

## 2010 Annual Report /Newsletter

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Kerry Rowe at the Royal Academy of Engineering in London, page 5



ConeTec Graduate award, page 3.



**Welcome to Kevin Mumford:** In January 2010, the centre welcomed its newest member, **Dr Kevin Mumford**, Assistant Professor in the Department of Civil Engineering at Queen`s. Kevin trained at McMaster University, studying the impact of air bubbles on contaminated groundwater, work for which he received the **Governor General`s Academic Gold Medal**. Kevin then spent 2009 as a postdoctoral researcher at UWO before accepting his faculty position at Queen`s. Kevin adds expertise on three-fluid phase flow within porous media to our team of Groundwater experts, with potential for application to new developments in carbon sequestration and remediation of contaminated ground

**Victor Milligan Lecture:** Generous support from Golder Associates is allowing the GeoEngineering Centre to host the **Victor Milligan Lecture Series** since 2009. This lecture series, honouring Dr Milligan and recognizing his many contributions to GeoEngineering in Canada and internationally, brings the Rankine and Terzaghi Lecturers to Kingston. Dr Milligan was one of the founders of Golder Associates, the first Editor of the Canadian Geotechnical Journal, and was himself the Thirty-Eighth Terzaghi Lecturer in 2002. The first Victor Milligan Lecture was presented by Mr Clyde Baker in November 2009. Mrs Milligan was in attendance, together with many former colleagues of Dr Milligan.



**Dr Tom O'Rourke** of Cornell University delivered the second Victor Milligan Lecture titled "Geohazards and Large Geographically Distributed Systems" on January 19th. Dr O'Rourke's lecture was based on his outstanding work on lifeline damage due to earthquakes, and described both his technical contributions and a systems view of the interacting issues affecting post-earthquake damage. Dr O'Rourke prepared and delivered this material in 2009 as the 49th Rankine Lecture for the British Geotechnical Association.



**Professor Chris Clayton** of the University of Southampton in the United Kingdom delivered the third Victor Milligan Lecture titled "Stiffness at small strain - research and practice" on September 29th. Dr Clayton's lecture was the 50th Rankine Lecture prepared and delivered earlier in 2010 for the British Geotechnical Association.



**Dr Robert Holtz** delivered the fourth Victor Milligan Lecture titled "Reinforced Soil Technology: From Experimental to the Familiar" on November 2. Bob Holtz, Professor of Civil Engineering at the University of Washington in Seattle is the co-author or editor of 10 books and book chapters, including "An Introduction to Geotechnical Engineering" (with W. D. Kovacs, 1981), and was the 2010 Terzaghi Lecturer for the American Society of Civil Engineers.

## CONETEC GRADUATE AWARD



Congratulations to MAsC student **Jon Foster**, the first recipient of the **ConeTec Graduate Award**. This award, endowed by **ConeTec Investigations Ltd**, provides support to graduate students undertaking research related to cone testing or other geotechnical research topics.

Shown here is **David Woeller, PEng**, President of ConeTec, making the presentation. Jon is conducting a study on slope stability in the Ottawa Valley under the supervision of **Dr Andy Take**.

## TUNNELING FIELD COURSE



**Dr. Nicholas Vlachopoulos** (cross-appointed to Queen's Geology from RMC) organized a very successful field course for the tunnelling students within the Queen's Geol/Geol Eng Dept. In collaboration with the National Technical University of Athens and the University of Thessaloniki (northern Greece), the 1 week course involved circumnavigating Greece and visiting tunnelling sites (road, rail, LRT) throughout the country in limestones, clays, gneiss, molassic rocks, flysch, phyllites, ophiolites, basement schists and fault zones. Tunnels in various construction stages facilitated student work including geological model construction, seismic hazard prediction, ground classification and tunnel design with presentations in the evenings. Participants included **Mark Diederichs** and MSc students **Connor Langford**, **Dani Delaloye**, **Anna Crockford**, **Colin Hume** and **Jeffrey Oke**.

## AWARDS AND OTHER HONOURS



**March 2010**

Congratulations to Ms **Azadeh Hoor** who has won the **34th Annual Michael Bozozuk Student Forum**, a competition for graduate students at Carleton, Ottawa, Queen`s and RMC. Azadeh`s presentation described part of her doctoral research work with **Dr Kerry Rowe**, examining how the longevity of leachate collection pipes is enhanced by active cooling to mitigate the high temperatures that can develop in landfills.



**April 2010**

The Natural Sciences and Engineering Research Council of Canada (**NSERC**) recently announced substantial increases in **Discovery Grant** funding to three Centre members.

