

**Education**

*B.Sc. (Hons), James Cook University, 1986*

**Golder Associates Ltd. – Calgary and Yellowknife*****Principal, Senior Water Quality Specialist***

John is a Principal and senior water quality specialist in the Calgary and Yellowknife offices. He has over 25 years of experience undertaking and managing surface water quality and limnological assessments of river and lake, and inshore marine environments.

John has been with Golder for over 11 years. Prior to joining Golder, John spent the majority of his professional career working on the east coast of northern Australia at the Australian Centre for Tropical Freshwater Research at James Cook University, Townsville, Queensland. While at the Centre, John managed the consulting component of the business, as well as its analytical service laboratory, and collaborated on a number of research projects that focused on freshwater and marine environments. Relevant work John undertook while at the Centre included the assessment of effects of mining and refinery operations to freshwater and inshore marine receiving environments, and the assessment of effects of agricultural runoff to coastal rivers and nearshore environments.

Since joining Golder, John has worked as a component lead, project manager, senior technical advisor, technical director, and project director for projects involving water quality baseline and assessment studies and environmental impact assessments. These projects have focused on mining and municipal business sectors. Although John's background is water quality, John's work at Golder has predominantly been associated with leading baseline and environmental impact assessments for mining projects in north-western Canada; the key mining projects John has been involved with include the environmental assessment, permitting processes, and annual environmental monitoring for the De Beers Gahcho Kué Diamond Mine, the Fortune NICO, and Dominion Diamond Mine Jay projects, as well as the annual aquatic effects monitoring program for the operational De Beers Snap Lake Diamond Mine. The key municipal project John has been involved with is leading the annual environmental monitoring program for the City of Edmonton, which he has been associated with since he joined Golder.

Currently, John splits his time 50/50 working from the Calgary and Yellowknife offices.

**Employment History*****Golder Associates Ltd. – Calgary, Alberta***

*Principal (appointed 2014), Senior Water Quality Scientist (2007 to Present)*

Design, implementation, management, and interpretation of water quality investigations, including environmental baseline studies and components of environmental impact assessments (EIAs); project coordination, management, and direction; report preparation; and senior technical review of environmental assessment reports.

**Australian Centre for Tropical Freshwater Research, James Cook University –  
Townsville, Queensland**

*Senior Water Quality Scientist / Water Quality Laboratory Manager  
(2002 to 2007)*

Design, implementation, management, and interpretation of commercial, municipal and industrial water quality assessments, environmental baseline studies and EIAs, and water quality research projects. Duties included external project development and management, staff management, report preparation, and public presentations. Concurrently managed a water quality laboratory that was responsible for water and sediment quality analysis.

**Australian Centre for Tropical Freshwater Research, James Cook University –  
Townsville, Queensland**

*Water Quality Scientist/Chemist (1988 to 2002)*

Assisted in the design, implementation, management, and interpretation of water quality research projects. Duties included planning and undertaking field surveys, laboratory analyses of water and sediment quality analyses, and preparation of proposals and reports.

**Department of Botany, James Cook University – Townsville, Queensland**

*Research Assistant / Demonstrator - Plant Physiology (1986 to 1987)*

Aided in a research program investigating amino acid distribution in C4 plants under sodium deficiency utilizing gel electrophoresis techniques. The position also demonstrated to third-year plant physiology practical classes.

**Department of Geology, James Cook University – Townsville, Queensland**

*Research Assistant (1985 to 1986)*

Aided in a research program funded by the Great Barrier Reef Marine Park Authority investigating the occurrence of crown-of-thorn starfish skeletal remains in vibra-core reef sediment samples collected from the Great Barrier Reef to determine outbreak frequency in recent history.

## PROJECT EXPERIENCE – MINING EXPERIENCE

**De Beers Gahcho Kué  
Mine – Environmental  
Impact Statement (EIS)  
/ Permitting /  
Monitoring /  
Regulatory Support  
Northwest Territories,  
Canada**

John is currently the Project Director for all Golder work being conducted at this mine (since 2016). In 2007, John started as the Aquatic Components Coordinator for the initial EIS phase of the Project (2007 to 2009), which included managing an external consultant retained by De Beers for completion of several of the aquatic component sections for the EIS. From 2012, John transitioned into the Technical Director leading the Golder technical team through a rewrite of the EIS and the EIR process with MVEIRB, and through the permitting process. These roles included participating as an expert panel witness in the MVEIRB and MVLWB technical sessions and public hearings. As Project Director, John is responsible for leading the Golder environment, water resource engineering, and construction teams, reviewing all Golder technical environmental products, including De Beers' environmental regulatory products (when needed), and maintaining a high level of engagement with the De Beers project teams (2007 to current).

**Baseline/EA/Permitting  
Dominion Diamond Jay  
Project**

Northwest Territories,  
Canada

John has been the senior water quality technical lead (since 2013) involved in the completion and reporting of water quality baseline data and the water quality assessment for the Developer's Assessment Report (DAR). This work included writing, reviewing, and preparing components of the assessment that involved summarizing the water management plan, describing site mitigation to reduce or eliminate potential Project effects to water quality (and the aquatic receiving environment), and assessing cumulative effects to a key downstream operation.

John supported the Golder and Dominion Diamond project team through the MVEIRB and permitting processes, including attendance at technical sessions and regulatory hearings as an expert panel witness for the water quality component.

John has contributed to the design of the Aquatics Effects Monitoring Program (AEMP) for the Jay Project, and worked with the permitting and engineering teams to develop a Total Suspended Sediment Management and Monitoring Plan for the Dyke Construction process.

**De Beers Snap Lake  
Mine – Monitoring /  
Regulatory Support**

Northwest Territories,  
Canada

John is currently the Project Director for the environmental work being conducted by Golder at this mine site (since 2017). In addition to this role, John has provided senior review and technical support to the AEMP water quality and/or sediment quality component team (since 2008).

**Giant Mine  
Environmental Support  
Services and Civil  
Design Contracts,  
PSPC/AECOM**

Northwest Territories,  
Canada

John is currently the Project Director for the project management team that provides oversight to the technical services delivery teams for a variety of tasks under these two contracts. With PSPC as the primary client, tasks include sub-contracting to AECOM or with AECOM sub-contracting to Golder.

**Giant Mine MMER  
Annual Reporting  
Program, AECOM  
(formerly DCNJV)**

Northwest Territories,  
Canada

John provides senior review and technical guidance to the water quality task lead (since 2010).

**Fortune Minerals NICO  
Project – Baseline / EA  
/ Permitting /  
Monitoring**

Northwest Territories,  
Canada

John was the water quality component lead (2009 to 2014) involved in the completion and reporting of water quality baseline data and water quality assessment for the DAR. The water quality assessment included integrating each of the aquatic components (e.g., hydrology, hydrogeology, sediment quality, aquatic health, and aquatic ecosystems) into the DAR. John participated in the MVEIRB regulatory and the MVLWB permitting processes as an expert panel witness in their respective technical sessions and public hearings.

Since 2016, John has provided project direction supporting the client and project permitting team for aquatics effects monitoring and associated regulatory processes.

**SaskPower Elizabeth  
Falls Project – EA**  
Saskatchewan, Canada

John provided senior review and technical support to the water quality and sediment quality effects assessment component lead and the water quality modelling component lead during the EA process. John also provided technical support to the Golder Project team through the Government and Stakeholder review process (2013 to 2015).

**Farim Phosphate  
Project GB Minerals  
Ltd. – River  
Morphology and  
Physical  
Oceanography  
Baseline Study**  
Guinea-Bissau

John provided senior review and technical support to the water quality component lead, and to the Golder Project team (2013).

**IMG / BP –  
Contaminants  
Sampling Program**  
Nunavut, Canada

John provided senior review and technical support to the field and water quality data analysis component leads during the contaminants program (2011 and 2012). This role included technical review of the field program sampling protocols, analytical techniques, and the water quality report.

**UTS/Teck Cominco  
Equinox Project –  
Water Quality Baseline  
Study**  
Alberta, Canada

John was the component lead (2008 to 2010) involved in the organization, management and preparation of the water quality and sediment quality baseline study for the Equinox Oil Sands development. John was also responsible for providing support and coordination to the client for the Pilot Plant testing program that will service the UTS/Teck Equinox and Frontier Oil Sands developments.

**AREVA Resources –  
McArthur River Ore  
Haulage Project  
Description and EIS**  
Saskatchewan, Canada

John contributed to the aquatic effects analysis of the environmental assessment process in the development of an expansion to the Cigar Lake Mine in northern Saskatchewan (2009 and 2010). The expansion included the construction, operation, and decommissioning of two new parallel pipelines that will deliver and discharge treated water from treatment facilities on the site to a single deep-water point in Seru Bay.

