Grant R. Carey, Ph.D., P.Eng.

EDUCATION

Ph.D.	University of Guelph, Guelph, Ontario, 2015
M. Eng.	Carleton University, Civil and Environmental Engineering, 2001
1997	One of two Canadian graduate students invited to a NATO Advanced Study Institute (Bioavailability of Organic Xenobiotics in the Environment) in the Czech Republic.
B.A.Sc.	University of Waterloo, Civil Engineering, 1993

EMPLOYMENT

2006-Present	President and CEO Porewater Solutions
2005-2006	Associate, and Director of Corporate Training Conestoga-Rovers & Associates
2002-2004	Senior Engineer Conestoga-Rovers & Associates
2000-2002	President and CEO Environmental Institute for Continuing Education (EICE)
1996-2002	President and CEO Environmental Software Solutions Inc. (ENSSI)
1996-1999	Carleton University Mediation Centre – Mediator, Conflict Resolution Program
1992-1996	Engineer Conestoga-Rovers & Associates

RESEARCH COLLABORATION

- Adjunct Professor, Department of Civil Engineering, University of Toronto.

PROFESSIONAL AFFILIATIONS

- California Groundwater Resources Association
- National Ground Water Association
- Ontario Professional Engineer

PROFILE OF PROFESSIONAL ACTIVITIES

Summary of Experience

Dr. Carey has worked on projects across North America with a focus on:

- Expert witness and litigation support services
- Chemical fate
- Groundwater modeling

- Back-diffusion, and development of cost-effective, long term site management strategies
- NAPL characterization, and remediation by natural or enhanced attenuation
- Regulatory negotiations

Dr. Carey has published more than 90 courses, seminars, and papers. Dr. Carey also has extensive experience in development and delivery of professional education, has training in mediation and facilitation, and has developed widely-used modeling and visualization tools which have been released as commercial and public domain products. Dr. Carey is also involved with state-of-the-art research projects related to model development for optimizing in-situ remediation and predicting back-diffusion remediation timeframe, including collaboration with the University of Toronto.

Site Remediation and Litigation

- San Fernando Valley Superfund Site (Area 2), Glendale, California – Expert peer review for implementation of a basin-scale investigation for delineation of hexavalent chromium, and groundwater modeling to evaluate capture zones for regional supply wells for VOCs, 1,4-dioxane, hexavalent chromium, and other emerging chemicals.
- Former manufacturing facility, Glendale, California – Expert peer review for monitoring and remediation of hexavalent chromium and chlorinated solvents.
- Former aerospace facility, Pacoima, California – Expert support for due diligence investigation and pending litigation.
- Chemical Manufacturing Facility, Kentucky – Expert support for implementation of a large RI/FS at a site with multiple DNAPL and LNAPL source zones, and litigation consultant for allocation of past costs.
- USA Petroleum site, San Jose, California – Retained as an expert witness regarding the fate of MTBE from a gas station release near a regional drinking water supply well.
- Manufacturing Facility, Phoenix, Arizona – Developed a regional groundwater flow and chemical transport model for litigation, to evaluate source release timing for a TCE plume in a multi-aquifer system with regional supply wells.
- Solvent Savers Superfund Site, Lincklaen Township, New York – DNAPL expert and supported regulatory negotiations.
- Aerospace manufacturing facility, San Diego, California – Expert peer review and regulatory negotiation support for implementation of a remedial investigation, feasibility study, and development of a Remedial Action Plan.
- Aerospace manufacturing facility, Phoenix, Arizona – Expert peer review for treatability pilot test analysis, and preparation of the corrective measures study and implementation plan.
- Cedar Chemical Site, Phillips County, Arkansas – Supported a PRP De Minimis evaluation.
- Former rocket manufacturing facility, Southern California – Conducted a detailed investigation of chemical fate (perchlorate and chlorinated solvents) including validation of a three-dimensional basin-wide groundwater flow model for the San Bernadino Basin.
- Canadian Tire Site, Toronto, Ontario – Developed a high resolution groundwater flow and multispecies reactive transport model to evaluate enhanced in-situ bioremediation of petroleum hydrocarbons.
- Confidential site, Ottawa, Ontario – Calibrated a groundwater flow and chemical transport model for evaluation of persulfate diffusion and reactivity in bedrock.