**Dr Mark Diederichs** had his NSERC discovery grant increased by 126% for his project titled "Improved mechanical models & engineering management strategies for the excavation damage zone (EDZ) in sedimentary rocks around underground nuclear waste".



**Dr Kent Novakowski** was given a 62% increase in his Discovery grant for his project titled "The role of the overburden-bedrock contact and upper bedrock properties in the recharge and contamination of shallow bedrock aquifers".

**Dr Andy Take** had his grant increased by 170% for his project titled "Effects of climate and climate change on the soil slopes of our natural and built environment".



Andy and Mark have also been awarded **Discovery Accelerator Supplements** of \$120,000 to boost their productivity even further over the next few years. These additional awards are exceptional, since these were two of only thirty awarded to all engineering scholars across Canada in 2010. Two other GeoEngineering team members already have these grants, so our team has a 25% success rate (the national success rate is 4%).

Discovery Grants are a key source of research support to Engineering Scholars in Canada since they promote open enquiry into research problems deemed of interest to the recipients in a way that other project-specific funding cannot. The competition for these funds has become intense in recent years, and these extraordinary increases place the level of support for these three scholars well over the average for their peers across Canada, strengthening the high level of research funding won by our team.





#### May 2010

Congratulations to Mr. **Kazi Rahman** who won the annual graduate student poster competition at the **2010 NoDig conference** of the North American Society of Trenchless Technology, held in Chicago during May. His poster outlined part of his doctoral research on three dimensional analysis of pipe bursting, conducted under the supervision of **Drs. Richard Brachman** and **Ian Moore**.



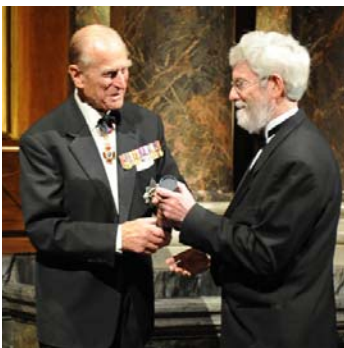
#### June 2010

The International Geosynthetics Society awarded Mr. **Saman Zarnani** (PhD candidate under the supervision of **Dr. Bathurst**) the **Young IGS Member Achievement Award** based on an international competition. This is an award that is given biennially to a young researcher under the age of 36 in the area of geosynthetics. It is very unusual for such a young person so early in their career to be recognized for outstanding technical contributions to the geosynthetics discipline.



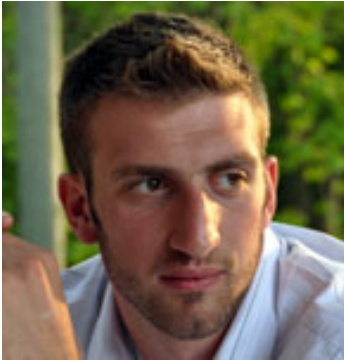
Dr. **Richard J. Bathurst** was awarded the **biennial International Geosynthetics Society Gold Medal Award** for his technical contributions to the advancement of geosynthetics in earth retaining wall technologies.

Dr. Bathurst has now won this medal for an unprecedented third time. He was the first Canadian to receive the medal (1994), the first person to receive it twice (1998) and now the first person to receive it three times.



#### July 2010

Kerry Rowe was elected as Fellow of the Royal Academy of Engineering in London, England. He is one of only six international Fellows, and the only Canadian, whose election was announced at the academy's annual general meeting in London on July 5. Kerry has previously been elected Fellow of both the Royal Society of Canada and the Canadian Academy of Engineering as well as professional societies in Canada, USA and Australia. This honour was bestowed by Prince Phillip at a ceremony in the UK in the Fall.



## August 2010

Congratulations to **Mr. Jeffrey Oke** who has recently won multiple awards. He has recently been awarded the Alexander Graham Bell Canada Graduate Scholarships and NSERC Postgraduate Scholarship awarded to high-calibre scholars who are engaged in master's or doctoral programs in the natural sciences or engineering.

Upon his recent graduation from the Royal Military College of Canada he recently won the following awards: The W.M. Carleton Monk Memorial Scholarship, the J.F. Lott Award, the Navy League of Canada Prize, the Commander Arturo Prat Leadership Award, and the Randy Gregg Award of Canadian Interuniversity Sport. Jeffrey is currently enrolled in a Master's program under the supervision of **Dr. Nicholas Vlachopoulos**. We congratulate Jeff on his recent outstanding achievements and welcome him to our team.