**Cameco Corporation –  
Cigar Lake EA,**  
Saskatchewan, Canada

John contributed to the environmental assessment for the Cigar Lake Mine McArthur River Mine in northern Saskatchewan (2010 and 2011).

**Strateco Resources –  
Water Quality Baseline  
Study – Matoush  
Exploration Ramp  
Project**  
Ontario, Canada

John provided senior review and technical guidance to the water quality component lead for the Project (2009 and 2010).

**DIAND-CARD –  
Tailings Lake  
Investigation, Colomac  
Mine**  
Northwest Territories,  
Canada

John provided senior technical review and guidance to the water quality component lead for the project (2009 and 2010).

**Cameco Corporation –  
Millennium Mine  
Project Proposal**  
Saskatchewan, Canada

John provided technical support for the environmental assessment process in the development of a project proposal for the Millennium Mine development in northern Saskatchewan (2009). This work included reviewing sections of the draft project description (e.g., detailed project information and the existing environment) with particular emphasis on the screening of potential Project effects to the biophysical environment.

## OTHER SELECT PROJECT EXPERIENCE

**City of Edmonton –  
North Saskatchewan  
River Environmental  
Monitoring Program**  
Alberta, Canada

John provides the senior technical review and guidance to the project team for a variety of environmental projects completed for the City, which includes the annual environmental monitoring program (EMP). The work that Golder completes for EMP includes undertaking a series of annual monitoring and sample collection programs in the North Saskatchewan River (NSR), municipal as well as storm sewer and combined sewer outfalls, tributaries to the NSR, and stormwater collection ponds and wetlands programs, deriving annual loading estimates of water quality constituent inputs, and preparing two annual reports (since 2007).

The role has developed from initially undertaking the data analysis and reporting components for the EMP, to currently providing the senior technical direction for the EMP. John has provided senior technical review and guidance for additional City projects, such as the NSR Intensive Intake Monitoring Program, and the Kennedale and Pylypow Wetland Monitoring Programs.

**City of Calgary – Bow  
River Water Quality  
Monitoring Station**  
Alberta, Canada

John provided senior technical review and guidance in the recommendation of a preferred site location of a remote water quality monitoring station on the Bow River downstream of Calgary, and the monitoring infrastructure and equipment required to monitor various water quality parameters in real-time and collect regular, time-based (baseflow) and event-based (stormflow) water samples (2015 to 2017).

**Stantec – Wabamun  
Regional  
Biomonitoring  
Program**  
Alberta, Canada

John provided senior review and technical support to the water quality and sediment quality component leads in this program (2009 to 2014, and 2016). The study area included power station cooling ponds, and adjacent localised lakes and streams.

**Shell Canada Ltd. –  
Environmental Gap  
Analysis / Water  
Quality Baseline Study,  
Groundbirch Project,**  
British Columbia,  
Canada

John provided senior review and technical support to the water quality component for a gap analysis and baseline study for this development (2010 and 2011).

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**PROFESSIONAL AFFILIATIONS**

Australian Freshwater Sciences Society

Australian Water Association

Canadian Society of Limnology

Society of International Limnology

International Water Association

**PUBLICATIONS****Journal Articles**

Chapman, P.M., Hayward, A. and J.W. Faithful. 2017. Total suspended solids effects on freshwater lake biota other than fish. *Bulletin of Environmental Contamination and Toxicology*. 99(4), 423–427.

Faithful, J.W. 2016. Physico-chemical changes in two northern headwater lakes in the Northwest Territories, Canada, during winter to spring transitions. *Journal of Great Lakes Research*. 42, 167-172. DOI 10.1016/j.jglr.2016.01.004

Vandenberg, J.A., Herrell, M., Faithful, J.W., Snow, A.M., Lacrampe, J., Bieber, C., Dayyani, S. and V. Chisholm. 2015. Multiple Modeling Approach for the Aquatic Effects Assessment of a Proposed Northern Diamond Mine Development. *Mine Water and the Environment*. DOI 10.1007/s10230-015-0337-5.

Brodie, J.E., Schroeder T., Rohde T., Faithful J.W., Masters B., Dekker A., Brando V. and M. Maugham. 2010. Dispersal of suspended sediments and nutrients in the Great Barrier Reef lagoon during river discharge events: conclusions from satellite remote sensing and concurrent flood plume sampling. *Marine and Freshwater Research*, 61, 651-664.

Mitchell, A., Reghenzani J., Faithful J.W., Furnas M. and J.E. Brodie. 2009. Relationships between land use and nutrient concentrations in streams draining a 'wet-tropics' catchment in northern Australia. *Marine and Freshwater Research*, 60, 1097-1108.

Bainbridge, Z.T., Brodie J.E., Faithful J.W., Sydes D.A. and S.E. Lewis. 2009. Identifying the land-based sources of suspended sediments, nutrients and pesticides discharged to the Great Barrier Reef from the Tully-Murray Basin, Queensland, Australia. *Marine and Freshwater Research*, 60, 1081-1090.

P.J., O'Reagain, Brodie J., Fraser G., Bushell J.J., Holloway C.H., Faithful J.W. and D. Haines. 2005. Nutrient loss and water quality under extensive grazing the upper Burdekin River catchment, north Queensland. *Marine Pollution Bulletin*, 51, 37-50.

Faithful J.W. and W. Finlayson. 2005. Water quality assessment for sustainable agriculture in the Wet Tropics – A community approach. *Marine Pollution Bulletin*, 51, 99-112.

Faithful J.W. and D.J. Griffiths. 2000. Turbid flow through a tropical reservoir (Lake Dalrymple, Queensland, Australia): responses to a summer storm event. *Lakes and Reservoirs: Research and Management*, 5, 231-247.

Faithful J.W. Phosphorus in Wetlands - A Review. 1997. *Queensland Department of Natural Resources, Brisbane*, ISBN 0 7242 7414 6, 53 pp.

P.D., Walbran, Henderson R.A., Faithful J.W., Polach H.A. and R.J. Sparkes. 1989. Crown-of-Thorn starfish outbreaks on the Great Barrier Reef: a geological perspective based upon the sediment record. *Coral Reefs*, 8, 67-78.

### Conference Proceedings

Herrell, M.K., J. Vandenberg, J.W. Faithful, A. Hayward and L. Novy. In Prep. *Influence of Probability Distribution Function Sampling Frequency on Stochastic Water Quality Model Predictions*. Proceedings of the 11<sup>th</sup> International Conference on Acid Rock Drainage & IMWA Annual Conference, September, 2015. Pretoria, South Africa.

Herrell, M.K., J. Vandenberg, J.W. Faithful, A. Hayward and L. Novy. In Prep. *Long-term Water Management of Saline Groundwater at the Ekati Diamond Mine*. Proceedings of the 11<sup>th</sup> International Conference on Acid Rock Drainage & IMWA Annual Conference, September, 2015. Pretoria, South Africa.

Herrell, M., J. Vandenberg and J.W. Faithful. 2015. *Designing meromictic pit lakes as a mine closure mitigation strategy in northern Canada*. Proceedings of the 10<sup>th</sup> International Conference on Acid Rock Drainage & IMWA Annual Conference, 21-24 April, 2015. Santiago, Chile.

Lewis, S. E., J.E. Brodie, Z.T. Bainbridge, A.M. Davis, J.W. Faithful, L. Liessman, K. Rohde and B. Masters. 2008. *Herbicide residues in waterways draining sugarcane catchments of the Great Barrier Reef*. Proceedings of the 5<sup>th</sup> SETAC World Congress, 3-7 August. Sydney, Australia.

Hately, L.R., J.D. Armour, J. Brodie, J.W. Faithful, G.L. Pitt and P.N. Nelson. 2007. *Modelling, monitoring and sediment tracing in the Tully River catchment, north Queensland: a comparison of techniques*. 2007 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December. Auckland, New Zealand.

Brodie, J., A.G. Dekker, V.E. Brando, B. Masters, J.W. Faithful, R. Noble and K. Rohde. 2006. *Extent and duration of the algal bloom in the Great Barrier Reef lagoon following river discharge events in the Mackay Whitsunday's Region, Australia*. 13<sup>th</sup> Australasian Remote Sensing and Photogrammetry Conference: Earth Observation – from Science to Solutions, November. Canberra.

Cooper, M., G. Shields, J.W. Faithful and J. Zhao. 2006. *Using sediment Sr/Nd isotopic ratios to determine sediment sources in the Burdekin Falls Dam, Queensland, Australia*. 16<sup>th</sup> Annual V.M. Goldschmidt Conference, August - September. Melbourne, Australia.

