baltimore, MD, May 7-10, 2007.

- Widdowson, M. "Natural Attenuation Software (NAS): A system for assessing combining source zone remediation with monitored natural attenuation", Federal Remediation Technologies Roundtable meeting, Arlington, VA, May 2, 2007 (invited).
- Widdowson, M., C. Quezada, and E. Mendez. "Time estimates for reaching compliance using source remediation combined with monitored natural attenuation", Annual Meeting and Exposition of the Geological Society of America, Philadelphia, PA, October 22-25, 2006.
- Widdowson, M. and E. Mendez. "Time of remediation estimates at a NAPL-contaminated fractured-rock site", Annual Meeting and Exposition of the Geological Society of America, Philadelphia, PA, October 22-25, 2006 (invited).
- Chapelle, F.H., B.G. Campbell, and M.A. Widdowson. "Assessing the long-term sustainability of monitored natural attenuation", Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 22-26, 2006.
- Rectanus, H.V., M. Widdowson, J. Novak, and F. Chapelle. "Evaluation of potentially bioavailable organic carbon at chlorinated solvent sites", Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 22-26, 2006.
- Widdowson, M., F. Chapelle, C. Casey, and M. Kram. "Estimating cleanup times associated with combining source area remediation with monitored natural attenuation", Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 22-26, 2006.
- Chapelle, F.H., B.G. Campbell, M.A. Widdowson, B.B. Looney, T.H. Weidemeier, and C.H. Sink. "A deterministic approach to assessing monitored and enhanced natural attenuation", In B. Sass (ed.), *Remediation of Chlorinated and Recalcitrant Compounds – 2006*, Paper G-53. Proceedings of the Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May, 2006.
- Widdowson, M., F. Chapelle, M. Kram, and C. Casey. "Estimating cleanup times associated with combining source area remediation with MNA", Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, November 29 - December 1, 2005.
- Widdowson, M., Q. Abdelal, and F. Chapelle. "Sustainability of reductive dechlorination at Type 2 chlorinated solvent sites", Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, November 29 - December 1, 2005.
- Mendez, E., M. Widdowson, F. Chapelle and C. Casey. "Natural Attenuation Software (NAS): Assessing remedial strategies and estimating timeframes", Eighth International *In Situ and On-Site Bioremediation* Symposium, Baltimore, MD, June 6-9, 2005.
- Rectanus, H., M. Widdowson, J. Novak, and F. Chapelle. "A method for quantifying bioavailable organic carbon in aquifer sediments", Eighth International *In Situ and On-Site Bioremediation* Symposium, Baltimore, MD, June 6-9, 2005.
- Widdowson, M.A. "Practical Use of Models to Assess Technical Impracticability and Monitored Natural Attenuation", National Ground Water Association Theis Conference – Environmental Decision Making: Restoration Versus Risk Reduction, Sedona, AZ, January 14-17, 2005 (invited).
- Widdowson, M., Q. Abdelal, and F. Chapelle. "Parameter estimation and calibration for modeling the fate and transport of chlorinated ethenes using SEAM3D and PEST", Partners in Environmental Technology Technical Symposium & Workshop, Washington, DC, November 30 - December 2, 2004.
- Novak, J.T. and M.A. Widdowson. "Incorporating natural attenuation into design and management strategies for contaminated sites", Annual Meeting of the Midwest Hazardous Substance Research Center, Purdue University, IN, August 5, 2004.
- Widdowson, M., Q. Abdelal, F. Chapelle and P. Sechrist. "Relative contribution of direct oxidation to attenuation of chlorinated ethenes in groundwater", In A.R. Gavaskar and A.S.C. Chen (eds.), *Remediation of Chlorinated and Recalcitrant Compounds – 2004*, Paper 3E-14. Proceedings of the Fourth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2004.

- Pitterle, M., M. Widdowson, J. Novak and R. Andersen. "Field tests to quantify creosote phytoremediation rate", In A.R. Gavaskar and A.S.C. Chen (eds.), Remediation of Chlorinated and Recalcitrant Compounds – 2004, Paper 4E-10. Proceedings of the Fourth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2004.
- Roller, J., Schreiber, M., Tadanier, C., Widdowson, M., and Johnson, J. "Arsenic Release Due to Dissimilatory Reduction of Iron Oxides in Petroleum-Contaminated Aquifers", Geological Society of America, Seattle, WA, November 2-5, 2003.
- Roller, J., Schreiber, M., Tadanier, C., Widdowson, M., and Johnson, J. "Arsenic Release Due to Dissimilatory Reduction of Iron Oxides in Petroleum-Contaminated Aquifers", Virginia Water Research Symposium, Blacksburg, VA, October 7-10, 2003.
- Novak, J.T. and M.A. Widdowson. "Incorporating natural attenuation into design and management strategies for contaminated sites", The U.S. Environmental Protection Agency/Hazardous Substance Research Center Meeting on Superfund Research, Cincinnati, OH, August 26-27, 2003.
- Chapelle, F.H., P.M. Bradley, C.C. Casey and M.A. Widdowson. "Contraction of a chlorinated ethene plume following source treatment", Seventh International Symposium on In Situ and On-Site Bioremediation, Orlando, FL, June 2-5, 2003.
- Widdowson, M.A. "Modeling natural attenuation of chlorinated ethenes under spatially-varying redox conditions", Seventh International Symposium on In Situ and On-Site Bioremediation, Orlando, FL, June 2-5, 2003.
- Widdowson, M.A., N. Anderson, J.F. Landmeyer, and D.W. Waddill. "Long-term validation of a model for natural attenuation in a gasoline-contaminated site", Seventh International Symposium on In Situ and On-Site Bioremediation, Orlando, FL, June 2-5, 2003.
- Novak, J.T. and M.A. Widdowson. "Incorporating natural attenuation into design and management strategies for contaminated sites", Annual Meeting of the Midwest Hazardous Substance Research Center, Kansas City, MO, May 13, 2003.
- Chapelle, F.H., M.A. Widdowson, E. Mendez, and C.C. Casey. "Estimating times of remediation associated with natural attenuation", Remediation Innovative Technology Seminar (RITS), NAVFAC Pacific Division, Waipahu, HI, May 6, 2003.
- Chapelle, F.H., M.A. Widdowson, E. Mendez, and C.C. Casey. "Estimating times of remediation associated with natural attenuation", Remediation Innovative Technology Seminar (RITS), NAVFAC EFA Chesapeake, Arlington, VA, May 1, 2003.
- Chapelle, F.H., M.A. Widdowson, E. Mendez, and C.C. Casey. "Estimating times of remediation associated with natural attenuation", Remediation Innovative Technology Seminar (RITS), NAVFAC Southern Division, Charleston, SC, April 29, 2003.
- Chapelle, F.H., M.A. Widdowson, E. Mendez, and C.C. Casey. "Estimating times of remediation associated with natural attenuation", Remediation Innovative Technology Seminar (RITS), NAVFAC EFA Northeast, Polusbo, WA, April 24, 2003.
- Chapelle, F.H., M.A. Widdowson, E. Mendez, and C.C. Casey. "Estimating times of remediation associated with natural attenuation", Remediation Innovative Technology Seminar (RITS), NAVFAC Southwest Division, San Diego, CA, April 22, 2003.
- Chapelle, F.H., M.A. Widdowson, E. Mendez, and C.C. Casey. "Estimating times of remediation associated with natural attenuation", Remediation Innovative Technology Seminar (RITS), NAVFAC Atlantic Division, Norfolk, VA, April 3, 2003.
- Chapelle, F.H., M.A. Widdowson, E. Mendez, and C.C. Casey. "Estimating times of remediation associated with natural attenuation", Remediation Innovative Technology Seminar (RITS), NAVFAC EFA Northeast, Philadelphia, PA, April 1, 2003.