**Dr. Nicholas Vlachopoulos** received grants from Department of National Defence Grants within the GeoEnvironmental field amounting to \$400K. This funding will, in part, support the ongoing graduate work of recent graduate students, **Ms. Tina Basso** (Queen's - Masters of Environmental Science) and **Mr. David Thebault** (RMC – Masters in Environmental Engineering). Congratulations to Dr. Vlachopoulos for his continued success and to Tina and David for their acceptance to their respective programs.



## September 2010

Mr **Saman Zarnani** (PhD candidate under the supervision of **Dr. Bathurst**) won the annual graduate student competition of the Canadian Geotechnical Society, and presented his lecture titled "Application of EPS Geofoam for Seismic Buffers in Rigid Retaining Walls" at a plenary session at the 63rd Annual Canadian Geotechnical Conference in Calgary on Tuesday September 14th. Congratulations also to undergraduate student **Eric Wolinsky**, who received second place in the undergraduate competition for his thesis titled "Application of Digital Signal Processing to the Measurement of Landslide Acceleration Using PIV Image Analysis" (Civil Engineering, Queen's; Advisor, **Dr. Take**), and to **Jennifer Brown** and **Candice Cooney** who won second place for their group report titled "Mapping Heat Transfer of Gas and Leachate Production at Closed Landfill Sites" (Department of Geological Sciences and Geological Engineering at Queen's; Advisor Steven Rose).





Congratulations to **Dr Richard Brachman** for receiving the 2010 Geosynthetics Award of the Canadian Geotechnical Society. This award, made at the Canadian Geotechnical Conference in Calgary was awarded by the Geosynthetics Division of the CGS, in recognition of a number of Richard's recent contributions to Geosynthetics research and practice.



**John Cholewa, Richard Brachman, and Ian Moore** received an honourable mention for the R.M. Quigley Award, for their paper in the Canadian Geotechnical Journal in 2009 "Response of a polyvinyl chloride water pipe when transverse to an underlying pipe replaced by pipe bursting". This article reports on part of John's doctoral project on pipe installation using directional drilling and pipe bursting; it provides experimental evidence and a new design procedure for assessing the impact of pipe bursting on other pipe infrastructure.



#### **December 2010**

**Dr Kerry Rowe** has been awarded the **Tier 1 Canada Research Chair in Geotechnical and Geoenvironmental Engineering**, representing an investment of \$1.4M over the next seven years. Our society generates a wide range of wastes, including municipal, industrial, hazardous, nuclear and mine waste, and Dr Rowe's research focuses on the measures in place in waste-disposal sites to ensure environmental protection, recognizing that some of them can, and will, fail at some time. This appointment to a Tier 1 (Senior) Canada Research Chair recognizes his world-leading expertise in both geotechnical and geoenvironmental aspects of the environmental protection systems in waste-disposal sites, including covers, systems to collect garbage fluids, and liners. Whether the natural (e.g., soils, such as gravel) or manmade materials (e.g., plastics), his research is addressing the question of how long it will last and what happens if it fails. The Canada Research Chair program is funded by the Government of Canada "to attract and retain some of the world's most accomplished and promising minds" (see <http://www.chairs-chaire.gc.ca/home-accueil-eng.aspx>).



At the annual meeting of the Japan IGS Chapter in Tokyo on 2 December, **Dr. Bathurst** and his colleague Dr. Miyata at the National Defense Academy in Japan were awarded the 2010 TECHNICAL ACHIEVEMENT AWARD of the IGS Japan Chapter for their work developing the K-stiffness Method for geosynthetic reinforced soil walls.

## Systems Training and Education in Water Assets Research and Development - STEWARD

STEWARD is a collaborative NSERC CREATE graduate training program between Dalhousie University and Queen's University, which aims to contribute to the advancement of Buried Infrastructure Water Technologies. It involves GeoEngineering Centre members **Ian Moore**, **Richard Brachman**, **Kerry Rowe**, **Greg Siemens**, and **Andy Take**, with Queen's colleagues **Yves Filion** and **Pascale Champagne**, academic collaborators Craig Lake, Graham Gagnon and others at Dalhousie University, and industry (Halifax Water, Utilities Kingston, and Stantec). The \$1.65M program has four themes:

- A. Water Quality in Distribution Systems.
- B. Buried Pipe Infrastructure Design, Assessment and Repair
- C. Water Protection Issues Associated with Buried Infrastructure
- D. Sustainable Distribution and Collection System Design and Optimization

The objective is to offer new training experiences and opportunities for graduate students in a variety of Civil Engineering sub-disciplines associated with municipal water and waste water systems. Thirteen students are now participating.

Dr Craig Lake (Dalhousie) conducts a tour of their water quality laboratory for Dr Yves Filion (Queen's) during the recent visit for the first annual STEWARD colloquium.