Cooper, M., J.W. Faithful, T. Steiglitz and G. Shields. 2005. *Sediment dynamics of a large tropical river system: the Burdekin River and Lake Dalrymple, Australia*. 10<sup>th</sup> International Symposium on the Interactions between Sediment and Water, August -September. Bled, Slovenia.

Taylor, J., T. Lloyd, A. Melzer and J.W. Faithful. 2004. *Conserving ecosystems and managing biodiversity in industrial land and seascapes – Yabulu Nickel Refinery experience*. Minerals Council of Australia, Inaugural Global Sustainable Development Conference, October. Melbourne, Australia.

Lukacs, G.P., C. Perna and J.W. Faithful. 2004. *Coastal wetlands of north-eastern Australia: Condition and management interventions*. Seventh Intecol International Wetlands Conference, July. Utrecht, The Netherlands.

Faithful, J.W. and W. Finlayson. 2004. *Water quality assessment for sustainable agriculture in the Wet Tropics – A community-assisted approach*. Catchment to Reef Conference, Great Barrier Reef Marine Park Authority, March. Townsville.

Faithful, J.W. and D. Burrows. 2003. *From blue to brown: persistently elevated turbidity resulting from damming the tropical Burdekin River*. Ninth International Conference on River Research and Applications, July. Albury.

Connor, R., J. Milsom, A. Melzer, B.M. Butler, J.W. Faithful, W. Dennison, T. Lloyd and G. Swain. 2003. *Ecosystem-based assessment and management of marine and estuarine systems at the QNI Yabulu Nickel Refinery, Townsville*. In: Protecting the Values of Rivers, Wetlands and the Reef. From: 2<sup>nd</sup> National Conference on Aquatic Environments: Sustaining our Aquatic Environments - Implementing Solutions, 20 - 23 November 2001, Townsville, QLD, Australia.

**Education**

M.Sc. Biology, York University, North York, Ontario, 1994

B.Sc. Biology, Honours, McMaster University, Hamilton, Ontario, 1991

**Golder Associates Ltd - Calgary****Principal, Fisheries Biologist**

Kristine is a project manager/director and senior fisheries biologist with 20 years of experience in aquatic and fisheries biology. She has field and office-based experience with a wide variety of projects in Alberta, British Columbia, and the Northwest Territories, including fisheries inventory and impact assessment for development projects, such as mining, oil and gas, seismic operations, linear developments and hydroelectric facilities. She has experience in the assessment and mitigation of impacts from a variety of development projects on fish, fish habitat and the aquatic ecosystem. As well as dealing with the scientific and technical aspects of these types of developments, Kristine has also been involved with the regulatory approval process under the Fisheries Act and the Alberta Codes of Practice for crossings under the Water Act.

Kristine has experience as technical director for large, multidisciplinary environmental assessments, and has also managed/directed the fisheries components for large environmental impact assessment projects. Kristine is currently the environmental technical director for the Dominion Diamond Jay Project and previously managed the fish and fish habitat component for the De Beers Gahcho Kué Project in the Northwest Territories. In the Oil Sands Region in Northern Alberta, Kristine managed/directed the fish and fish habitat components for several environmental impact assessments. Kristine was also involved in impact assessment, permit approvals and hearing preparation and support for the fish and fish habitat component of the Mackenzie Gas Project. Kristine has also been the Project Manager/Director for large multidisciplinary environmental assessments projects.

**Employment History****Golder Associates Ltd. – Calgary, Alberta**

*Principal, Senior Fisheries Biologist (2000 to Present)*

Responsible for managing/directing projects or tasks related to environmental assessment, impact mitigation and management, and monitoring of proposed mining, oil and gas, and linear developments in western and northern Canada. Also responsible for senior technical advice, project management, client liaison, proposal preparation, report writing, and regulatory engagement and support

*Aquatics Division Manager (2008 to 2009)*

Division manager responsible for about 40 professionals in the fields of fisheries and water quality as well as support staff. The role included the participation in the office management team, supervision of group manager's activities, financial analysis and reporting, recruiting and personnel management, and contribution to strategic decisions within the division.

*Fisheries Group Manager (2006 to 2008)*

Group manager responsible for about 20 professionals (fisheries biologists and technicians). Responsibilities included scheduling and management of staff, workload allocation, recruitment, budgeting, and financial management.

***Triton Environmental Consultants Ltd. – British Columbia, Canada****Biologist/Project Manager (1996 to 1999)*

Biologist for watershed inventory, fish habitat assessment and impact assessment projects. Field and office experience with a wide variety of environmental projects, including Forest Renewal BC funded lake and stream inventory, stream classification according to the Forest Practices Code, and watershed restoration program. Involved with background review, data analysis and interpretation, and report writing for environmental impact assessments. Responsible for proposal preparation, client liaison and budget tracking for selected projects. Supervised field crews in remote locations and coordinated data collection, entry and analysis, and report preparation.

***Ontario Ministry of Natural Resources – Maple, Ontario****Community Dynamics Biologist (1995 to 1995)*

Statistical analyses and report writing, focusing on salmonid/invertebrate interactions.

***York University, Biology Department – North York, Ontario****Research Assistant / Teaching Assistant (1992 to 1994)*

Limnological assessment including sampling for crayfish, benthic invertebrates, zooplankton and aquatic plants in Lake Simcoe, Ontario. Performed laboratory experiments of crayfish respiration and crayfish predation on salmonid embryos. Modelled effects of crayfish predation rates on the lake trout population of Lake Simcoe. Maintained salmonid embryos and adult crayfish in a wet laboratory. Laboratory assistant for undergraduate courses in Comparative Vertebrate Anatomy, Biology of Animals, Ichthyology and Natural Science.

***Ontario Ministry of Natural Resources – Maple, Ontario****Fisheries Resource Technician (1992 to 1993)*

Limnological, invertebrate and fish sampling. Performed measurements of crayfish distribution and calculated estimates of density.

**PROJECT EXPERIENCE – ENVIRONMENTAL IMPACT ASSESSMENT****Dominion Diamond  
Misery Underground  
Project**

Northwest Territories

Environmental Technical Director during preparation of the supporting information for the water licence and land use permit application and for the initial comment responses.

**Dominion Diamond Jay  
Project**

Northwest Territories

Environmental Technical Director during the environmental assessment review and water licencing processes, including review of Information Request responses, hearing preparation and support, client liaison, regulatory engagement, and coordination with the engineering team. During the development of the Developer's Assessment Report, was the aquatics technical director and fish and fish habitat senior review.

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- Teck Coal Baldy Ridge Extension Project**  
Sparwood, BC
- Project Director for the baseline data collection phase of the environmental assessment for the Teck Coal Baldy Ridge Extension Project. Provided support and direction to the Project Manager. Responsible for final senior review, quality control, and risk management.
- De Beers Canada Inc. Gahcho Kué Project**  
Northwest Territories
- Managed the fish and fish habitat component for the environmental impact statement for the project. Responsible for report preparation, responses to Information Requests, attending regulatory/technical meetings, and development of the Aquatic Effects Monitoring Program. Also involved in providing regulatory support and advice, offsetting planning, and Health and Safety.
- Cenovus Energy Christina Lake Phase H and Eastern Expansion**  
Conklin, AB
- Senior advice and direction to fish and fish habitat component lead on the completion of baseline studies, environmental impact assessment reporting, and preparation of Supplemental Information Requests.
- Cenovus FCCL Kirby West Project**  
Conklin, AB
- Fish and fish habitat component director for the baseline studies for the Cenovus Kirby West project.
- Cenovus Energy Pelican Lake Grand Rapids Project**  
Wabasca, Alberta
- Project Manager for the environmental impact assessment for the Cenovus Pelican Lake Grand Rapids project. Responsible for scheduling, Health and Safety, cost tracking, quality control, report review, client liaison and regulatory advice.
- Cenovus Energy Grand Rapids Pre-Disturbance Assessment**  
Wabasca, Alberta
- Project Director for the pre-disturbance assessment for the Cenovus Pelican Lake Grand Rapids project.
- Shell Canada Jackpine Mine Expansion & Pierre River Mine**  
Fort McMurray, AB
- Managed the environmental impact assessment for the fish and fish habitat component of the project. Involved in the development of the Conceptual Compensation Plan to meet the requirement for No Net Loss, as well as follow-up work related to the project.
- ConocoPhillips, Surmont Expansion**  
Conklin, AB
- Responsible for providing senior advice and direction to fish and fish habitat component lead on the completion of baseline studies and report preparation.
- MEG Energy, Christina Lake Regional Project Phase 2**  
Conklin, AB
- Managed the completion of baseline studies and an environmental impact assessment as the fish and fish habitat component lead, including responses to Supplemental Information Requests and Statements of Concern.
- Suncor Energy, Voyageur South**  
Fort McMurray, AB
- As the fish and fish habitat component lead, managed the completion of baseline studies and an environmental impact assessment for the Suncor Voyageur oil sands development in watersheds north of Fort McMurray.
- Mackenzie Gas Project**  
Northwest Territories
- Involved in task management, impact assessment, field planning and report preparation for the fish and fish habitat component of the Mackenzie Gas Project. Participated in preparation of the Environmental Impact Statement and responding to Information Requests. Involved in permit approval process and hearing preparation/support.