- Seaspan Site, British Columbia – Calibrated a three-dimensional transient (tidal oscillation) freshwater groundwater flow model for a coastal site and evaluated remedial design alternatives and sediment cap performance based on groundwater flow and chemical transport modeling;
- Union Bay Site, British Columbia – Calibrated a three-dimensional transient (tidal oscillation) groundwater flow model based on seasonal positions of the freshwater-seawater interface, and used a one-dimensional groundwater flow and chemical transport model to compare remedial alternative performance based on mass discharge reductions;
- Savannah River National Laboratory (SRNL) – Conducted a reactive transport modeling study to evaluate the mass balance for a chlorinated solvent plume attenuation at PlattsburghAir Force Base (New York) on behalf of SRNL's research efforts related to natural and enhanced attenuation
- Vandenberg Air Force Base, California - Modeled tracer tests and bioremediation pilot tests to evaluate remedial performance as part of a Department of Defense (ESTCP) project related to the design of soluble substrate injection systems
- Texas Central Gulf Coast Aquifer Groundwater Availability Model – calibrated a regional groundwater flow model that covered an area that represents more than 10% of the drinking water supply for Texas, and used this model to predict water supply resources over a 50-year period in the future.
- Source Water Protection Study, Region of Waterloo, Ontario – Peer reviewed a regional groundwater flow model which was developed to evaluate three-dimensional groundwater directions, velocities, and to support a regional vulnerability assessment;
- Mine Exploration Project, Alaska – calibration of a 5,000 km^2 watershed-scale groundwater flow model to evaluate how future mining operations may influence groundwater and surface water resources, including a transient water balance calibration for 14 subwatersheds;
- Birkerod Site, Denmark – Developed a density-dependent soil vapor flow and transport model to evaluate the distribution of TCE mass flux and to evaluate the performance of a soil vapor extraction system.
- Sydney Tar Ponds, Sydney, Nova Scotia – Senior Modeler for groundwater flow and transport modeling in Phase II/III Environmental Assessment
- Superfund site in Tacoma, Washington – developed the conceptual and simulation models for a groundwater trench recirculation system in a tidally-influenced aquifer, including the simulation of tidal effects on time-varying groundwater extraction/injection rates using SWIFT/486
- ArvinMeritor Site, Allegan, Michigan – developed a groundwater flow model for a site next to the Kalamazoo River to evaluate the design of a permeable reactive barrier.
- Chemical manufacturing facility in Elmira, Ontario – developed groundwater flow model for designing a shallow aquifer extraction system adjacent to a surface water tributary, and assisted in the development of a phased approach for construction and testing of the extraction network.
- Former sand and gravel quarry, Maryland - Developed and calibrated a groundwater flow model to evaluate the range in dewatering pumping rates in support of a large excavation and bioremediation program
- Evaluated MNA for groundwater contaminated by chlorinated solvents and/or petroleum hydrocarbons at numerous sites
- Evaluated the influence of permeable and low-permeability landfill caps on the natural attenuation of chlorinated solvents such as TCE in an underlying aquifer