# Casey Station, the Commonwealth of Australia.

Design, construction and monitoring of experimental containment areas to be used for the treatment of fuel contaminated soil at Australia's Casey Station, Antarctica.

## **Rebecca McWatters**

Postdoctoral Fellow, *GeoEngineering* Centre at Queen's-RMC

## Supervised by **R. Kerry Rowe**

Professor and Canada Research Chair in Geotechnical and Geoenvironmental Engineering

This research involves the design, construction and monitoring of experimental containment areas (biopiles) used for the treatment of hydrocarbon contaminated soil at Australia's Casey Station in Antarctica. This involves remediation of approximately 600m<sup>3</sup> of soil contaminated by Special Antarctic Blend (SAB) diesel, ATK (aviation fuel) and other hydrocarbons. An aeration system within the biopile is used to extract hydrocarbons, while nutrient addition is added to enhance hydrocarbon degradation in the cold region environment. Research will be focused on the long-term performance of geosynthetics used in containment design to impede advective and diffusive contaminant migration (total hydrocarbons and volatile organic compounds). Geosynthetics include HDPE geomembranes, geocomposite clay liners (GCLs) and geotextiles. Contaminant migration through the barrier system will be monitored in the field using a system of monitoring pipes and sample extraction areas. Samples of the geomembranes, GCLs and geotextiles will be exhumed periodically to study changes in physical and diffusive properties with age and exposure to freeze-thaw conditions and cold region environments. This project is a collaboration between the Australian Antarctic Division of Kingston, Tasmania, Australia, Monash University, Melbourne, Victoria, Australia and Queen's University, Kingston, Ontario, Canada.



Liner construction in Antarctica



Rebecca installing sensors on the liner in Antarctica

# NCHRP 15-38 : Structural design requirements for culvert joints.

David Becerril (PhD Student), Yu Wang (MSc Student).

Supervised by Ian Moore in collaboration with Halil Sezen (Ohio State University)

Sponsor: The National Collaborative Highway Research Program of the Transportation Research Board (US Academy of Sciences) see <http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2510>

Objectives: The objective of this research is to develop structural design requirements for joints in flexible and rigid culverts to withstand variations in construction, support, and loading conditions. These requirements shall be suitable for consideration for adoption by the AASHTO Highway Subcommittee on Bridges and Structures. The work features field-scale testing in the GeoEngineering laboratory at Queen's, field testing in Ohio, and three dimensional finite element analyses.



Field testing in Ohio

David Becerril monitoring one of his experiments.



Jointed concrete, steel and HDPE pipes before burial and testing in the large test pit at West Campus.

## 2010 Graduates

The following GeoEngineers associated with the Centre have recently completed their training, and have moved on to the next phase of their career.

- Jennifer Kavalench, MSc, (supervisor Heather Jamieson) October 2010, AMEC, Mississauga
- Ryan Brunt, MES, (supervisor Heather Jamieson) April 2010, Agriculture Canada
- Zoey Walden, MES, (supervisor Heather Jamieson) December 2010, Canadian Energy Research Institute
- Müge Balkaya, PhD, (supervisor Ian Moore), March 2010, postdoctoral position at Istanbul Technical University
- Khaled Abdelatty, PhD, (supervisor Kerry Rowe) 2010, Assistant professor, Zagazig University, Egypt
- Rebecca McWatters, PhD, (supervisor Kerry Rowe) 2010, PDF Queen's University
- Binguang Huang, PhD, (supervisor Richard Bathurst) 2010, AMEC, Edmonton.

## Recent Publications

### A

Ampiah, N.A., Fam, A. and Moore, I.D. 2010. Effect of wrinkles on circumferential strength of cast-in-place composite polymer liner used in retrofitting pressure pipes, ASCE, J. Materials in Civil Eng. Journal of Materials in Civil Engineering, Vol. 22, No. 12. pp. 1304-1314.

Andrade, C.F., Jamieson, H.E., Praharaj, T., Fortin, D., Kyser, T.K. 2010. Biogeochemical cycling of arsenic in mine-impacted sediments and co-existing pore waters. Applied Geochemistry 25, 199–211.

Azad, F.M, Airey, D.W, Rowe, R.K., and El-Zein, A. 2010. "Laboratory Investigation of Thermally Induced Desiccation of Secondary Geosynthetic Clay Liner on the Base of Double Composite Liner Systems" 6<sup>th</sup> International Conference on Environmental Geotechnics, New Delhi, November 2010, 354-359.