**ConocoPhillips  
Surmont Phase 2**  
Fort McMurray, AB

Managed the fisheries component involving an update to the project description for the ConocoPhillips Surmont EIA.

**MEG Energy, Christina  
Lake Regional Project**  
Conklin, AB

Managed the completion of baseline studies and an environmental impact assessment as the aquatic resources component lead for the MEG Energy Christina Lake Regional Project located near Conklin, Alberta.

**Sunshine Village  
Corporation, Healy  
Creek**  
Banff, AB

Fish and fish habitat task manager for an environmental assessment for water withdrawal from Healy Creek for snowmaking operations at Sunshine Village in Banff National Park. Co-ordinated baseline field studies, data compilation and report preparation. Involved in regulatory liaison and providing technical advice.

**OPTI/Nexen, South  
Lease Baseline Project**  
Conklin, AB

Managed the completion of field studies as fish and fish habitat discipline lead for the OPTI/Nexen South Lease baseline studies, as a proposed expansion to the Long Lake Project.

**PetroCanada, Meadow  
Creek II Project**  
Fort McMurray, AB

Managed the completion of baseline studies as fish and fish habitat discipline lead for a proposed expansion to the PetroCanada Meadow Creek Project.

**Rio Alto Exploration  
(now Canadian  
Natural), Kirby Project**  
Conklin, AB

As aquatic resources component lead, managed and participated in baseline aquatic studies and the completion of the environmental impact assessment for Rio Alto Exploration Ltd.'s (now Canadian Natural) Kirby SAGD development near Conklin, Alberta.

**TransAlta Utilities,  
Keephills EIA**  
Keephills, AB

Collected water and sediment quality samples and water quality measurements within the power plant cooling pond and other local waterbodies to provide baseline data for the impact assessment.

**True North (now UTS),  
Fort Hills Project**  
Fort McMurray, AB

Collected baseline inventory data in lake and stream habitats for a proposed oil sands development in the Fort McMurray area. Field studies included the collection of water quality, habitat mapping, discharge and fish inventory data.

**Taseko Mines,  
Prosperity Project**  
Williams Lake, BC

Data analyses and impact assessment reporting for water quality data collected for the proposed Prosperity Gold-Copper project near Williams Lake, BC.

## PROJECT EXPERIENCE – LINEAR DEVELOPMENTS

**NextBridge  
Infrastructure  
East West Tie  
Transmission Project**  
Northwestern Ontario

Senior review and direction for the fish and fish habitat component of the environmental assessment and permitting support projects. Included environmental assessment review, responding to stakeholder comments, and providing regulatory advice.

**Wataynikaneyap Power  
Phase 1 and Phase 2**  
Northwestern Ontario

Senior review and direction for the fish and fish habitat component of the environmental assessment for both the Phase 1, the New Transmission Line to Pickle Lake Project, and Phase 2, Connecting 17 Remove First Nation Communities. Included baseline and environmental assessment review, responding to stakeholder comments, and providing regulatory advice.

- Mackenzie Gas Project**  
NWT  
Involved in task management, impact assessment, field planning and report preparation for the fish and fish habitat component of the Mackenzie Gas Project. Participated in the preparation of the Environmental Impact Statement and responding to Information Requests.
- Parks Canada, TransCanada Highway Twinning, Phase IIIB**  
Banff, AB  
Managed completion of the fish and fish habitat component of the environmental screening for the proposed twinning of Phase IIIB of the TransCanada Highway in Banff National Park, including the collection of baseline field data at proposed watercourse crossings.
- OPTI/Nexen, Watercourse Crossings**  
Anzac, AB  
Managed fish and fish habitat studies for pipeline and watercourse crossings in the Long Lake and Jackfish leases. Provided technical advice to OPTI/Nexen related to provincial and federal requirements for their linear infrastructure and prepared applications and supplementary reports for the proposed crossings.
- Paramount Resources, Pipeline Crossings**  
Northern Alberta  
Managed studies to assess fish and fish habitat at proposed pipeline watercourse crossings associated with numerous gathering systems and prepared necessary documents for review by provincial and federal authorities.
- Alaska Gas Producers Pipeline Team, Feasibility Study**  
Calgary, AB  
Involved in the fish and fish habitat investigation along three pipeline routes proposed by a consortium of Alaskan North Slope Gas producers, including reconnaissance level surveys of fish habitat along proposed pipeline routes.

## PROJECT EXPERIENCE – SEISMIC OPERATIONS

- Aguila, Winter Seismic Monitoring**  
Mackenzie Delta, NWT  
Provided senior advice on an aquatic monitoring project for Aguila's winter seismic program in the Mackenzie Delta.
- Chevron Canada Resources, Winter Seismic Monitoring**  
Mackenzie Delta, NWT  
Managed aquatic monitoring projects at ChevronTexaco's winter seismic programs in the Mackenzie Delta, which involved field coordination, client liaison, data analyses and report preparation.
- De Beers Canada, Air Gun Seismic**  
Yellowknife, NWT  
Provided technical expertise to the team involved in the preparation of a project description for a proposed air gun seismic operation in Snap Lake.
- WesternGeco, Winter Seismic Monitoring**  
Mackenzie Delta, NWT  
Project manager for environmental monitoring of winter seismic programs conducted in the Mackenzie Delta at the Parsons Lake, Nuna, and Tittlalik seismic programs. Field coordination, sampling, client and regulatory liaison, data analyses, and report preparation. Field studies monitored water quality during drilling and water overpressures during blasting, according to protocols established by Fisheries and Oceans Canada.
- Salmo Consulting, Monitoring Data Review**  
Calgary, AB  
Project manager for data analyses of water quality and overpressure monitoring data collected in the Mackenzie Delta during the winter of 2002. Data from multiple programs and program areas were compiled, analyzed, and summarized in a report, which was incorporated into a background paper on the Use of Explosives in Waterbodies for the Canadian Association of Petroleum Producers.

**Salmo Consulting, Fish  
Deterrent Review**  
Calgary, AB

Involved in the review of fish deterrent literature and the applicability for seismic operations. A summary of the information was produced, as well as a study design and cost estimate for testing of potential deterrents.

**Gulf Canada  
Resources, Seismic  
Monitoring**  
Parsons Lake, NWT

Monitoring of summer seismic activities in Parsons Lake, NWT, including blast-induced overpressure monitoring, turbidity monitoring, and water and sediment quality sampling. A report was prepared summarizing the monitoring results.

## PROJECT EXPERIENCE – AQUATIC STUDIES

**Fisheries and Ocean  
Canada, Pathways of  
Effects**  
Calgary, AB

Managed project to conduct a literature review to provide scientific evidence for the linkages between certain physical activities and the endpoints of temperature and dissolved oxygen, as part of DFO's "Pathways of Effects" methodology. This involved identification of linkages, database searches, selection of relevant literature and summarizing into a report.

**City of Calgary, Pine  
Creek Baseline**  
Calgary, Alberta

Fish and fish habitat component lead for the first phase of aquatic baseline studies of Pine Creek, a tributary to the Bow River south of Calgary. Developed study plan and coordinated field data collection.

**Fisheries and Ocean  
Canada, Dredging  
Review**  
Inuvik, NWT

Managed project to conduct a literature review on the potential physical and biological effects of dredging in the Beaufort Sea. The results were summarized, including the aquatic organisms present in the Beaufort Seas, past dredging operation, environmental effects of dredging, mitigation and recovery, and appropriate legislation and guidelines.

**Petrobank, Coal Bed  
Methane Project**  
Princeton, BC

Managed literature review and completion of baseline fish and fish habitat studies for a proposed coal bed methane project. Seasonal studies were developed to meet the draft Code of Practice for coal bed methane operations.

**Sunshine Village  
Corporation, Healy  
Creek**  
Banff, AB

Task manager for project to perform bank repair and restoration to Healy Creek at the Sunshine Village base area. Prior to construction, a site visit was conducted and reports prepared for Fisheries and Oceans and Parks Canada. Further baseline fish habitat studies were conducted during construction, as well as suspended sediment monitoring.