- Manufacturing Facility, Cambridge, Ontario – involved with regulatory negotiations and development of a field program to evaluate potential presence of an on-site solvent source and delineate contribution from an upgradient plume.
- Forest Waste Landfill Superfund Site, Michigan – developed a reactive transport model to simulate kinetic oxygen demand from various geochemical solutes, pyrite, DOC, and 20 organic chemicals of concern. The modeling of kinetic COD demonstrated that an in-situ oxygen curtain was a feasible remedy, which saved the client more than $500,000.
- North Sanitary Landfill Superfund Site, Dayton, Ohio – managed the application of a multispecies reactive transport model to evaluate risks associated with natural attenuation of a landfill leachate plume, including representation of a number of chlorinated solvents, petroleum hydrocarbons, and inorganic chemicals of concern including manganese and arsenic.
- Rockwell Site, Cambridge, Ontario – conducted a modeling evaluation of matrix diffusion effects on TCE attenuation in groundwater using an analytical model (CRAFLUSH) and a one-dimensional numerical model (MT3DMS).
- Former Alsons Facility, Hillsdale, Michigan – evaluated potential for DNAPL migration in underground utilities and relative contributions from multiple sites.
- Fike Superfund Site, West Virginia – conducted a comprehensive assessment of MNA lines of evidence at a former pharmaceutical facility, including an evaluation of natural attenuation for 30 organic chemicals (chlorinated solvents and PAHs) and nine inorganic constituents.
- U.S. Navy flight facility, California – developed a custom subroutine for a redox-dependent transport model (BioRedox-MT3DMS) to evaluate the performance of a biosparging remedy for a BTEX plume.
- Municipal landfill, Waterloo, Ontario – Used a one-dimensional variably saturated flow and transport model to assess leachate migration potential through the vadose zone: 1) municipal landfill in Waterloo, Ontario, and 2) sludge lagoon in Cincinnati, Ohio
- Collaborated with a scientist from the U.S. Army Corps. Waterways Experiment Station to conduct a study of how BioRedox-MT3DMS could be applied to predict the natural attenuation of common explosives such as TNT and RDX
- Assisted researchers in the United States, Canada, the United Kingdom, and the Netherlands in applying BioRedox-MT3DMS to model conditions observed during field research studies involving the natural attenuation or enhanced bioremediation of various organic pollutants
- Former manufacturing facility, Illinois – chemical fingerprinting to delineate plumes from multiple sources and evaluated kinetics associated with 1,1,1-TCA degradation pathways to 1,1-DCE and 1,1-DCA in preparation for litigation.
- Douglas Autotech Facility – conducted a preliminary cost allocation assessment for TCE and DCE plumes involving numerous facilities, and presented results of this evaluation to opposition parties as part of a pre-litigation meeting.
- Manufacturing Facility, Barrie, Ontario –peer reviewed a fate and transport assessment conducted on behalf of a neighboring facility, and developed an alternate assessment of cost allocation that was used in litigation settlement discussions.
- Municipal landfill, Los Angeles, California – conducted a landfill gas modeling study and a critique of the proponent's groundwater modeling study, in support of an environmental hearing involving the closure of a municipal landfill site (affecting $4 billion dollars in future revenue)
- Proposed municipal landfill in an abandoned quarry, Hamilton, Ontario – conducted a critique of proponent's groundwater modeling study in support of an environmental permit hearing

- Sand and gravel quarry, Caledon, Ontario – Conducted a detailed critical review of a groundwater modeling to assess the impact of water resource management alternatives in support of an environmental permit hearing

Soil/Landfill Gas

- Municipal landfill, Los Angeles, California – used a two-dimensional density-dependent vapor flow and transport model (Vapor-2D) to simulate the extent of landfill gas impact on underlying groundwater resources, and peer reviewed opposition report for a multi-billion dollar landfill impact assessment hearing
- Hazardous waste landfill, Phoenix, Arizona – used a two-dimensional density-dependent vapor flow and transport model to assess the extent of potential migration of 1,2-DCA from a spill
- Used a two-dimensional landfill gas model (Vapor-2D) to simulate the performance of vertical barrier walls in controlling gas migration from the landfill: 1) municipal landfill, Toronto, Ontario, and 2) municipal landfill, Mississauga, Ontario
- Developed three-dimensional vapor flow models to aid in the optimization of soil vapor extraction/injection systems: 1) hazardous waste landfill Superfund site in Phoenix, Arizona, and 2) municipal landfill and former drum disposal Superfund site in Lapeer County, Michigan
- Conducted feasibility studies and remedial designs for soil vapor extraction and/or injection systems: 1) Municipal landfill and former drum disposal Superfund site in Lapeer County, Michigan, 2) Hazardous waste landfill in Phoenix, Arizona, 3) former drum dispel Superfund site (once ranked 4th in priority among all NPL sites in the United States) Hardeman County, Tennessee, 4) Automobile manufacturing facility in Pontiac, Michigan, and 5) Manufacturing facility in Frewsburg, New York