- Novak, J.T. and M.A. Widdowson. "Characterization of degradation mechanisms for PAH compounds by poplar trees", Third International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 20-23, 2002.
- Filz, G.M., M.A. Widdowson, and J.C. Little. "Barrier-controlled monitored natural attenuation", Third International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 20-23, 2002.
- Novak, J.T. and M.A. Widdowson. "Incorporating natural attenuation into design and management strategies for contaminated sites", Annual Meeting of the Midwest Hazardous Substance Research Center, Purdue University, IN, May 14-15, 2001.
- Widdowson, M.A., J.T. Novak, M. Elliott, S. Robinson, M.S. Lawrence and E.M. Panhorst. "Phytoremediation of a creosote-contaminated cross tie treatment facility using poplar trees", Railroad Environmental Conference, Urbana-Champaign, IL, September 26-27, 2001.
- Novak, J.T., S. Robinson, S. Crosswell, G. Fetterolf and M.A. Widdowson. "Accelerated Degradation of creosote compounds in surface soils by grasses", Railroad Environmental Conference, Urbana-Champaign, IL, September 26-27, 2001.
- Widdowson, M.A., J.R. Zoekler, and J.T. Novak, "Intrinsic aerobic biodegradation of MTBE in gasoline-contaminated aquifer sediments", First International Congress on Petroleum Contaminated Soil, Sediments and Water, London, England, August 14-17, 2001.
- Widdowson, M.A., F.H. Chapelle, H.V. Rectanus, and J.S. Brauner, "Relationship between NAPL mass and remediation time using monitored natural attenuation", First International Congress on Petroleum Contaminated Soil, Sediments and Water, London, England, August 14-17, 2001.
- Widdowson, M.A., J.S. Brauner, J.S. and F.H. Chapelle. "A decision-making tool for assessing monitored natural attenuation and estimating cleanup times", Sixth International Symposium on In Situ and On-Site Bioremediation, San Diego, CA, June 4-7, 2001.
- Chapelle, F.H., Widdowson M.A., and Casey, C.C. "Estimating cleanup times associated with monitored natural attenuation", Sixth International Symposium on In Situ and On-Site Bioremediation, San Diego, CA, June 4-7, 2001.
- Chapelle, F.H., Widdowson M.A., and Casey, C.C. "Estimating cleanup times associated with monitored natural attenuation", Spring Meeting - American Geophysical Union, Boston, MA, May 29-June 1, 2001.
- Widdowson M.A., "Validation of the SEAM3D Reductive Dechlorination Package at a TCE-contaminated facility", Partners in Environmental Technology Technical Symposium & Workshop, Arlington, VA, November 28-30, 2000.
- Widdowson, M.A., J.T. Novak, D.F. Berry, H.V. Rectanus, and F.Y. Wang. "Spatial variation of reductive dechlorination in a PCE-contaminated aquifer", Second International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 22-25, 2000.
- Novak, J.T. M.A. Widdowson, M. Elliott, and S. Robinson. "Phytoremediation of a creosote contaminated site - A field study", In: G.B. Wickramanayake, A.R. Gavaskar, B.C. Alleman, and V.S. Magar (Eds.), *Bioremediation and Phytoremediation of Chlorinated and Recalcitrant Compounds*, C2-4:493-500. Battelle Press: Columbus, OH. Second International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 22-25, 2000.
- Widdowson M.A., Novak, J.T., Berry, D.F., MacEwen, S.J., Dronfield, D.G., Errett, A.H., and Lade, N.A., "Investigation of intrinsic bioremediation at NAB Little Creek, Site 12: I. Hydrogeochemical Assessment", International Symposium on Subsurface Microbiology, Vail, CO, August 18-22, 1999.
- Berry, D.F., Higgins, M.J., Rectanus, H., Widdowson M.A., and Novak, J.T., "Investigation of intrinsic bioremediation at NAB Little Creek, Site 12: II. Microbiological Assessment", International Symposium on Subsurface Microbiology, Vail, CO, August 18-22, 1999.
- Brauner, J.S., M.A. Widdowson, J.T. Novak, and N.G. Love. "Intrinsic bioremediation of PAH compounds at a fuel-contaminated site", Fifth International Symposium on In Situ and On-Site Bioremediation, San Diego, CA, April 19-22, 1999, 5(6), 45-50, 1999.