**TransCanada  
Pipelines, Michel Creek**  
Calgary, AB

Prepared an assessment of the extent and significance of an inadvertent release of sediments into Michel Creek during construction of a pipeline crossing.

**Cominco Mines, Risk  
Assessment**  
Trail, BC

Preparation of a problem formulation report for a screening level risk assessment. Responsibilities included literature review and summary, data analysis, and report preparation.

**TransAlta Utilities,  
Weed Harvesting**  
Wabamun Lake, AB

Monitoring of weed harvesting program in Wabamun Lake, including field work and reporting. Performed fish salvage in outlet canal of Wabamun power plant..

**Queen Charlotte Power**  
Moresby Island, BC

Collected background fisheries and limnological information for proposed hydroelectric project near Takakia and Moresby Lakes, Queen Charlotte Islands.

**PROJECT EXPERIENCE – FORESTRY**

**Slocan, Tolko,  
Weldwood**  
Quesnel, BC

Watershed inventory in various working areas within the Quesnel TSA. Responsible for field logistics, data collection, analyses, and report writing.

**Carrier Lumber**  
Prince George, BC

Watershed inventory in the Missinka watershed. Responsible for lake inventory data collection and report writing.

**Riverside Industries**  
Chilcotin, BC

Reconnaissance level lake inventories of lakes in the Chilcotin region of BC. Responsible for lake inventory data collection, report writing, and budgeting.

**Ministry of  
Environment, Lands  
and Parks**  
North Coast, BC

Lake inventory of remote lakes on the North Coast of BC, involving bathymetry, fish sampling, limnological and water sampling. Responsible for budgeting, client liaison, field logistics, data collection, analyses, and report writing.

**Ministry of Forests**  
Terrace, BC

Stream Survey and Riparian Classification for streams in the Nass watershed according to the Forest Practices Code.

**Skeena Sawmills**  
Terrace, BC

Classified fish streams, riparian management areas and wetlands in accordance to the Forest Practices Code in various watersheds on the North Coast of BC.

**International Forest  
Products**  
North Coast, BC

Inventory and classification of streams within the Kumealon Lake watershed on the North Coast of BC.

**PROFESSIONAL AFFILIATIONS**

Member, Alberta Society of Professional Biologists (ASPB)

**Education**

M.A.Sc.  
 Biological/Environmental  
 Engineering, Dalhousie  
 University, Halifax, NS,  
 2007

B.Eng. Environmental  
 Engineering, Dalhousie  
 University, Halifax, NS,  
 2005

B.Sc. Biology, Cape Breton  
 University, Sydney, NS,  
 2002

**Golder Associates Ltd. - Calgary**

**Water Quality Specialist**

Alison Snow joined Golder Associates Ltd. in May 2011, as a Water Quality Specialist. Her educational background includes a Bachelor of Science from Cape Breton University, a Bachelor of Environmental Engineering from Dalhousie University, and a Master of Applied Science in Biological/Environmental Engineering from Dalhousie University. Her responsibilities include developing models that simulate surface water flow and quality, summarizing large datasets containing water quality for input into water quality models, and preparing modelling reports and presentations.

**Employment History**

**Golder Associates Ltd. – Calgary, AB**  
*Water Quality Specialist (2011 to Present)*

Responsibilities include developing models for surface water flow and quality, summarizing large datasets containing water quality for input into water quality models, and preparing modelling reports and presentations.

**PROJECT EXPERIENCE – DEVELOPING DISCHARGE LIMITS**

**Public Works and  
 Government Services  
 Canada  
 Giant Mine  
 NWT, Canada  
 (07/2016 to ongoing)**

Calculating effluent quality criteria to provide support for the Baker Creek Post-Environmental Assessment investigations for Giant Mine. The project involves identifying parameters for which effluent quality criteria should be developed; defining appropriate site-specific water quality objectives for Yellowknife Bay for each parameter; calculating effluent quality criteria; and producing a report documenting the effluent quality criteria.

**De Beers Canada Inc.  
 Snap Lake Mine  
 NWT, Canada  
 (01/2016 to 12/2016)**

Calculated effluent quality criteria for the De Beers Canada Inc. Snap Lake Mine. The project involved identifying parameters for which effluent quality criteria should be developed; defining appropriate site-specific water quality objectives for Snap Lake for each parameter; calculating effluent quality criteria; producing a report documenting the effluent quality criteria; and appearing at technical sessions and public hearings in 2014 and 2015 as an expert witness to present and explain the study findings.

**Dominion Diamond  
 Ekati Corporation  
 Jay Project  
 NWT, Canada  
 (09/2012 to 06/2015)**

Calculated effluent quality criteria for the Dominion Diamond Ekati Corporation Jay Project. The project involved identifying parameters for which effluent quality criteria should be developed; defining appropriate site-specific water quality objectives for Lac du Sauvage for each parameter; calculating effluent quality criteria; and producing a report documenting the results of the project.

**PROJECT EXPERIENCE – WATER QUALITY MODELING**

**Public Works and  
Government Services  
Canada  
Giant Mine**  
NWT, Canada  
(07/2016 to ongoing)

Modelling present-day arsenic loading to Baker Creek and Yellowknife Bay to provide support for the Baker Creek Post-Environment Assessment investigations for Giant Mine. Roles involved guiding the modelling of arsenic concentrations and loads to Baker Creek and Yellowknife Bay using GoldSim and producing a presentation and report explaining the study findings.

Modelling the mixing characteristics of water discharged from a water treatment plant to four locations on Yellowknife Bay for three outfall design options. Roles involve guiding the near-field modelling using CORMIX; calculating parameter concentrations at a distance of 200 m from the outfall; comparing parameter concentrations in Yellowknife Bay to relevant water quality guidelines; evaluating the sensitivity of model results to changes in model inputs; and, producing a presentation and report explaining the study findings.

Hydrodynamic and water quality modelling lead to support Baker Creek Post-Environmental Assessment investigations for Giant Mine. Roles involve guiding the modelling of water quality in Yellowknife Bay using GEMSS to predict the effects of remediation on bay water quality; producing a report explaining the findings. Constituents modelled included total dissolved solids, temperature, nutrients, major ions, and metals.

**Dominion Diamond  
Ekati Corporation  
Jay Project**  
NWT, Canada  
(01/2014 to 12/2016)

Hydrodynamic and water quality modelling lead; guided the modelling of water quality in Lac du Sauvage and Lac de Gras using GEMSS to predict the effects of future mine developments on lake water quality as part of the Dominion Diamond Ekati Corporation Developer's Assessment Report. Parameters modelled included total dissolved solids, temperature, nutrients, major ions, and metals.

**De Beers Canada Inc.  
Snap Lake Mine**  
NWT, Canada  
(09/2012 to 06/2015)

Updated the Snap Lake water quality model that was developed in GEMSS to predict the effects of mining on lake water quality as part of the De Beers Canada Inc. Snap Lake Mine water licence amendment and environmental assessment (EA1314-02). Parameters modelled included total dissolved solids, temperature, oxygen, nutrients, major ions, and metals. Appeared at technical sessions and public hearings in 2014 and 2015 as an expert witness to present and explain the model results.

**Seabridge Gold Inc.  
Courageous Lake  
Project**  
NWT, Canada  
(03/2012 to 07/2012)

Modelled the water quality of Courageous Lake using GEMSS to predict the effects of future mine developments on lake water quality. Parameters modelled included total dissolved solids, temperature and water velocity.

**De Beers Canada Inc.  
Gahcho Kué Project**  
NWT, Canada  
(05/2011 to 05/2012)

Modelled the water quality of Kennady Lake using GEMSS to predict the effects of future mine developments on lake water quality as part of the De Beers Canada Inc. Gahcho Kué Environmental Assessment. Parameters modelled included temperature, dissolved oxygen and nutrients.

**TRAINING****GoldSim Workshop**

GoldSim Technology Group, June 26-28, 2012

**CE-QUAL-W2 Version 3.7 Workshop**

Portland State University Professional Development Center, June 11-15, 2012

**3-Dimensional Hydrodynamic and Water Quality Modeling Using GEMSS**

ERM Inc. – Surface water Modelling Group, May 23-25, 2011

**PUBLICATIONS****Refereed Journal  
Articles**

Snow, A. and J. Vandenberg. 2016. Learned Discourses: Timely Scientific Opinions. Simple but Effective Model Calibration for Nitrite in Northern Environments. *Integrated Environmental Assessment and Management*. 12 (4): 821-822.