Landfill Remediation

- Municipal landfill, Rhinelander, Wisconsin – developed a natural attenuation analysis used to successfully negotiate reduced scope in the landfill cap to an environmental hearing (cost savings of $8 million)
- Municipal landfill and former drum disposal Superfund site, Lapeer County, Michigan - developed a $600,000 field program to support remediation by natural attenuation at a municipal landfill site, coordinated the field work, managed the data analysis and participated in negotiations with the USEPA and state regulatory agency to reduce the scope of the groundwater remedy (cost savings of more than $5 million)
- Municipal landfill, Allegan County, Michigan – evaluated the adverse influence of landfill cap installation on groundwater quality in the underlying aquifer
- Initiated the joint analysis of landfill natural attenuation at a Superfund site involving key scientists from the USEPA Office of Research and Development, and Thomas Christensen from the Technical University of Denmark

Guidance Manual Development and Peer Review

- Participated on various ITRC teams to develop guidance manuals for site characterization and remediation including the following teams: Characterization and Remediation of Fractured Rock, Remediation of Complex Sites, DNAPL Site Characterization, Contaminated Sediments – Remediation, Integrated DNAPL Site Strategies (IDSS), and Enhanced Attenuation of Chlorinated Organics (EACO). Was previously involved as an internet-based training instructor for two ITRC seminars: Mass Flux and Mass Discharge, and Remediation of Contaminated Sediments. Received the EACO team Industry Affiliates Program Award that recognizes outstanding contributions from industry members.
- Managed a contract with the Ministry of the Environment to edit the 2nd draft of the Ontario Phase II Environmental Site Assessment Technical Guidance Manual;

Model Development

Dr. Carey has developed a variety of commercial and public domain software tools, including:

In-Situ Remediation (ISR-MT3DMS) – three-dimensional reactive transport model based on the MT3DMS framework, for simulating the performance of in-situ remediation technologies, including enhanced in-situ bioremediation (EISB) and in-situ chemical oxidation. Model includes an innovative local domain approach for modeling forward and back-diffusion, and also includes the reaction package from BioRedox. Collaborating with Dr. Brent Sleep at the University of Toronto on a joint research project to evaluate back-diffusion model input parameters for ISR-MT3DMS.

Visual Bio – radial diagram visualization tool for delineating biodegradation zones in groundwater and illustrating lines of evidence in support of MNA and EISB remedies.

NAPL Depletion Model – semi-analytical screening model for simulating the depletion timeframe for LNAPL or DNAPL source zones.

BioRedox-MT3DMS (1999) – a three-dimensional finite difference model for simulating multispecies contaminant transport, including advection, dispersion, sorption, and coupled biodegradation-redox reactions between electron donors and electron acceptors. BioRedox-MT3DMS can simulate oxidation, reduction, and co-metabolic reactions, and is capable of modeling sequential transformation pathways for chlorinated solvents and petroleum hydrocarbons. BioRedox-MT3DMS is also capable of simulating equilibrium or rate-limited dissolution of light or dense NAPL sources, and includes a leachate composition model to represent time-varying landfill constituent concentrations leaching to underlying aquifers. BioRedox-MT3DMS was previously available in the public domain.

SEQUENCE (1999) – a visualization tool that uses a modified radial diagram approach to illustrate the effects of natural attenuation on groundwater redox conditions. SEQUENCE may also be used to evaluate spatial and temporal trends for chlorinated solvent species. The visual aids prepared using SEQUENCE provide convincing evidence for the effectiveness of remediation by natural attenuation. SEQUENCE integrates these radial diagram tools with a comprehensive data management system is available. SEQUENCE was previously sold as a commercial product.

BioTrends (1999) – a suite of tools for evaluating spatial and temporal trends using x-y charts with unique features that were specifically designed for evaluating chemical analytical data. Additional tools are provided for calculating first-order degradation rates between well pairs, or the average degradation rates along a flowpath based on a log-linear regression analysis, using the methods presented in the USEPA and AFCEE natural attenuation protocols. Another tool is provided to calculate the natural attenuation "score" for a site based on criteria presented in the USEPA protocol. BioTrends is integrated with a chemical properties database (CHEMbase), and the same project data management system used for the SEQUENCE visualization tool. BioTrends was previously sold as a commercial product.

BioTracker (1999) – a one-dimensional screening model that is integrated with visualization tools for transport model calibration and documentation. BioTracker utilizes a one-dimensional version of the BioRedox finite difference model to simulate multispecies transport processes including advection, dispersion, sorption, and single or sequential transformation reactions with optional halogen accumulation. BioTracker incorporates a particle tracking tool that delineates flowpaths downgradient from one or more point source locations. The customized particle tracking routine utilizes Surfer contour maps of observed or simulated groundwater elevations as input. BioTracker is also integrated directly to the same project data management system used with BioTrends and SEQUENCE, and it is integrated with a chemical properties database (CHEMbase). BioTracker was previously sold as a commercial product.