### B

Bathurst, R.J. and Huang, B. 2010. A geosynthetic modular block connection creep test apparatus, methodology and interpretation, ASTM Geotechnical Testing Journal, Vol. 33, No. 2, 103-111.

Bathurst, R.J., Miyata, Y. and Allen, T.M. 2010. Invited plenary paper. Facing displacements in geosynthetic reinforced soil walls. Earth Retention Conference 3 (ER2010), ASCE Geo-Institute, Bellevue, Washington 1-4 August, 18 p.

Bathurst, R.J., Allen, T.M. and Huang B. 2010. Invited panel paper. Current issues for the internal stability design of geosynthetic reinforced soil, 9th International Geosynthetics Conference, Guaruja, Brazil, 23-27 May, pp. 533-546.

Beddoe, R.A., Take, W.A. and Rowe, R.K. 2010. "Development of suction measurement techniques to quantify the water retention behaviour of GCLs", *Geosynthetics International*, 17(5): 301 –312.

Bostwick, L.E., Rowe, R.K., Take, W.A. and Brachman, R.W.I. 2010 "Anisotropy and directional shrinkage of geosynthetic clay liners", *Geosynthetics International*, 17(3): 157-170.

Brachman, R.W.I, Gudina, S., Rowe, R.K. and Take, W.A. 2010. "Adhesion from supplemental bentonite placed at GCL overlaps", 63<sup>st</sup> Canadian Geotechnical Conference, Calgary, September 2010, 1359-1364.

Brachman, R.W.I., McLeod, H.A., Moore, I.D. and Take, A.W.A. 2010 Three-dimensional ground displacements from static pipe bursting in stiff clay, *Canadian Geotechnical Journal*, Vol. 47(4), pp. 439-450.

Brachman, R.W.I., and Sabir, A. 2010. Geomembrane puncture and strains from stones in an underlying clay layer, *Geotextiles and Geomembranes*, 28(4): 335-343.

Brachman, R.B., Mak, A.C. and Moore, I.D. 2010. Ultimate limit state of a deep-corrugated large-span box culvert, *Transportation Research Record*, No. 2201: 55-61.

## C

Chehab, A.G. and Moore, I.D. 2010. Pipe-Soil Shear Interaction Stiffness in Horizontal Directional Drilling and Pipe Bursting, *Geomechanics and Geoengineering*, Vol. 5, No. 2, pp. 69-77.

Chehab, A.G. and Moore, I.D. 2010. Parametric study examining the short and long term response of HDPE pipes when installed by horizontal directional drilling. *Tunnelling and Underground Space Technology*, Vol. 25, pp: 782–794.

Cholewa, J.A., Brachman, R.W.I., and Moore, I.D. 2010. Stress-strain measurements for HDPE pipe during and after simulated installation by horizontal directional drilling, *Tunnelling and Underground Space Technology*, 25(6): 773-781.

Cholewa, J.A., Brachman, R.W.I., and Moore, I.D. 2010. Effectiveness of viscoelastic models for prediction of tensile axial strains during cyclic loading of high-density polyethylene pipe, *ASCE J. Pipeline Systems Engineering and Practice*, 1(2): 77-83.



Clyde, E.J., Champagne, P., Jamieson, H.E. 2010. The use of passive treatment alternatives for the mitigation of acidic drainage at the Williams Brothers Mine, California: Bench-Scale Study. *Applied Geochemistry* 25, 958-971.

Corriveau, M.C., Jamieson, H.E., Parsons, M.B., Campbell, J.L., Lanzirotti, A. 2010b. Direct characterization of airborne particles associated with arsenic-rich mine tailings: Particle size, mineralogy and texture. *Applied Geochem.* (in press).

#### D

Dickinson, S., Brachman, R.W.I., and Rowe, R.K. 2010. Thickness and hydraulic performance of geosynthetic clay liners overlying a geonet, *ASCE Journal of Geotechnical and Geoenvironmental Engineering*, 136(4): 552-561.

Dickinson, S., and Brachman, R.W.I. 2010. Permeability and internal erosion of a GCL beneath coarse gravel, *Geosynthetics International*, 17(3): 112-123.

Dittrich, J.P., Rowe, R.K., Becker D.E. and Lo, K.Y. 2010. "Influence of ex-solved gases on slope performance at the Sarnia approach cut to the St. Clair tunnel", *Canadian Geotechnical Journal*, 47(9): 971-984.

#### F

Fawcett, S.E., Jamieson, H.E. 2010. The Distinction between ore processing and post-depositional transformation on the speciation of As and Sb in mine waste and sediment *Chemical Geology*, Published online February 2010.