Vandenberg, J.A., M. Herrell, J.W. Faithful, A.M. Snow, J. Lacrampe, C. Bieber, S. Dayyani and V. Chisholm. Multiple Modelling Approach for the Aquatic Effects Assessment of a Proposed Northern Diamond Mine Development. *Mine Water and the Environment*, 10.1007/s10230-015-0337-5

Snow, A., B.C. Anderson and B. Wootton. Flow-through land-based aquaculture wastewater and its treatment in subsurface flow constructed wetlands. *Environmental Reviews*, 20 (2012), p54.

**Refereed Conference  
Proceedings**

Snow, A., B.C. Anderson and B. Wootton. 2010. *Treatment performance of a cold climate hybrid subsurface flow constructed wetland receiving land-based aquaculture wastewater during the first 2 years of operation*. 12th IWA International Conference on Wetland Systems for Water Pollution Control, October 4 - 8. Venice, Italy.

Anderson, B.C., B. Husk, B. Wootton, C. McClure and A. Snow. 2010. *Watershed approaches for nuisance algae control in small freshwater lakes: Field investigations*. CSCE 11th International Environmental Specialty Conference, June 9 - 12. Winnipeg, Canada.

**Conference  
Presentation**

Snow, A., J. Vandenberg, S. Prakash, V. Chisholm, and A. Hood. 2014. Water Quality Modelling in Northern Canada. Canadian Conference for Fisheries Research & Society of Canadian Limnologists, January 3-5. Yellowknife, NWT, Canada.

**Education**

*B.Sc. Environmental Science, Royal Roads University (RRU), Victoria, BC, 2000*

*Honours Graduate Integrated Environmental Planning Technology, Selkirk College, Castlegar, BC, 1999*

**Golder Associates Ltd. – Calgary*****Associate, Senior Air Quality Specialist***

Mr. Madland is an Associate and Sr. Air Quality Scientist in Golder's Calgary operations. He has worked in the Calgary office since 2000. He received an Environmental Planning Technology Diploma from Selkirk College in 1999 and a B.Sc. in Environmental Science from Royal Roads University (Victoria, BC) in 2000.

Chris has been involved in a wide range of air quality projects in all regions in Canada, and internationally, but has specific expertise on meteorological monitoring, air quality and dust assessment and management in Canada. He has a range of experience in air quality assessment, management program development, ambient monitoring programs and expert testimony including siting, permitting, installation, maintenance and reporting for the mining, oil and gas, utilities and manufacturing sectors. Mr. Madland is a practical thinker and understands the unique constraints of air quality management at operational facilities. He has contributed to the air quality assessment development and review for many of the EIAs that have been produced by Golder Associates since 2000 and has coordinated the air quality component of several regulatory applications.

**Employment History*****Golder Associates Ltd. – Calgary, Alberta***

*Air Quality Scientist (2000 to Present)*

Air quality scientist assisting on Environmental Impact Assessments, emission inventories, regulatory strategy and ambient air quality monitoring projects. Responsibilities include project management, air monitoring, fugitive emissions detection and quantification, data analysis, emission calculations, environmental management planning modelling, hearing preparation, expert testimony, meteorological data analysis preparation, regulatory guidance, regulatory liaison, client liaison, report peer review, report preparation and supplemental responses.

***British Columbia Hydro – Castlegar, British Columbia***

*Student Biologist (1998 to 2000)*

Participated in various reservoir and dam management programs, produced documents supporting BC Hydro's application for ISO 14001 certification.

**PROJECT EXPERIENCE – OIL AND GAS**

**Canadian Association  
of Petroleum  
Producers – Critical  
Review of Siting  
Criteria for Air Quality  
Monitoring Stations**  
Calgary, Alberta

Golder was hired to undertake a critical, multijurisdictional review of the criteria used to site air quality monitoring stations. The work focused on evaluating western Canadian provinces' and the U.S. EPA siting criteria, relative to their intended purpose, e.g., regional monitoring vs facility fence-line compliance. Mr. Madland conducted this review.

**Confidential Oil and Gas Clients – Remote Detection and Quantification of Fugitive Emissions**  
Alberta

A series of confidential oil and gas developers hired Golder to participate with an Alberta company called Airdar to provide 24/7 un-manned surveillance of their operations site and to provide a forensic review of publicly collected air monitoring data to determine site-wide and source-specific fugitive emissions. Emission sources, known and previously unknown were located and quantified to demonstrate improvements in emissions performance. Target gases included total hydrocarbons including methane, H<sub>2</sub>S, and SO<sub>2</sub>. Mr. Madland was responsible for the execution of these projects.

**MEG Energy – Fugitive Emissions Monitoring Program**  
Christina Lake, Alberta

Golder was hired to undertake a fugitive emissions monitoring study at MEG Energy's Christina Lake Regional project. The focus was to identify emissions from storage tanks and process vessels. The equipment used was a series of PID/FID detectors and hand-held chemiluminescence sensors for H<sub>2</sub>S. Mr. Madland oversaw the development of the monitoring program.

**Suncor Energy Inc. Firebag Odour Assessment**  
Fort McMurray, Alberta

Suncor requested Golder's assistance with the identification and control of odour issues at the Firebag Facility. Golder performed preliminary monitoring at the Firebag site to identify potential sources of odour and helped to address this issue. Ongoing work has led to Golder being asked to develop an on-site fugitive emissions inventory. Responsible for emission calculations, air monitoring, and data analysis.

**Imperial Oil Ltd. Kearl Oil Sands Project**  
Fort McMurray, Alberta

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) of the Kearl Oil Sands mine for Imperial Oil. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological dataset. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan to the Cold Lake area. Air quality predictions were made using the CALPUFF dispersion model, run in the 3-D mode. Responsible for emission calculations and QA/QC.

**Tervita Corporation - Fugitive Emissions Monitoring Program**  
Gull Lake,  
Saskatchewan

Golder was hired to undertake a fugitive emissions monitoring study at Tervita Corporation's Gull Lake Oil Field Disposal Facility. The focus was to identify emissions from storage tanks and to determine fence-line concentrations of VOCs and H<sub>2</sub>S and process vessels. The equipment used was a series of PID/FID detectors and hand-held chemiluminescence sensors for H<sub>2</sub>S. Mr. Madland oversaw the development of the monitoring program and managed the field component and reporting of this program.

**KeySpan Energy Canada Fugitive Emission Monitoring**  
Rocky Mountain House, Alberta

Golder was retained by KeySpan Energy Canada to identify sources of H<sub>2</sub>S and hydrocarbons from the Strachan gas plant through emissions monitoring. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC and report preparation.

**Suncor Energy Inc. Voyageur Project EIA**

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) for the Suncor Voyageur Project. The air quality sections of the EIA evaluated cumulative air pollutant concentrations and acid deposition across the Oil Sands Region, using the CALPUFF dispersion model (3-D mode).

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Fort McMurray, Alberta

The EIA made use of Golder's regional emissions database and 3-D meteorological data set, which cover the area from Fort Chipewyan to the Cold Lake area. Responsibilities included air monitoring, data analysis and report preparation.

**AMEC Earth and Environmental Limited**  
**Mackenzie Gas Pipeline EIA**  
Northwest Territories

As part of a consulting consortium, Golder was responsible for the completion of the air quality components of the Environmental Impact Assessment (EIA). The air quality assessment evaluated air pollutant concentrations and acid deposition resulting from cumulative emission sources across the length of the proposed pipeline, from the Mackenzie Delta in the north to Zama, Alberta in the south. Air quality predictions were made using the CALPUFF dispersion model (2-D mode). This project also included participation in the regulatory review and public hearings. Air Component/Discipline Lead and Emission Coordinator responsible for emission calculations, data analysis, QA/QC, hearing preparation and report preparation.

**Anadarko Canada Corp. East Liard Gas Gathering System**  
Deh Cho Region,  
Northwest Territories

Anadarko proposed to build a pipeline to link the existing Chevron K-29 well site with the existing Anadarko A-68 well site, north of Fort Liard, Deh Cho Region, NWT. Golder completed both the air quality and noise assessment for the dehydration and compression facility at the start of the pipeline, and the compressor station situated along the pipeline. Responsible for data analysis and report preparation.

**Canadian Natural Resources Ltd. Primrose East Oil Sands Project**  
Cold Lake, Alberta

Golder was retained to prepare an Environmental Impact Assessment (EIA) for the Canadian Natural Primrose East Oil Sands Project. This Steam-Assisted Gravity Drainage (SAGD) project is an expansion of the existing Canadian Natural Primrose and Wolf Lake facilities. Air quality and noise assessments were completed as part of the EIA. Responsibilities included noise monitoring.

**Canadian Natural Resources Ltd. Primrose North Monitoring**  
Cold Lake, Alberta

Canadian Natural Resources retained Golder to prepare an application to AENV for a continuous air quality monitoring station and four passive air monitoring stations near the Primrose North Oil Sands Facility. Responsibilities included air monitoring, data analysis and report preparation.