Rate Inverse Models (1998) – two-dimensional and three-dimensional analytical solutions based on the Domenico solution for estimating first-order chemical biodegradation rates based on field-measured data. These models were previously distributed at short courses.

Vapor-2D (1992) – a two-dimensional finite element model that simulates multispecies, density-dependent vapor flow and transport. Vapor-2D was modified to predict the migration of gasoline vapors from a subsurface spill area, and includes a multicomponent NAPL source model. Vapor-2D was successfully validated by simulating laboratory experiments of vapor flow and transport of heptane in the vadose zone, and Vapor-2D has been used to assess density-dependent vapor migration at field sites. Vapor-2D is currently a proprietary model.

LEACHATE (1997) – developed a batch flushing model to simulate rate-limited mass transfer of leachate from a landfill with varying infiltration rates, including a component to quantify the effects of biodegradation for chlorinated solvents.

Training Services

- Toronto District School Board, Toronto, Ontario - Developed the outline and script for an interactive multimedia online course on Supervisor responsibilities that includes the development of a Health and Safety Action Plan for school Principals, Vice-Principals, and Superintendants.
- Walkerton Clean Water Centre, Walkerton, Ontario – designed and facilitated two think tank sessions involving provincial water quality experts and stakeholders representing all levels of government, First Nations groups, and training agencies. Also prepared the Operator Training Work Plan for the Walkerton Clean Water Centre based on feedback from the think tank sessions.
- Ontario Ministry of the Environment Vendor of Record for Technical Training – Project Manager for this Vendor of Record, and CRA was the only vendor selected in all four available training categories

that included the development of classroom courses, instruction of classroom courses, development of technology assisted training, and development of correspondence courses)

- Ontario Ministry of the Environment Brownfields Legislation Training – designed and developed an interactive internet seminar that was broadcast to more than 20 MOE offices across Ontario, to provide training to provincial officers on the new Brownfield site legislation
- Ontario Ministry of the Environment Agriculture Training – designed and developed a four-week course for training new ministry agricultural enforcement officers.
- Ontario Ministry of the Environment Health and Safety Awareness for Water Treatment Plant Inspectors– Technical advisor for the development of a storyboard for an e-learning health and safety course targeted to MOE officers involved with water treatment plant inspections.
- Ontario Ministry of the Environment – attended the four-day MOE workshop "Effective Facilitation Techniques" with the Brownfields Transition Team, with an emphasis on collaborative and interactive learning exercises.
- Florida Department of Environmental Protection – provided technical advice for the design and development of a series of online courses to be delivered to professionals across Florida, involving risk assessment and remediation topics.
- CRA Institute Workforce Training – Director of Corporate training programs delivered to more than 2,000 staff in more than 60 offices in North America, South America, and Europe.
    - K-W Chamber of Commerce Award of Excellence for Workforce Training – Runner-up for the 2005 Award.
    - Managed corporate meetings broadcast utilizing webcast and teleconference software to more than 50 offices and involving more than 300 people.
    - Directed all business operations for the Environmental Institute for Continuing Education, including the delivery of more than 200 webcasts in a three-year period, sales of more than 100 asynchronous CD-ROM and web-based seminars, and certification of participation for professional engineers and scientists.
- Developed an easy-to-use e-learning interface that allows for cost-effective development of Flash-based multimedia courses.