- Brauner, J.S. and M.A. Widdowson. "Interpreting natural attenuation of petroleum hydrocarbons in a heterogeneous aquifer using SEAM3D", Fifth International Symposium on In Situ and On-Site Bioremediation, San Diego, CA, April 19-22, 1999.
- Fetterolf, G.J, J.T. Novak, S.B. Crosswell, and M.A. Widdowson. "Phytoremediation of creosote-contaminated surface soil", Fifth International Symposium on In Situ and On-Site Bioremediation, San Diego, CA, April 19-22, 1999, 5(8), 19-24, 1999.
- Widdowson, M.A., D.W. Waddill, and N.A. Lade. "Development and application of a sequential electron-accepting model (SEAM3D) for the transport and biodegradation of petroleum hydrocarbon compounds", U.S. Geological Survey Toxic Waste Program Technical Meeting, Charleston, SC, March 7-11. 1999. (Invited)
- Widdowson, M.A. and D.W. Waddill. "Modeling intrinsic bioremediation of chlorinated solvents in groundwater", First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 18-21, 1998.
- Widdowson, M.A. "Modeling intrinsic bioremediation in groundwater", National Ground Water Association National Convention, AGWSE Technical Program "Biological Aspects of Ground Water", Las Vegas, NV, September 4-6, 1997 (Invited).
- Widdowson, M.A., D.W. Waddill, C.E. Ruiz. "SEAM3D: A numerical model for three-dimensional solute transport and sequential electron acceptor-based bioremediation in groundwater", *XXVIIIth International Association of Hydraulic Research Congress*, San Francisco, CA, August 11-15, 1997.
- Killingstad, M.W., M.A. Widdowson, and R.L. Smith. "Two-dimensional numerical modeling of enhanced in situ denitrification", Spring Meeting, American Geophysical Union, Baltimore, MD, May 27-30, 1997.
- Widdowson, M.A., J.S. Brauner, and D.W. Waddill. "Sequential electron acceptor modeling for the assessment of intrinsic bioremediation", Fourth International Symposium on In Situ and On-Site Bioreclamation, New Orleans, LA, April 28-May 1, 1997.
- Waddill, D.W. and M.A. Widdowson. "3-D model for aerobic and sequential anaerobic biodegradation of groundwater contaminants", Fourth International Symposium on In Situ and On-Site Bioreclamation, New Orleans, LA, April 28-May 1, 1997.
- Waddill, D.W., M.A. Widdowson and J.S. Brauner. "SEAM2D: A numerical model for two-dimensional solute transport and sequential electron acceptor-based bioremediation of LNAPL-contaminated aquifers", ASCE Environmental Engineering Division Conference on Non-Aqueous Phase Liquids (NAPLs) in the Subsurface Environment: Assessment and Remediation, Washington, DC, November 21-25, 1996.
- Widdowson, M.A. "Intrinsic remediation", ASCE Virginia Section Annual Meeting, Roanoke, VA, September 20, 1996. (Invited)
- Widdowson, M.A., J.S. Brauner, and D.W. Waddill. "Numerical modeling of sequential electron acceptor-based biodegradation of solutes in groundwater", European Geophysical Society XXI General Assembly, The Hague, Netherlands, May 6-10, 1996.
- Brauner, J.S. and M.A. Widdowson. "Sequential electron acceptor model for evaluation of in situ bioremediation of petroleum hydrocarbon contaminants in groundwater." In *Annals of the New York Academy of Sciences*, vol. 829, 399-419, 1997. *Engineering Foundation Conference on Bioremediation*, Palm Coast, FL, January 21-26, 1996.
- Widdowson, M.A. and W.E. Orne. "A multi-level groundwater sampling device", Ninth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Association of Ground Water Scientists and Engineers, Las Vegas, NV, May 2-4, 1995.
- Widdowson, M.A., C. M. Aelion, R. P. Ray, and H. W. Reeves. "Soil vapor extraction pilot study at a Piedmont UST site", Third International Symposium on In Situ and On-Site Bioreclamation, San Diego, CA, April 24 - 28, 1995.