**Cenovus Foster Creek Monitoring Program**  
Foster Creek, Alberta

Golder conducted a siting assessment in accordance with the Alberta Air Monitoring Directive for the installation of a continuous air quality monitoring trailer at the Foster Creek site. Project Manager responsible for air monitoring, QA/QC, environmental management planning model, regulatory guidance and report preparation.

**Cenovus Christina Lake Project Debottlenecking and Expansion**  
Christina Lake, Alberta

Golder was retained by EnCana to assist in approval amendments associated with the Phase 1B Debottlenecking and Expansion at the Christina Lake Thermal Project. The Christina Lake Thermal Project is a SAGD project located in Alberta's Athabasca oil sands region. The work included completing the air quality and noise assessments, required as part of the approval amendment applications to Alberta Environment and the Alberta Energy and Utilities Board (EUB). The air quality assessment included establishing an air emission profile

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	<p>for the project, as well as determining the air quality impacts using the CALPUFF dispersion model. Responsibilities included emission calculations and data analysis.</p>
<p><b>Chevron Canada Ltd. M-25 Meteorological Monitoring</b> Fort Liard, Northwest Territories</p>	<p>This project involved implementing and managing a meteorological monitoring program at the Chevron Canada F-25 and K-29 wells near Ft. Liard in the Northwest Territories. The parameters monitored at each site included wind speed, wind direction temperature and solar radiation. Responsibilities included limited client liaison.</p>
<p><b>Fossil Water Catalyst Facility Air Assessment</b> Fort Saskatchewan, Alberta</p>	<p>Fossil Water proposed a catalyst recycling facility near Fort Saskatchewan, Alberta. Golder was retained to provide an assessment of air quality and to assist with various application components. Air Component Discipline Lead, Modelling Coordinator and Emission Coordinator responsible for emission calculations, air dispersion modelling, QA/QC, data analysis and report preparation.</p>
<p><b>Cenovus Energy Christina Lake Thermal Project Monitoring Program</b> Christina Lake, Alberta</p>	<p>An air quality and meteorological monitoring plan and on-site assessment program were conducted to evaluate facility emissions from the Christina Lake Thermal Project. The project involved the establishment of an air quality and meteorology monitoring station, interpretation of data and regular reporting and liaising with government officials on behalf of the client. Involved in the siting of the continuous and the static stations, and oversaw the installation of the monitoring program hardware. Also responsible for the ongoing management of some components of the program, data quality assurance and reporting.</p>
<p><b>Petro-Canada Oil and Gas Meadow Creek Project EIA</b> Fort McMurray, Alberta</p>	<p>Golder was responsible for the completion of the Environmental Impact Assessment (EIA) and application to develop a Steam-Assisted Gravity Drainage (SAGD) project in the Athabasca Oil Sands Region. The air quality component of the project evaluated acid deposition in the region as well as local and regional concentrations of sulphur dioxide, nitrogen dioxide, particulate matter, secondary particulates, carbon monoxide, reduced sulphurs, volatile organic compounds, trace metals and polycyclic aromatic hydrocarbons. The CALPUFF model (3-D mode) was used for this assessment. Assisted with emissions calculations and with report preparation.</p>
<p><b>Chevron Canada Resources Air Quality Evaluation of the K-29 Facility</b> Ft. Liard, Northwest Territories</p>	<p>A well-test flaring assessment was completed for a proposed gas processing facility near Ft. Liard, NWT. The project involved the estimation of facility emissions and a dispersion modelling analysis of the SO<sub>2</sub> emissions from a flare. The site location was in very complex terrain and required the use of the CTSCREEN model to determine the necessary flare height that would result in no exceedances of the ambient SO<sub>2</sub> guidelines. Involvement in the project included client liaison.</p>
<p><b>Shell Canada Ltd. Jackpine Mine-Phase 1 EIA</b> Fort McMurray, Alberta</p>	<p>Golder was responsible for the completion of the recent Environmental Impact Assessment (EIA) of the Jackpine Mine – Phase 1 Oil Sands mine for Shell Canada. As part of the EIA, Golder was responsible for the completion of the air quality components of the project, which included the use of the Golder's regional emissions database and 3-D meteorological data set. The air quality assessment evaluated air concentrations and acid deposition resulting from cumulative emissions sources across the Oil Sands Region, spanning from Fort Chipewyan in the north to the Cold Lake area in the south. Air quality predictions</p>

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were made using the CALPUFF dispersion model, run in the 3-D mode. Responsibilities included calculation and summary of facility and regional emissions, and report preparation.

**Shell Grosmont  
Venture In-situ Oil  
Sands Project Baseline  
Studies**  
Wabasca, Alberta

Golder was retained to complete baseline noise, air quality and meteorological data collection for the Shell Grosmont in-situ oil sands project west of Fort McMurray. Component/Discipline Lead responsible for air monitoring, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

**Alliance Pipeline  
Hazard Assessment**  
Saskatchewan

Golder was retained to conduct a hazard assessment of a potential accidental condensate release associated with waste heat recovery at the Alliance Kerrobert facility. Responsibilities included data analysis, hazard assessment and report preparation.

**Confidential Client Oil  
Processing Facility  
Hazard Assessment**  
Alberta

Golder conducted a hazard assessment of a potential uncontrolled hydrogen sulphide (H<sub>2</sub>S) release from an oil processing facility under a range of meteorological conditions. Project Manager responsible for hazard assessment and report preparation.

## PROJECT EXPERIENCE - POWER

**ATCO Power,  
Heartland Generating  
Station Air Quality  
Assessment**  
Strathcona County,  
Alberta

Golder prepared an air quality assessment to support an industrial approval application for a natural gas fired power plant in Alberta's Industrial Heartland. Mr. Madland participated in and oversaw the development and writing of the air quality assessment.

**TransAlta Utilities  
Sundance 7  
Generating Station Air  
Quality Assessment**  
Wabamun, Alberta

Golder prepared an air quality assessment to support an industrial approval application for a natural gas fired power plant in Alberta's Wabamun generating are. Mr. Madland participated in and oversaw the development and writing of the air quality assessment and provided expert testimony at the Alberta Utilities Commission regulatory hearing.

**TransAlta Utilities  
Highvale Mine, Pit 9 Air  
Quality Assessment**  
Wabamun, Alberta

Mr. Madland participated in the development of and reviewed an air quality assessment prepared in support of TransAlta Utilities application to expand the Highvale Mine (Pit 9). Specifically, Mr. Madland's role was to oversee the writing of the air quality assessment report.

**Enmax Energy Corp,  
Bonnybrook Energy  
Centre, Alberta Utilities  
Commission Appeal**  
Calgary, Alberta

Golder prepared an application for a permit to construct, operate and reclaim the Enmax Bonnybrook Energy Centre in Calgary, Alberta. The process included an Alberta Utilities Commission Hearing on the matter. Mr. Madland participated as support to an expert witness with matters related to air quality at the Appeal hearing.

**TransAlta Utilities  
Corp. Centralia Mine**  
Washington

Golder completed baseline field work for TransAlta's Centralia Mine in Washington State. The project was managed out of the Golder Calgary office. However, air and noise monitoring was conducted by the Golder Gainesville office. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC and report preparation.

## PROJECT EXPERIENCE - MINING

**Baffinland Mary River  
Project – Haul Road  
and Crusher Dust  
Evaluation**  
Mary River, Nunavut

Golder was retained by Baffinland to conduct a critical review of dust management activities at it's Mary River facility, haul road and port with a goal of satisfying the Department of Fisheries and Oceans requirement to prevent pollution of adjacent, fish-bearing streams. Mr. Madland was responsible for the delivery of this program.

**Baffinland Mary River  
Project - Safe Harbour  
Meteorological  
Monitoring**  
Pond Inlet, Nunavut

Golder was commissioned through a subcontract to provide a series of three meteorological stations intended to provide data to support the development of a safe harbour for staging vessels bound for the Mary River Project. Mr. Madland procured and installed the meteorological stations in August of 2014.

**Agnico Eagle Whale  
Tail Pit and Haul Road  
Expansion**  
Baker Lake, Nunavut

Golder was tasked with the development of the air quality technical reports necessary for the development of the Agnico Eagle Whale Tail Pit and the associated haul road near Baker Lake, Nunavut. This included the development of an air quality and dust management plan with particular emphasis on the haul road. Mr. Madland was responsible for the development of this monitoring and management program.