Alternative Dispute Resolution

- received extensive training over a 3-year period in advanced mediation, facilitation, and coaching skills
- attended workshops on advanced mediation training, with an emphasis on diagnosing conflict, the transformative mediation model, and strategies for managing high-conflict mediations
- mediated disputes involving intercultural issues, organizational team-building and strategic planning
- provided professional coaching and role-playing services to the Graduate Certificate Program in Conflict Resolution, Carleton University (Department of Law)
- assisted in the development of several workshops related to alternative dispute resolution

SHORT COURSES, WORKSHOPS, AND TRAINING SEMINARS

- Invited instructor for a workshop entitled "Visual Bio: Innovative Tool for Visualizing MNA and Enhanced Biodegradation", at the 2017 Cleanup Conference, Melbourne, Australia, September 10, 2017.
- Invited Instructor for the ITRC webinar entitled "Remediation of Contaminated Sediments" offered from 2014 through 2016.
- Invited Instructor for the ITRC webinar entitled "Use and Measurement of Mass Flux and Mass Discharge" offered from 2010 through 2016.
- Invited Instructor for a 1.5-hour short course entitled "Mass Flux/Discharge: DNAPL and Back-Diffusion" at the 24th Annual NAPRM Training Program, United States Environmental Protection Agency, Pittsburgh, Pennsylvania.
- Instructor for a 4-hour short course entitled "Using the NAPL Depletion Model for Estimating Timeframes for Natural and Enhanced Attenuation", presented at the Third International Symposium on Bioremediation and Sustainable Environmental Technologies, Miami, Florida, May 18, 2015.
- Invited Instructor for 2015 Smart Remediation short course with presentation entitled "A New Paradigm for Managing Chlorinated Solvent Sites" in Ottawa, Ontario February 12, 2015.
- Invited Instructor for 2013 Smart Remediation short course with presentation entitled "Using Mass Discharge to Reduce Remediation Costs" in Ottawa, Ontario and in Toronto, Ontario, 2013.
- Instructor for a DNAPL workshop with presentation entitled "NAPL Dissolution and Fate of Groundwater Plumes", Louisville, Kentucky, December 7, 2012.
- Invited instructor for the Smart Remediation short course with presentation entitled "The Influence of Back-Diffusion on Remediation Success", Ottawa, Ontario, April 15, 2011.
- Instructor for the one-hour seminar entitled "Improving Groundwater Model Defensibility in Litigation", San Francisco, California, May 21, 2014. (pre-approved for MCLE credit)
- Invited instructor on behalf of ITRC for a session entitled: Development of Remedial Goals Based on Mass Discharge Reductions, at the NEWMOA Enhanced In-Situ Bioremediation short course offered in Westford Massachusetts and Dayville Connecticut on October 5th and 6th, 2010.
- Instructor for a 4-hour short course entitled: Decision-Making Framework for DNAPL Sites Using a Cost-Risk-Benefit Analysis, presented at ConSoil 2010 September 23, 2010, Salzburg, Austria.
- Instructor for a 4-hour short course entitled: Decision-Making Framework for DNAPL Sites Using a Cost-Risk-Benefit Analysis, presented at Battelle 2010 Remediation of Chlorinated and Recalcitrant Compounds, May 26, 2010, Monterey, California.
- Invited instructor for a short course entitled: Approaches for the Remediation of DNAPL Sites and Tools for Measuring Mass Flux and Mass Discharge in the Remediation Process (An ITRC Short Course), presented at Battelle 2010 Remediation of Chlorinated and Recalcitrant Compounds, May 23, 2010, Monterey, California.
- Senior Instructor for the following seminars which were delivered by webcast or on CD-ROM to clients in North America, Europe, Australia, and Africa:
    - Application of SEQUENCE Radial Diagrams for Visualizing Natural Attenuation Trends for Chlorinated Solvents and Redox Indicators;
    - Avoiding Common Mistakes when Estimating First-Order Biodegradation Rates;
    - Arsenic Mobilization during Natural Attenuation of Organic Compounds;

  - Biodegradation Process and Biodegradability of Petroleum Hydrocarbons and Chlorinated Solvents;
  - Case Study of Innovative Techniques for Evaluating In-Situ Remediation;
  - Introduction to Biogeochemical Processes;
  - Overview of Bioremediation Transport Models for Evaluating Natural and Enhanced Bioremediation;
  - Overview of Monitored Natural Attenuation: Key Concepts and Regulatory Issues;
  - Overview of the Remediation ToolKit: Trend Analysis, Visualization, and Modeling Tools;
  - Reactive Transport Modeling for Evaluating Natural and Enhanced Bioremediation;
  - Visualizing the Effectiveness of MNA and Enhanced Attenuation Remedies Using SEQUENCE;
  - Visual Trend Analysis Methods for Evaluating Monitored Natural Attenuation Trends