- Aelion, C. M., M. A. Widdowson, R. P. Ray, H. W. Reeves, and J. N. Shaw. "Soil vapor and off-gas monitoring during soil venting and air sparging", Third International Symposium on In Situ and On-Site Bioreclamation, San Diego, CA, April 24 - 28, 1995.
- Widdowson, M. A., R. P. Ray, H. W. Reeves, and C. M. Aelion. "Integrated site characterization for soil vapor extraction design", Geoenvironment 2000 Specialty Conference, ASCE, New Orleans, LA, February 23 - 25, 1995.
- Aelion, C.M., M.A. Widdowson, R.P. Ray, and H.W. Reeves. "In situ air sparging and bioremediation in a saprolitic aquifer contaminated with gasoline", I&EC Special Symposium, American Chemical Society, September, 27-29, 1994.
- Widdowson, M.A. and S. Dufrense. "Numerical simulation of in situ bioremediation of BTEX with nitrate as an electron acceptor", Spring Meeting, American Geophysical Union, Baltimore, MD, May 23-27, 1994.
- Widdowson, M.A. and D.M. Scaturro. "Experimental evaluation of a multi-level drive point sampler for quantifying hydraulic conductivity", Spring Meeting, American Geophysical Union, Baltimore, MD, May 24-28, 1993.
- Ray, R.P., M.A. Widdowson, H.W. Reeves and C.M. Aelion. "Soil sampling and laboratory testing for SVE/sparging in Piedmont soils: Measurement of spatial variation and field confirmation", Spring Meeting, AGU, May 24-28, 1993.
- Widdowson, M.A. "Modeling and field experiments to determine mixing and hydraulic control at an *in situ* bioremediation project", Second International Symposium on In Situ and On-Site Bioreclamation, Battelle /EPA, San Diego, CA, April 5-8, 1993.
- Widdowson, M.A., D.M. Scaturro, L.M. Blakley and R.L. Nichols. "Evaluation of field data and procedures for hydraulic conductivity analysis using multi-level sampling rigs", Spring Meeting, American Geophysical Union, Montreal, Canada, May 11-16, 1992.
- Widdowson, M.A., W.H. Orne, D.M. Scaturro and R.L. Nichols. "Development of a computer-controlled data acquisition system for multi-level groundwater sampling at an aquifer tracer test", Spring Meeting, American Geophysical Union, Montreal, Canada, May 11-16, 1992.
- Widdowson, M.A. "Technical challenges to groundwater remediation", Conference on Environmental Law, Greenville, SC, Columbia, SC, and Charleston, SC. April 8-10, 1992, respectively. (Invited)
- Widdowson, M.A., R.L. Nichols and L.M. Blakley. "Application of tracer tests in groundwater remediation design", Hydraulics Division, American Society of Civil Engineers, Nashville, TN, July 29-August 2, 1991.
- Widdowson, M.A., M.E. Meadows, J.R. Dickerson, P. Talwani, M. Schaeffer and W.E. Orne\*. "Hydrologic impact of reservoir filling on a fractured crystalline-rock aquifer", Irrigation and Drainage Division, ASCE, Honolulu, HI, August 11-15, 1991.
- Talwani, P., M. Salvador, G. Randall and M. Widdowson. "Induced seismicity studies at Bad Creek Project, South Carolina Phase 2 - the impoundment stage", Spring Meeting, American Geophysical Union, May 28-31, 1991.
- Dickerson, J.R., M.A. Widdowson and M.E. Meadows. "Low cost multi-purpose data acquisition", Fifth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Association of Ground Water Scientists and Engineers, Las Vegas, NV, May 11-15, 1991.
- Aelion, C.M. and M.A. Widdowson. "Numerical modeling and field application to the *in situ* bioremediation of subsurface contamination at a JP-4 jet fuel spill", Annual Meeting, American Society of Microbiology, May, 1991.
- Widdowson, M.A. "*In situ* groundwater remediation", Conference on Engineering and Management, Columbia, SC. January 24, 1991. (Invited)
- Talwani, P., A. Ownby, K. Rajendran, M. Widdowson and M. Schaeffer. "Bad Creek project: A progress report", Fall Meeting, AGU, December 3-7, 1990.

- Widdowson, M.A., and J.L. Sapp. “Denitrification in groundwater: Modeling the fate and transport of nitrate”, Fall Meeting, American Geophysical Union, San Francisco, CA, December 3-7, 1990.
- Talwani, P., A. Ownby, K. Rajendran, M. Widdowson and M. Schaeffer. “A field study of reservoir induced seismicity at Bad Creek, S.C., the pre-impoundment phase”, Meeting of the Eastern Section of the Seismological Society, October, 1990.
- Widdowson, M.A. “An analysis technique for multi-level and partially penetrating slug test data”, Spring Meeting, American Geophysical Union, Baltimore, MD, May 29-June 1, 1990.
- Widdowson, M.A. “Modeling nitrate transport coupled to denitrification in the saturated zone”, *National Water Conference*, Irrigation and Drainage Division, American Society of Civil Engineers, Newark, DE, July 11-15, 1989.
- Widdowson, M.A., F.J. Molz and J.G. Melville. “Analysis of multi-level slug test data to determine hydraulic conductivity distribution”, *Solving Ground Water Problems with Models*, Conference and Exposition, Association of Ground Water Scientists and Engineers, Indianapolis, IN, February 14-16, 1989.
- Widdowson, M.A., F.J. Molz and L.D. Benefield. “Modeling multiple organic contaminant transport and biotransformations under aerobic and anaerobic (denitrifying) conditions in the subsurface”, *Petroleum Hydrocarbons and Organic Chemicals in Ground Water*, Association of Ground Water Scientists and Engineers, Houston, TX, November 14-16, 1988.
- Widdowson, M.A. and F.J. Molz. “Solution technique for a coupled system of equations describing advection-dominated transport and biotransformations in the subsurface”, *Computational Mechanics*, Atlanta, GA, April 6-8, 1988.
- Widdowson, M.A., F.J. Molz and L.D. Benefield. “A numerical transport model for oxygen- and nitrate-based respiration linked to substrate and nutrient availability in porous media”, Fall Meeting, American Geophysical Union, San Francisco, CA, December 7-11, 1987.
- Molz, F.J. and M.A. Widdowson. “Internal inconsistencies in dispersion-dominated models that incorporate chemical and microbial kinetics”, Spring Meeting, American Geophysical Union, May 18-21, 1987.
- Widdowson, M.A., F.J. Molz and L.D. Benefield. “Development and application of a model for simulation of microbial growth dynamics coupled to nutrient and oxygen transport in porous media”, *Solving Ground Water Problems with Models*, Conference and Exposition, Association of Ground Water Scientists and Engineers, Denver, CO, February 14-16, 1987.
- Widdowson, M.A., F.J. Molz and L.D. Benefield. “Experimental and theoretical studies of microbial growth dynamics coupled to nutrient and oxygen transport in porous media”, Microbial Processes in the Transport, Fate and *In Situ* Treatment of Subsurface Contaminants, American Geophysical Union Chapman Conference, Snow Bird, UT, October 1-3, 1986.
- Molz, F.J., Widdowson, M.A. and L.D. Benefield. “Simulation of microbial growth dynamics coupled to nutrient and oxygen transport in porous media”, Spring Meeting, American Geophysical Union, May 19-22, 1986.