#### H

Hegele, P.R., K.G. Mumford 2010, Analysis and simulation of gas flow in saturated porous media, Poster presentation at the Queen's University Water Research Group Student Symposium, Kingston, ON, September 24, 2010.

Hosney, M.S. and Rowe, R.K. 2010. "GCLs for use in covers over arsenic-contaminated mine wastes", 63<sup>st</sup> Canadian Geotechnical Conference, Calgary, September 2010, 1162-1169.

Huang, B., Bathurst, R.J., Hatami, K. and Allen, T.M. 2010. Influence of toe restraint on reinforced soil segmental walls, *Canadian Geotechnical Journal*, Vol. 47, No. 8, 885-904.

#### J

Jeong, H.-Y. and Moore, I.D. 2010. Calculations for central stress minimum under sand piles using continuum analysis, *Zeitschrift für Angewandte Mathematik und Mechanik (J. for Applied Mathematics and Mechanics)*, Vol. 90, No. 1, pp. 65 – 71.

Jones, D., McWatters, R.S., Rowe, R.K. and Markle, J. 2010. "PCB migration in a 24 year old PCB Storage Facility", 63<sup>st</sup> Canadian Geotechnical Conference, Calgary, September 2010, 1400-1405.

## K

Kalenchuk, K.S., Hutchinson, D.J. and Diederichs, M.S. 2010. Analysis of Beaugard Landslide deformation patterns using integrated data from multiple slope monitoring sources. Can. Young Geotech. Eng. Geol. Conf. Waterton, AB.

Kalenchuk, K.S., Hutchinson, D.J. and Diederichs, M.S. 2010. Development and calibration of numerical models for investigating trigger scenarios and mitigation techniques for massive landslide hazard management. Proc. of Geo2010 – Canadian Geotechnical Conference, Calgary, AB: 8 pages.

Kalenchuk, K.S., Hutchinson D.J., Diederichs M.S., Barla G., Barla M. and Piovano G. 2010. Numerical modelling of the Beaugard landslide, a comparison of two approaches to mixed continuum discontinuum numerical simulations. Proc. of Eurock 2010: Lausanne, Switzerland: 639-642.

Krol, M.M., K.G. Mumford, R.L. Johnson, B.E. Sleep. 2010. Effect of gas bubble mobilization on contaminant transport during thermal remediation, Abstract H53F-1134, Poster presentation at the 2010 Fall meeting, AGU, San Francisco, CA, December 13-17, 2010.

## L

Lake, C.B. and Rowe, R.K. 2010. Contaminant Transport Through GCL-based Liner Systems, Chapter 5 in Geosynthetic Clay Liners for Waste Containment Facilities, A. Bouazza and J.J. Bowders, Jr. Eds., CRC Press, ISBN: 9780415467339, ISBN 10: 0415467330, pp. 85-104.

Lange, K., Rowe, R.K. and Jamieson, H. 2010. The potential role of geosynthetic clay liners in mine water treatment systems, Geotextiles and Geomembranes, 28(2):199-205.

Lange, K., Rowe, R.K. Jamieson, H., Flemming, R.L., and Lanzirrotti, A. 2010. Characterization of geosynthetic clay liner bentonite using micro-analytical methods, Applied Geochemistry, 25(7):1056-1069.

Lato, M., Diederichs, M., Hutchinson, D.J. 2010. Bias correction for Lidar scanning of rock outcrops for structural characterization Rock Mechanics and Rock Eng., 43 (5), 615-628.

Lato, M., Diederichs, M.S., and Hutchinson, D.J. 2010. Evaluating roadside rockmasses for rockfall hazards from LiDAR data: optimizing data collection and processing protocols. Proc. of EUROCK 2010, Lausanne, Switzerland, June.

Lato M, Hutchinson D, and Diederichs M. 2010. Geomechanical feature extraction and analysis using LiDAR data: IOC Mine. CIM Bulletin, Dec 2009 / January 2010 , 4 (8), Paper 12.

## M

McWatters, R. and Rowe, R.K. 2010. Diffusive transport of VOCs through LLDPE and two Co-Extruded Geomembranes, ASCE Journal of Geotechnical and Geoenvironmental Engineering, 136(9): 1167-1177.

Meunier, L., Walker, S.R., Koch, I., Wragg, J. Parsons, M.B., Jamieson, H.E., Reimer, K.J. 2010. Effects of Soil Composition and Mineralogy on the Bioaccessibility of Arsenic from Tailings and Soil in Gold Mine Districts of Nova Scotia. *Environmental Science Technology* 44, 2667–2674.

Miyata, Y., Bathurst, R.J., Konami, T. and Dobashi, K. 2010. Influence of transient flooding on multi-anchor walls, *Soils and Foundations*, Vol. 50, No. 3 (June) 373-384.