- Senior instructor for a half-day short course "Evaluating the Effectiveness of Monitored Natural Attenuation and Enhanced Attenuation Remedies, delivered to the New Jersey Department of Environmental Protection, Trenton, New Jersey, June 28, 2006.
- Co-author of a half-day short course "Evaluating the Effectiveness of In-Situ Remediation", which was delivered to CRA clients, regulators, and other consultants in Phoenix, Houston, Atlanata, and Princeton in 2005.
- Invited to co-present a seminar at the University of Waterloo Department of Earth Sciences, "Case Study of Innovative Modeling and Visualization Techniques for Evaluating In-Situ Remediation Technologies", Waterloo, Ontario, December 3, 2004.
- Instructor for a two-hour seminar entitled "Summary of the Ontario Phase II Environmental Site Assessment Technical Guidance Manual", which was delivered at an Ontario Ministry of the Environment workshop in Toronto, Ontario, March 13, 2003.
- Senior Instructor for a half-day short course "Visualization and Modeling of Monitored Natural Attenuation" Hartford, Connecticut, March 13, 2003.
- Senior Instructor for a half-day short course "Practical Reactive Transport Modeling for Evaluating In-Situ Bioremediation", presented at the Sixth International Symposium on In Situ and On-Site Bioremediation, San Diego, California, June 4-7, 2001
- Senior Instructor for a 3-day short course "Advanced Ground Water Modeling Techniques for Evaluating Performance of Natural Attenuation and Enhanced Bioremediation: A computer workshop using the three-dimensional BioRedox model", organized by the National Ground Water Association and offered in February 2000 (Albuquerque, New Mexico) and September 2000 (Toronto, Ontario).
- Senior instructor for a 3-day short course "Innovative Tools for the Analysis, Visualization, and Modeling of Natural Attenuation: Featuring the MoNA ToolKit and Visual Modflow", organized by Waterloo Hydrogeologic and offered in Waterloo, Ontario, October 2-4, 2000
- Senior instructor for a 1-day short course "Innovative Tools for the Analysis, Visualization, and Modeling of Natural Attenuation: Featuring the MoNA ToolKit" Waterloo, Ontario, October 1, 2000.
- Instructor for a 2-day natural attenuation course organized by EPIC Education Program Innovations Centre: "Remediation by Natural Attenuation", October 18-19, 1999, Etobicoke, Ontario

- Presented a seminar "Visualizing Natural Attenuation Trends" at the Groundwater Pollution and Hydrology short course organized by Princeton Groundwater, December 7-11, 1998, Las Vegas, Nevada

PUBLICATIONS

Book Contributions

Carey, G.R., P.J. Van Geel, E.A. McBean, and F.A. Rovers, 1999, Application of a Biodegradation-Redox Model for Predicting Bioremediation Performance, in P. Baveye, J.C. Block, and V.V. Goncharuk, (Eds.), Bioavailability of Organic Xenobiotics in the Environment: Practical Consequences for the Environment, Kluwer Academic Publishers, pp. 73-77.

Farquhar, G.J. and G.R. Carey, 1991, An Overview of Landfill Practices Now and in the Future, Municipal Solid Waste Management: Making Decisions in the Face of Uncertainty, University of Waterloo Press, Waterloo, Ontario, pp. 77-92.

Refereed Journal Papers

Carey, G.R., E.A. McBean, and S. Feenstra, 2017, Estimating Transverse Dispersivity Based on Hydraulic Conductivity, accepted for publication with minor revisions in *Environmental Technology & Innovation*.

Carey, G.R., E.A. McBean, and S. Feenstra, 2017, Through-Discharge Decline Rate for Layers of Residual DNAPL: 1. Field-scale multicomponent source, in preparation for submittal to *Water Resources Research*.

Carey, G.R., E.A. McBean, and S. Feenstra, 2017, Through-Discharge Decline Rate for Layers of Residual DNAPL: 2. Empirical Regression, in preparation for submittal to *Water Resources Research*.

Carey, G.R., E.A. McBean, and S. Feenstra, 2017, NAPL Depletion Model Development and Case Studies, in preparation.

Carey, G.R., E.A. McBean, and S. Feenstra, 2016, Estimating Tortuosity Coefficient based on Hydraulic Conductivity, *Ground Water*.