## **EXTERNALLY-FUNDED RESEARCH**

- National Science Foundation, “Affect of Petroleum Deposit Geometry on Biodegradation Potential and Long Term Persistence”, \$60,000, 12 months, Amy Pruden (PI).
- U.S. Army Corps, “Bench Scale TNT Degradation Study, Groundwater Model and GIS Support”, \$174,473, 24 months, Amy Pruden (co-PI)
- Environmental Security Technology Certification Program (ESTCP), “Improved Field Evaluation of NAPL Dissolution and Source Longevity at the Former Williams AFB”, \$124,000, 24 months.
- Environmental Security Technology Certification Program (ESTCP), “Verification of Methods for Assessing the Sustainability of Monitored Natural Attenuation”, \$231,392, 36 months, J.T. Novak (co-PI).

U.S. Army Engineering Research and Development Center, “Development of a Model for Contaminant, Carbon, and Nutrient Mass Fluxes in Contaminated Sediment”, \$45,000, 18 months.

U.S. Department of Education, “GAANN: An Interdisciplinary Program in Environmental Biogeochemistry”, \$35,049, 12 months, John Little (PI).

U.S. Environmental Protection Agency via Hazardous Substance Research Center at Purdue University/Virginia Tech, “Incorporating Natural Attenuation and Phytoremediation into Design”, \$68,847, 6 months, J.T. Novak (PI).

Environmental Security Technology Certification Program, “Estimating Cleanup Times Associated with Combining Source-Area Remediation with Monitored Natural Attenuation”, \$121,090, 24 months.

U.S. Geological Survey, “Computational Model for the Uptake of Contaminants from Groundwater by Phreatophytes”, \$40,000, 30 months.

Strategic Environmental Research and Development Program (SERDP), “Integrated Protocol For Assessment Of Long-Term Sustainability Of Monitored Natural Attenuation Of Chlorinated Solvent Plumes”, \$807,490 (\$1,662,667 total budget with ORNL and USGS), 48 months, J.T. Novak (co-PI).

Naval Facilities Engineering Service Center, “Estimation Of Timeframes for and Comparison of Groundwater Remediation Technologies”, \$200,000, 24 months.

U.S. Navy/CH2M Hill, “Feasibility Study Modeling – NAB Little Creek”, \$24,210, 12 months.

U.S. Environmental Protection Agency via Hazardous Substance Research Center at Purdue University/Virginia Tech, “Incorporating Natural Attenuation into Design and Management Strategies for Contaminated Sites”, \$291,000, 36 months, J.T. Novak (PI).

Virginia Water Resources Research Center, “Evaluating processes that control natural attenuation of nitrate in natural waters”, \$5,000, 12 months.

U.S. Navy/U.S. Geological Survey, “Guidelines and Procedures for Determining Restoration Timeframes Associated with Monitored Natural Attenuation at Naval Facilities”, \$140,000, 18 months.

U.S. Army Waterways Experiment Station, “SEAM3D Reductive Dechlorination Package for Simulation of Intrinsic Bioremediation in Aquifers”, \$30,000, 12 months.

U.S. Army/Law Engineering and Environmental Services, “Bioventing Pilot Test at Building 900, Douge Creek Village, Ft. Belvoir”, \$5,500, 8 months, J.T. Novak (co-PI).

U.S. Army/Law Engineering and Environmental Services, “Groundwater Flow Modeling of the Aquifer System at Ft. Belvoir: Phase II”, \$15,000, 9 months.

U.S. Navy/CH2M Hill, “Investigation of Intrinsic Bioremediation at Site 12, Naval Amphibious Base Little Creek”, \$234,700, 21 months, J.T. Novak and Duane Berry (co-PIs).

U.S. Department of Defense/Army Research Office, “Modeling the Fate and Transport of BTEX and MTBE in Groundwater”, \$132,608, 36 months.

U.S. Army/Law Engineering and Environmental Services, “Groundwater Flow Modeling of the Aquifer System at Ft. Belvoir: Phase I”, \$14,480, 6 months.

Norfolk Southern Corporation, “Phytoremediation of Creosote - Contaminated Soil and Groundwater at the Oneida Tie Yard Site”, \$400,364, 36 months, J.T. Novak (PI).

U.S. Army/Horne Engineering, “Evaluation of Intrinsic Bioremediation at the Douge Creek Subdivision Ft. Belvoir, VA”, \$28,800, 12 months, J.T. Novak and N.G. Love (co-PI).

Norfolk Southern Corporation, “An Investigation into the Use of Biologically-Based Treatment Technologies for Waste Oil Volume Reduction at Norfolk Southern Corp”, \$119,916, 36 months, N.G. Love (PI) and J.T. Novak.

U.S. Department of Agriculture/Health Research Institute, “In Situ Determination of the Fate and Transport of Nitrate and Ammonium in a Sandy Aquifer”, \$65,700, 36 months.

U.S. Army Waterways Experiment Station, “Three-Dimensional, Sequential Electron Acceptor Model for Simulating In Situ Bioremediation Coupled to Solute Transport”, \$100,000, 24 months.

Virginia Water Resources Research Center, "In Situ Bioremediation of Xenobiotic Compounds by Iron-Reducing Organisms in Groundwater: Development and Validation of a Numerical Model", \$9,367, 13 months.

U.S. Geological Survey, "Numerical Simulation of *In Situ* Bioremediation", \$17,892, 9 months.

South Carolina Hazardous Waste Management Research Fund, "Field Demonstration of *In Situ* Stripping and Bioremediation of Petroleum-Derived Contamination in the Piedmont Region", \$303,501, 24 months, R.P. Ray, H.W. Reeves and C.M. Aelion (co-PIs).