Miyata, Y., Bathurst, R.J. and Konami, T. 2010. Uncertainty of load-resistance models in design of multi-anchor reinforced soil walls, *Proc. of 9th national symposium on ground improvement*, Fukui, Japan. pp. 265-270 (in Japanese).

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Mumford, K.G., D.M. O'Carroll 2010. Effect of contact line friction on dynamic effects in capillary pressure, Poster presentation at the 2010 Gordon Research Conference for Flow and Transport in Permeable Media, Lewiston, ME, July 11-16, 2010.

Mumford, K.G., J.E. Smith, S.E. Dickson 2010. Transport of volatile contaminants in groundwater by gas expansion and mobilization above a dense nonaqueous phase liquid pool, *Geochimica et Cosmochimica Acta*, 74(11) Supplement 1, A737, Presented at the 2010 Goldschmidt conference in Knoxville, TN, June 13-18, 2010.

Mustafa, N., K.G. Mumford, D.M. O'Carroll, J.I. Gerhard. 2010. Assessing the risk of organic contaminants at off-site receptors, Poster presentation at Canadian Brownfields 2010, Toronto, ON, November 1-3, 2010.

## O

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## P

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## Q

Quinn P.E., Hutchinson, D.J., Diederichs, M.S., Rowe, K. 2010. Regional scale landslide susceptibility mapping using the weights of evidence method: An example applied to linear infrastructure. *Canadian Geotechnical Journal*, 47 (8), 905-927.

## R

Rowe, R.K. 2010. Role of GCL's in controlling leakage through composite liners, Keynote lecture, 3rd International Symposium on GCLs, Würzburg, Germany, September 2010, 3-13.

Rowe, R.K. and Abdelaal, F.B., Islam, M.Z., and Hsuan Y.G. 2010. The strange effect of increasing temperature in accelerated ageing of HDPE geomembranes immersed in liquids, 9th Int. Conf. on Geosynthetics, Guarujá, Brazil, May 2010, 793-798.

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Rowe, R.K., Hoor, A. and Pollard, A. 2010. Examination of a method for reducing the temperature of MSW landfill liners, *ASCE Journal of Environmental Engineering*, 136(8): 794-803.

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#### T

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#### V

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#### Y

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#### Z

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## PERSONNEL

<b>MSc Students</b>	Supervisors
Ashe, Lauren	Rowe, Civil, QU
Bailey, Brennan	Hutchinson, Geological
Bassa, Tina	Vlachopoulos, Civil, RMC
Branscombe, Laura	Diederichs, Geological
Brunt, Ryan	Jamieson, Whitelaw, Geological/Biosciences
Drysdale, Jessica	Jamieson, Geological
Dunlop, Stephen	Hutchinson, Geological
Elliot, T.	Hutchinson, Geological (Waterloo)
Elmhirst, Laura	Novakowski, Civil, QU
Fekete, Stephanie *	Diederichs, Geological
Foster, Jonathan *	Take, Brachman, Civil,QU
Ghazvinian, Ehsan *	Diederichs, Geological
Grell, Stephanie	Novakowski, Civil, QU
Hannon, Chris	Take, Civil, QU
Hume, Colin *	Diederichs, Geological
Irfan, Huma*	Rowe, Civil, QU
Jaggard, Heather	Jamieson, Geological
Jones, Daniel	Rowe, Civil, QU
Kavalench, Jennifer	Jamieson, Geological
Langford, C.	Vlachopoulos, Civil, QU
Lay, Geoff	Brachman, Civil, QU
Liu, Kaiwen *	Rowe, Civil, QU
Mai, Van	Moore, Civil, QU
Martin, Eric	Kueper, Civil, QU
McKenzie, Brendan	Brachman, Civil, QU
Oghabi, Pegah	Moore, Civil, QU
Oke, Jeffrey	Diederichs, Geological, QU, Vlachopoulos, Civil, RMC
Chris Oldroyd	Siemens, Civil, RMC
Peters, Stephen	Siemens, Civil, RMC (completed January 2011)
Sealey, Heather	Jamieson, Geological
Sheppard, Amanda	Take, Civil, QU
Smith, Reid	Novakowski, Civil, QU
Snelling, Paige	Godin, McKinnon, Geological
Snyder, James	Archibald, Mining
Swartz, Howard	Moore, Civil, Qu
Thebault, David	Vlachopoulos, Civil, QU
Thompson, Justin	Archibald, Mining
Trimper, Shawn	Novakowski, Civil, QU
Verge, Ashley	Rowe, Civil, QU
Walden, Zoey	Jamieson, Geological/BioSciences
Wang, Yu	Ian Moore, Civil, QU
Wemp, Ashley	Kueper, Civil, QU