Carey, G.R., S.W. Chapman, B.L. Parker, and R. McGregor, 2015, Application of an Adapted Version of MT3DMS for Modeling Back-Diffusion Remediation Timeframes, *Remediation Journal*, Autumn 2015, p. 55-79.

Carey, G.R., E.A. McBean, and S. Feenstra, 2014, DNAPL Source Depletion: 1. Predicting Rates and Timeframes, *Remediation Journal*, Summer 2014, p. *21-47*.

Carey, G.R., E.A. McBean, and S. Feenstra, 2014, DNAPL Source Depletion: 2. Attainable Goals and Cost-Benefit Analyses, *Remediation Journal*, Autumn 2014, p. 79-106.

Schreiber, M., G.R., D. Feinstein, Carey and J. Bahr, 2004, Mechanisms of Electron Acceptor Utilization, *Journal of Contaminant Hydrology*, 73(1-4), p. 99-127.

Carey, G.R., P.J. Van Geel, T.H. Wiedemeier, and E.A. Mcbean, 2003, A Modified Radial Diagram Approach for Evaluating Natural Attenuation Trends for Chlorinated Solvents and Inorganic Redox Indicators, *Ground Water Monitoring and Remediation*, 23(4): 75-81.

Carey, G.R., T.H. Wiedemeier, P.J. Van Geel, E.A. McBean, J.R. Murphy, and F.A. Rovers, 1999, Visualizing Natural Attenuation Trends: Petroleum Hydrocarbons Attenuation at the Hill Air Force Base, *Bioremediation Journal*, 3(4): 379-393

Software Manuals

Carey, G.R., 2015, NAPL Depletion Model (NDM): User's Guide, Porewater Solutions, Ottawa, Ontario, Canada.

Carey, G.R., P.J. Van Geel, and J.R. Murphy, 1999, BIOREDOX-MT3DMS: A Coupled Biodegradation-Redox Model for Simulating Natural and Enhanced Bioremediation of Organic Pollutants – V2.0 User's Guide, Conestoga-Rovers & Associates, Waterloo, Ontario, Canada

Carey, G.R., P.J. Van Geel, and J.R. Murphy, 1999, BIOREDOX-MT3DMS: A Coupled Biodegradation-Redox Model for Simulating Natural and Enhanced Bioremediation of Organic Pollutants – V2.0 Verification Manual, Conestoga-Rovers & Associates, Waterloo, Ontario, Canada

Carey, G.R., 1999, BIOREDOX-MT3DMS Tutorial Guide: Modeling Natural Attenuation at the Plattsburgh Air Force Base, Conestoga-Rovers & Associates, Waterloo, Ontario, Canada

Carey, G.R., 1999, The Remediation ToolKit (SEQUENCE, BioTrends, BioTracker) – User's Guide, Conestoga-Rovers & Associates, Waterloo, Ontario, Canada

Other Publications and Presentations

Carey, G.R., 2016, In-Situ Remediation (ISR-MT3DMS) For Modeling Back-Diffusion Timeframes, platform presentation at the 10th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle, Palm Springs, California, May 22-26, 2016.

Carey, G.R., 2016, Forensic Analysis of NAPL Architecture at a Field Site using the NAPL Depletion Model (NDM), poster presentation at the 10th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Battelle, Palm Springs, California, May 22-26, 2016.

Carey, G.R., 2015, Using the NAPL Depletion Model (NDM) for Forensic Analysis of NAPL Architecture at a Field Site, presented at the 30th Biennial Groundwater Conference, Sacremento, California, October 6-7, 2015.

Carey, G.R., 2015, Using In-Situ Remediation (ISR-MT3DMS) to Model Back-Diffusion Timeframe for Thin Silts and Clays, presented at the 30th Biennial Groundwater Conference, Sacremento, California, October 6-7, 2015.

Carey, G.R., 2015, Invited to Chair the Fractured Rock Session at Cleanup 2015 Conference, organized by CRC Care, Melbourne, Australia, September 13-16, 2015.

Carey, G.R., 2015, Review of Characterization Methods for NAPL Source Zone Delineation and Mass Estimation, Invited Keynote presentation at Cleanup 2015 Conference, organized by CRC Care, Melbourne, Australia, September 13-16, 2015.

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