U.S. Department of Energy/Oak Ridge National Laboratory, "Partnership in Computational Science: Groundwater Transport", \$20,342, 8 months, R.P. Ray (co-PI).

U.S. Geological Survey, "Transport Modeling and Multi-level Monitoring at a Bioremediation Project", \$8,740, 12 months.

U.S. Department of Energy/Westinghouse Savannah River Co. (SCUREF), "Establishment of a Field Geohydrology Site", \$45,333, 20 months, M.E. Meadows (co-PI).

National Science Foundation, Instrumentation and Laboratory Improvement program, "Development of Undergraduate Curriculum in Groundwater Hydrology: Experimental Investigation and Computer Simulation", \$33,465, 30 months, M.E. Meadows and A.S. McAnally (co-PIs).

U.S. Department of Energy/Westinghouse Savannah River Co. (SCUREF), "Field Tests for Groundwater Flow and Transport at the TNX Area", \$124,080, 19 months.

U.S. Geological Survey, "Solute Transport Modeling of a Bioremediation Project at Hanahan, SC", \$16,087, 12 months.

## TEACHING EXPERIENCE

Virginia Tech	CEE 2804	Introduction to Civil and Environmental Engineering
	CEE 3304	Fluid Mechanics for Civil and Environmental Engineers
	CEE 3314	Water Resources Engineering
	CEE 4314	Groundwater Resources
	CEE 5354	Numerical Modeling of Groundwater Flow & Transport
	CEE 5374	Dynamics of Groundwater
	CEE 5774	Hazardous Waste Management
University of South Carolina	ENGR 360	Fluid Mechanics
	ECIV 350	Introduction to Environmental Engineering
	ECIV 563	Subsurface Hydrology
	ECIV 761	Numerical Methods in Subsurface Hydrology
	ECIV 763	Groundwater Hydraulics
	ECIV 764	Contaminant Transport
Auburn University	CE 310	Hydraulics I

## OTHER PROFESSIONAL EXPERIENCE

Consultant – BEM Systems, Remedial Action Work Plan, Newark, NJ, 9/09-12/10.

Consultant – U.S. Air Force, Former Williams AFB, Phoenix, AZ, 3/07-4/11.

Expert testimony – Remediation Products, Inc., Patent pertaining to groundwater remediation, 9/08-5/10.

Consultant – U.S. Army Corps of Engineers, McCormick and Baxter Superfund Site, Sacramento, CA, 9/07-8/09.

Consultant – Groundwater resource development and feasibility study, South-Central Virginia, 7/07-11/07.

Expert testimony – Lincoln Preservation Foundation, 5/01-11/01.

Expert testimony - American Electric Power on Groundwater Contamination, 4/00-6/00.

Consultant - South Carolina Electric and Gas/Fluor Daniel GTI. Calhoun Park Area Superfund Site, Charleston, SC. Phytoremediation Feasibility Study, 9/98-1/99.

Consultant and expert testimony (report) to U.S. Congress - U.S. Navy, Indian Head Division, Indian Head, MD. Recommendation for Long-Term Water Supply for the Indian Head Division, 11/94-1/95.

Consultant and expert testimony - Hilton Head Island Public Service District #1, Hilton Head Island, SC. Recommendations for long-term Public Water Supply for Hilton Head Island. Technical Review of Engineering and Hydrogeologic Reports related to Groundwater Resource Development, 1/92-7/93.

Consultant and expert testimony - Forest Land Company, Columbia, SC. Investigation of Groundwater Contamination, Sabre Saw Chain Superfund Site, Pontiac, SC, 10/90-8/92.

Consultant - Post, Buckley, Schuh & Jernigan, Inc., Columbia, SC. Subsurface Contaminant Transport Modeling, Kalama Specialty Chemicals Superfund Site, Beaufort, SC, 11/90-1/92.

Consultant and expert testimony - J. Hollingsworth, Greenville, SC. Dewatering of a Limestone Aquifer, Williamsburg Co., SC, 1/89-5/90.

Consultant - Electric Power Research Institute, Palo Alto, CA. Analysis and Review of a Groundwater Flow Computer Program (EFLOW), 12/87-6/88.

Post-Doctoral Fellow - Field Tests to Determine Hydraulic Conductivity Distribution in Heterogeneous Aquifers, Auburn University Mobile Site, USEPA funded research, 6/87-6/88.

Graduate Research Assistant - Forced-Gradient Tracer Experiments at the Auburn University Mobile Site, "Experimental and Theoretical Studies of Contaminant Dispersion in Groundwater", USEPA funded research, 8/84-6/87.

## **PUBLIC SERVICE, EXTENSION, AND PROFESSIONAL ACCOMPLISHMENTS**

### *Continuing education contributions, course development, delivery of courses*

SERDP/ESTCP Tools for Management of Chlorinated Solvent-Contaminated Sites. "Improved Field Evaluation of NAPL Dissolution and Source Longevity", Partners in Environmental Technology, 1-day workshop, 80 attendees, Washington, DC, December 3, 2009.

Environmental Professionals' Organization of Connecticut. "Combining Engineered Contaminant Source-Area Treatment Technologies with Monitored Natural Attenuation for Site Cleanup", 1-day short course, 52 attendees, Hartford, CT, March 26, 2009.

National Ground Water Association. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 12 attendees, Providence, RI, March 23-24, 2009.

U.S. Navy/Battelle Memorial Institute. "Estimating MNA Remedial Timeframes with Natural Attenuation Software (NAS)", 1-day short course, 38 attendees, Norfolk, VA, May 6, 2008.

U.S. Navy/Battelle Memorial Institute. "Estimating MNA Remedial Timeframes with Natural Attenuation Software (NAS)", 1-day short course, 25 attendees, Honolulu, HI, April 29, 2008.

U.S. Navy/Battelle Memorial Institute. "Estimating MNA Remedial Timeframes with Natural Attenuation Software (NAS)", 1-day short course, 21 attendees, Silverdale, WA, April 17, 2008.