Wolinsky, Eric	Take, Civil, QU
<b>PhD</b>	Supervisors
Abdel-Aal, Fady *	Rowe, Civil, QU
Abdelatty, Khaled *	Rowe, Civil, QU (completed 2010)
Almahakeri, Mohamed	Moore, Fam, Civil, QU
Baird, Alan	McKinnon, Mining
Balkaya, Muge	Moore, Civil, QU (completed 2010)
Becerill, David	Moore, Civil, QU
Beddoe, Ryley *	Take, Rowe, Civil, QU
Brown, Mike	Moore, Fam, Civil, QU
Carvalho-Maia, J.A.	Diederichs, Geological
Chappel, Melissa *	Brachman, Rowe, Civil, QU
DeGagne, Dave	McKinnon, Mining
De Sisto, Stephanie	Jamieson, Parsons, Geological
Elshimi, Tamer *	Moore, Brachman, Civil, QU
Ewais, Amr *	Rowe, Civil, QU
Ezzein, Fawzy *	Bathurst, Civil, RMC
Goveas, Len *	Rowe, Take, Civil, QU
Hansen, Scott *	Kueper, Civil, QU
Hoor, Azadeh *	Rowe, Civil, QU
Hosney, Mohamed *	Rowe, Civil, QU
Huang, Bing Quan *	Bathurst, Civil, RMC (completed 2010)
Joshi, Prabeen*	Rowe, Civil, QU
Kalenchuk, Katherine *	Diederichs, Hutchinson, Geological
Khader, Omar	Novakowski, Civil, QU
Kozuskanich, John	Novakowski, Civil, QU
Lato, Matt *	Hutchinson, Diederichs, Geological
Lim, Bee Fong *	Siemens, Civil, RMC
Mabrouk, Ahmed *	Rowe, Civil, QU
Mah, Jason	Samson, McKinnon, Mining
Mann, Vanessa	Novakowski, Civil, QU
Martin, Eric	Kueper, Civil, QU
McWatters, Rebecca *	Rowe, Civil, QU (completed 2010)
Perras, Matthew	Diederichs, Geological
Praamsma, Titia *	Novakowski, Civil, QU
Rahman, Kazi *	Moore, Brachman, Civil, QU
Rodriguez, David	Kueper, Civil, QU
Sabir, Ali *	Brachman, Civil, QU
Saheli-Taghizadeh, Pooneh *	Rowe, Civil, QU
Saiyar Sarai, Masoumeh *	Moore, Take, Civil, QU
Schauerte, Morgan	Novakowski, Civil, QU
Taechakumthorn, Chalermopol *	Rowe, Civil, QU
Vallejos, Javier	McKinnon, Mining
Yu, Yan *	Rowe, Civil, QU
Zarnani, Saman *	Bathurst, Civil, QU

<b>Research Directors</b>	<b>Areas of Expertise</b>
James Archibald	Geomechanics and Geosynthetics
Richard Bathurst	Geotechnical and Geosynthetics
Richard Brachman	Geotechnical, Geoenvironmental, and Geomechanics
Mark Diederichs	Geotechnical and Geomechanics
Jean Hutchinson	Geotechnical and Geomechanics
Heather Jamieson	Geochemistry and Geoenvironmental
Bernard Kueper	Geoenvironmental and Hydrogeology
Steve McKinnon	Geomechanics and Geotechnical
Ian Moore	Geotechnical, Geosynthetics, and Geomechanics
Kevin Mumford	Hydrogeology and Geoenvironmental
Kent Novakowski	Geoenvironmental and Hydrogeology
Gerald Raymond	Geotechnical and Geosynthetics
Vicki Remenda	Hydrogeology and Geoenvironmental
Kerry Rowe	Geoenvironmental, Geosynthetics, and Geotechnical
Greg Siemens	Geotechnical and Geosynthetics
Andy Take	Geotechnical and Geomechanics
Nicholas Vlachopoulos	Geotechnical, Geoenvironmental and Geomechanics
<b>Associate Research Directors</b>	
Edwin Safari	Geotechnical and Geoenvironmental
<b>Associate Members</b>	
Rob Harrap	Geographical Information Systems, Hazard Mapping
John Poland	Environmental Assessment and Remediation
Ken Reimer	Environmental Assessments and Biotechnology
Allison Rutter	Environmental Remediation and Analysis
Stephen Walker	Geochemistry and Geoenvironmental