U.S. Navy/Battelle Memorial Institute. "Estimating MNA Remedial Timeframes with Natural Attenuation Software (NAS)", 1-day short course, 75 attendees, San Diego, CA, April 15, 2008.

National Ground Water Association. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 14 attendees, Tucson, AZ, March 17-18, 2008.

Environmental Professionals' Organization of Connecticut. "Estimating cleanup times associated with combining source-area remediation with natural attenuation", 1-day short course, 52 attendees, Hartford, CT, March 28, 2007.

Licensed Site Professional Association of Massachusetts. "Estimating cleanup times associated with combining source-area remediation with natural attenuation", 1-day short course, 50 attendees, Boston, MA, March 26, 2007.

National Ground Water Association. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 15 attendees, Tampa, FL, February 5-6, 2007.

Environmental Professionals' Organization of Connecticut. "Estimating cleanup times associated with combining source-area remediation with natural attenuation", 1-day short course, 55 attendees, Hartford, CT, November 6, 2006.

Battelle Memorial Institute, "Estimating remediation times using monitored natural attenuation", half-day short course, 26 attendees, Monterey, CA, May 21, 2006.

Licensed Site Professional Association of Massachusetts. "Estimating cleanup times associated with combining source-area remediation with natural attenuation", 1-day short courses, 80 attendees (total), Boston, MA, April 4-5, 2006.

Environmental Professionals' Organization of Connecticut. "Estimating cleanup times associated with combining source-area remediation with natural attenuation", 1-day short courses, 100 attendees (total), Hartford, CT, March 28-29, 2006.

National Ground Water Association. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 15 attendees, Denver, CO, March 2-3, 2006.

National Ground Water Association. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 16 attendees, Nashville, TN, October 3-4, 2005.

Battelle Memorial Institute, "Reactive transport modeling of natural attenuation", 1-day short course, 20 attendees, Baltimore, MD, June 5, 2005.

Battelle Memorial Institute, "Estimating remediation times using monitored natural attenuation", half-day short course, 40 attendees, Baltimore, MD, June 8, 2005.

State Coalition for Remediation of Drycleaners. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 32 attendees, Raleigh, NC, May 3-4, 2005.

American Institute of Professional Geologists. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 30 attendees, Saratoga Springs, NY, October 4-5, 2004.

Oklahoma Ground Water Association. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 18 attendees, Oklahoma, OK, March 10-11, 2004.

National Ground Water Association. "Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal", 2-day short course, 36 attendees, Portland, OR, February 23-24, 2004.

Naval Facilities Engineering Command and Naval Facilities Engineering Service Center, "Estimating cleanup times associated with combining source-area remediation with natural attenuation", 2-day short course, 30 attendees, Charleston, SC, August 5-6, 2003.

Naval Facilities Engineering Command and Naval Facilities Engineering Service Center, "Estimating cleanup times associated with combining source-area remediation with natural attenuation", 2-day short course, 33 attendees, San Diego, CA, July 22-23, 2003.

Battelle Memorial Institute, "Estimating remediation times using monitored natural attenuation", half-day short course, 32 attendees, Orlando, FL, June 4, 2003.

Battelle Memorial Institute, “Reactive transport modeling of natural attenuation”, 1-day short course, 28 attendees, Orlando, FL, June 1, 2003.

Washington Hydrology Society and Washington State Department of Ecology, “Estimating Remediation Times Using Monitored Natural Attenuation”, half-day workshop, 48 attendees, Tacoma WA, April 10, 2003.

Wyoming Department of Environmental Quality and National Ground Water Association, “Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal”, 2-day short course, 46 attendees, Cheyenne WY, March 18-19, 2003.

National Ground Water Association. “Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal”, 2-day short course, 28 attendees, Orlando, FL, December 4-5, 2002.

National Ground Water Association. “Estimating Times of Remediation Associated with Monitored Natural Attenuation and Contaminant Source Removal”, 2-day short course, 31 attendees, Scottsdale, AZ, May 5-6, 2002.

Virginia Department of Environmental Quality. “Modeling contaminant plumes at petroleum-contaminated sites”, 1-day short course, 40 attendees, Blacksburg, VA, June 24, 1997.

Virginia Department of Environmental Quality. “Intrinsic bioremediation”, 2-day short course, 36 attendees, Blacksburg, VA, November 18-19, 1996.

U.S. Navy Atlantic Division, Naval Facilities Engineering Command. “Intrinsic bioremediation in groundwater”, 1-day short course, 24 attendees, Norfolk, VA, November 6, 1996.

South Carolina Department of Health and Environmental Control. “Field techniques for measuring hydrologic properties”, 1-day short course, 84 attendees, Columbia, SC, March 1, 1992.

#### *Professional and University Service*

Session chair (“Sustainability of Monitored Natural Attenuation), Fifth International Conference on Chlorinated and Recalcitrant Compounds, Monterey, CA, May 22-26, 2006.

Chair and Organizer, expert scientific panel on “Sustainability of Monitored Natural Attenuation of Chlorinated Solvents – Microbial Processes” for Strategic Environmental Research and Development Program (SERDP), Alexandria, VA, October 1-2, 2003.

Chair and Organizer, expert scientific panel on “Sustainability of Monitored Natural Attenuation of Chlorinated Solvents – Physical Processes” for Strategic Environmental Research and Development Program (SERDP), Herndon, VA, May 28, 2003.

Chair and Coordinator of special technical session entitled “Models for Natural Attenuation”, The Fourth International Symposium on In Situ and On-Site Bioreclamation, June, 2001.

Chair and Coordinator of special technical session entitled “Modeling”, The Fifth International Symposium on In Situ and On-Site Bioreclamation, April, 1999.

Chair and Coordinator of special technical session entitled “Modeling”, The Fourth International Symposium on In Situ and On-Site Bioreclamation, April-May, 1997.

Chair and Coordinator of special technical session entitled “Modeling”, The Third International Symposium on In Situ and On-Site Bioreclamation, April, 1995.

Chair and Coordinator of special technical session entitled “Low Permeability Application”, The Third International Symposium on In Situ and On-Site Bioreclamation, April, 1995.

Technical Advisor to Wildewood Company, Columbia, SC. Investigation of TCE contamination of groundwater, springs, and surface waters, Amphitol Spring Valley Site, Columbia, SC, 8/91-6/92.

Technical Resources Committee, Myrtle Beach Aquifer Storage Recovery Project, SC Water Resources Commission, 1991-92.

Project Peer Review, U.S. Department of Energy/Office of Health and Environmental Research Subsurface Science Program: Deep Probe Microbiology Subprogram, Salt Lake City, UT, April 24-26, 1991.

Chair of technical session entitled "Surface Water/Ground Water Interaction: Model Development", ASCE Irrigation and Drainage Engineering Conference, 1991.

Technical Advisor to Earth Science Program on *In Situ* Bioremediation, Lawrence Livermore National Laboratory, May 1, 1990.

Technical Advisor to U.S. Department of Energy/Office of Health and Environmental Research Workshop on "Intermediate-Scale Experimentation to Investigate Microbiological, Chemical and Hydrologic Processes Affecting Subsurface Reactive Contaminant Migration", Lewes, Del., April 24-25, 1990.

Technical Advisor to Allied Chemical Corporation, Air quality emissions at the Irmo, SC, 1990.

Chair and Coordinator of special technical session entitled "Microbial Processes in Subsurface-Contaminant Geochemistry", Fall Meeting, American Geophysical Union (sponsorship from the Groundwater Committee of the AGU Hydrology Section), 1990.

Chair of technical session entitled "Water Quality Analysis: Research and Findings" at the Coastal Zone Symposium, American Society of Civil Engineers, 1989.

Advisory Committee, South Carolina Environmental Training Center, Sumter, SC, 1988 - 1990.

Manuscripts reviewed for presses and journals:

- *Environmental Science and Technology*, American Chemical Society.
- *Water Resources Research*, American Geophysical Union.
- *Ground Water*, National Ground Water Association.
- *Ground Water Monitoring and Remediation*, National Ground Water Association.
- *Journal of Environmental Engineering*, ASCE, American Society of Civil Engineers.
- *Journal of Hydraulic Engineering*, ASCE.
- *Journal of Irrigation and Drainage Engineering Division*, ASCE.
- *Journal of Bioremediation*
- *Journal of Theoretical Biology*
- *Advances in Water Resources*
- *Water Research*
- *Journal of Hydrologic Processes*
- *Journal of the University of Kuwait (Science)*.
- *McGraw-Hill*
- *J. Wiley*

Grant proposals reviewed for funding agencies:

- U.S. Environmental Protection Agency SBIR Program
- National Institute of Environmental Health Sciences Superfund Basic Research Program
- U.S. Department of Energy
- University of Wisconsin Water Resources Institute
- Environment Canada

Public Health Assessment Review:

- U.S. Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services – Oak Ridge Reservation, TN.
- U.S. Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services – Brookhaven National Lab, NY.

Promotion and Tenure External Review:

- University of Kansas, Department of Civil, Environmental, and Architectural Engineering, promotion (to associate professor) and tenure case.
- Clemson University, Department of Environmental Engineering and Science, promotion (to full professor) case.
- Virginia Tech, Department of Biological Systems Engineering, College of Agriculture and Life Sciences, promotion (to associate professor) and tenure case.

Department Service:

Assistant Department Head and Graduate Director (2009-present)  
 Chair, Search Committee, Sustainable Infrastructure (2010-11)  
 Instructional Laboratory Equipment Committee (2009-present)  
 Coordinator, Environmental and Water Resources Engineering Graduate Program (2003-08)  
 Chair, Search Committees (3), Environmental and Water Resources Engineering (2007-08)  
 Departmental Representative, College of Engineering Promotion and Tenure Committee (2007-08)  
 Promotion and Tenure Committee (2005-08)  
 Computer Committee (2004-07)  
 Geoenvironmental Engineering Graduate Option, Hydrosystems Representative (1996-2003)  
 Search Committee, Geospatial Faculty/Associate Director CGIT (2002-03)  
 Promotion and Tenure Committee (1999-2002); Chair (2001-02)  
 Environmental Faculty Search Committee I (1999-2000)  
 Environmental Faculty Search Committee II (2000-01)  
 Coordinator, Hydrosystems Graduate Program (1999-2001)  
 Hydrosystems Laboratory Coordinator (1993-1999)  
 ASCE Student Chapter Advisor (1996-1999)  
 Civil Engineering Advising, Working Group (1997)  
 CE Measurements, Working Group on CE Curriculum (1997)  
 CE Computer Applications, Working Group on CE Curriculum (1997)  
 Shop Technician Assessment Committee (1994-present)  
 Environmental Faculty Search Committee I (1996-97)  
 Environmental Faculty Search Committee II (1996-97)  
 Budget Advisory Committee (1995-1996)  
 Environmental/Hydrosystems/Geotechnical Research Initiative (1994-95)  
 Computer Committee (1993-96)  
 Hydrosystems Faculty Search Committee (1993-94)

College Service:

COE Promotion and Tenure Committee, CEE representative (2007-2008)  
 COE Executive Committee, CEE representative (2003-2005)  
 COE Cluster Hire Search Committee, Computational Science and Engineering (2003-2004)

University Service:

Commission on University Support (2006-present)  
 Harry S. Truman Scholarship Committee  
 Morris Udall Scholarship Committee

Working Group on "Virginia Tech as an Environmental Role Model" (Chair)  
American Society of Civil Engineers, Student Chapter Advisor (1996-99)  
Virginia Tech Bicycle Club, Advisor (1995-96)