**Dominion Diamond Jay  
Project Air Quality and  
Dust Management  
Program**  
Barrenlands,  
Northwest Territories

Golder has provided technical air quality assistance to Dominion Diamond through their assessment and permitting process. This has included a requirement to develop a series of predictive air quality models as well as to develop an air quality management plan with specific attention to the haul road between the open pit and the processing facility several tens of kilometres distant. Mr. Madland oversaw the development of the air quality and dust management plan and presented the plan at various public consultation venues.

**Khan Resources  
Meteorological Station  
Installation**  
Mongolia

Golder provided baseline air quality and meteorological support to Khan Resources for a uranium mine in Mongolia. The project included training of on-site personnel to conduct the on-going portion of the program once installation was complete. Component Discipline Lead responsible for air monitoring, meteorological data analysis preparation, report preparation, meteorological monitoring, client liaison and meteorological monitoring training.

**De Beers Gahcho Kue  
Mine Air Quality and  
Dust Management Plan**  
Barrenlands,  
Northwest Territories

Golder has a long history supporting De Beers with air quality assessment and air quality management work at three of its Canadian Operations including the Gahcho Kue Mine, the Snap Lake Mine and the Victor mine. Recent work has included the development of an Air Quality Management Plan for the Gahcho Kue Project. Mr. Madland oversaw the development of the air quality management program.

**Dynatec Corporation  
Ambatovy EIA**  
Madagascar

Golder was retained by Dynatec Corporation to complete an Environmental Impact Assessment (EIA) for a nickel/cobalt mine in Madagascar. The EIA included assessments of air quality and noise for the open pit mine, slurry pipeline, processing plant, tailings facility and port expansion. The air quality assessment included an ambient air quality component (SO<sub>2</sub>, NO<sub>x</sub> and others) as well as dust deposition, which was of particular concern in the ecologically diverse region. Responsible for emission calculations, QA/QC and data analysis.

**DeBeers Canada Inc.  
Snap Lake Monitoring**  
Snap Lake, Northwest  
Territories

The Snap Lake Diamond Mine EIA was in preparation for several years. The original development was owned by Winspear; however, DeBeers later purchased the project. In addition to the EIA, Golder was responsible for the development of, operation and maintenance of the ambient air and meteorological monitoring at the site. Air Component/Discipline Lead and Emission Coordinator responsible for regulatory liaison, emission calculations, QA/QC, air monitoring and data analysis.

**Diavik Diamond Mines  
Inc. EIA Review**  
Lac de Gras,  
Northwest Territories

Golder was retained by Diavik Diamond Mines Inc. to complete a peer review of the original EA completed for the Diavik diamond mine in Lac de Gras, NWT. Responsible for QA/QC and report peer review.

**BacTech Mining  
Mckinnon Creek Mine**  
Revelstoke, British  
Columbia

During early project planning BacTech Mining commissioned a meteorological monitoring program in the vicinity of a former metals mine. BacTech planned to develop a gold, lead and zinc deposit approximately 45 km north of Revelstoke, B.C. Golder was responsible for conducting the EIA, based on permitting and approval in 2006. The mine was planned to be underground and ore processing was planned to be done using a bioleach system. Project Manager responsible for air monitoring, data analysis and report preparation.

**Ivanhoe Mines Inc. Oyu  
Tolgoi Dust  
Management Plan**  
Mongolia

Ivanhoe Mines Inc. needed to manage widely-dispersed fugitive dust associated with operations planned for southern Mongolia at the Oyu Tolgoi site. One of the most difficult aspects of managing dust generation in this location is the local climate. Golder developed a dust management plan that included controls and monitoring. Air Component/Discipline Lead responsible for emission calculations, data analysis, environmental management planning and report preparation.

**UEX West Bear  
Baseline Air Quality  
Monitoring**  
Northern  
Saskatchewan

Golder was retained by UEX to undertake environmental baseline monitoring studies at a uranium deposit in northern Saskatchewan to support a pending application to develop an open-pit mine at the site. The air and noise team designed and implemented a baseline air monitoring program for particulates radon, SO<sub>2</sub> and NO<sub>2</sub>. Air Component/Discipline Lead responsible for air monitoring, data analysis and report preparation.

**Dundee George &  
Goose Meteorological  
Monitoring**  
Bathurst Inlet, Nunavut

Golder was contracted to maintain two meteorological stations installed in August 2004 at two exploration camps near Bathurst Inlet, Nunavut. Work included calibration, repair, download and reporting of data from stations at George and Goose Lakes. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC and report preparation.

**Miramar Mining Corporation Ambient Air Quality Monitoring**  
Bathurst Inlet, Nunavut

Miramar Mining Corporation is developing a gold mine near Cambridge Bay on Victoria Island, Nunavut. Golder was retained to provide background air quality and meteorological monitoring services in support of their permit application process. A Hi-Volume sampler and meteorological monitoring program was implemented during the summer months. Responsibilities included program development, instrument selection and procurement, installation and training of on-site staff in the maintenance of monitoring components. Also responsible for data analysis, QA/QC and reporting for this project.

**DeBeers Canada Mining Inc. Snap Lake Diamond Mine Monitoring Program**  
Snap Lake, Northwest Territories

Golder provided ongoing support to DeBeers Canada for applications to the Government of the Northwest Territories to construct and operate an underground diamond mine in the vicinity of Snap Lake, NWT. This support included siting, installation, maintenance and calibration of equipment for monitoring programs, as well as development of standard operating procedures and environmental management plans for sample collection and completion of monitoring reports. Also responsible for annual ambient air quality and meteorological monitoring reporting, QA/QC and ongoing client support for the monitoring programs.

**Lafarge Construction Material Limited Ambient Air Quality Monitoring**  
Calgary, Alberta

Provided consulting services to Lafarge regarding a proposed gravel pit east of Calgary, Alberta. Work included the preparation of a monitoring plan and guidance to Lafarge on placement options for a particulate and meteorological monitoring system in the vicinity of the proposed operation. Contributed to the monitoring plan and proposal, coordinated the station siting process, procured all necessary monitoring hardware, installed and calibrated the requisite systems, QA/QC and coordinated ongoing client support and reporting.

**Inmet Mining Corporation Izok Meteorological Monitoring**  
Izok Lake, Nunavut

This project involved implementing and managing a meteorological monitoring program at the Izok Lake Project in Nunavut. The parameters monitored at each site included precipitation, wind speed, wind direction, temperature and solar radiation. The meteorological monitoring formed part of a comprehensive program designed to establish baseline hydrologic and climatic conditions at the proposed mine site. Responsibilities include supervising on-site installation of the meteorological station.

**Miramar Mining Corporation Doris North Gold Project EIS**  
Bathurst Inlet, Nunavut

Golder prepared an air quality and noise assessment for the Miramar Doris North Gold Project located near Bathurst Inlet, Nunavut. The assessment was prepared to support the Environmental Impact Study (EIS) for submission to the Nunavut Impact Review Board. Air Component/Discipline Lead responsible for air monitoring, data analysis, QA/QC, environmental management planning and report preparation.

**Strateco Resources Uranium Exploration Project Meteorological Station Installation**  
Northern Quebec

Golder was retained to install a meteorological monitoring station at the Strateco Resources base camp in northern Quebec. Component/Discipline Lead responsible for meteorological data analysis preparation, report preparation, meteorological monitoring, training and client liaison.

**Hope Bay Mining Ltd.  
Doris North Gold Mine  
EIA**

South of Cambridge  
Bay, Nunavut

Hope Bay Mining retained Golder Edmonton to provide on-going support following completion of an Environmental Impact Assessment (EIA) for their gold mine in Nunavut. The project required that Air Quality and Noise Management Plans be developed. Component/Discipline Lead responsible for air dispersion modelling, air monitoring, emission calculations, meteorological data analysis preparation, report preparation and client liaison.

**DeBeers Canada Inc.  
Gahcho Kue Review**

Gahcho Kue, Northwest  
Territories

Golder was retained by DeBeers to conduct a peer review of a draft Environmental Impact Assessment (EIA) for their Gahcho Kue Project. The review included the EIA methodology and all technical components, including air quality and noise. Responsibilities included report peer review.

**Great Western  
Minerals Group Hoidas  
Lake Monitoring**

Hoidas Lake,  
Saskatchewan

The Hoidas Lake facility (Great Western Minerals Group) is a remote rare earth elements mining exploration camp in the northwest corner of Saskatchewan. Golder conducted a baseline air quality monitoring program at the site to provide data to support a potential Environmental Impact Assessment. Component/Discipline Lead responsible for air monitoring, data analysis, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

**Fortune Minerals Nico  
Mine Monitoring  
Program**

Northwest Territories

Fortune Minerals is planning to develop an underground/open-pit mine approximately 160 km northwest of Yellowknife. Golder was retained to assist Fortune with their application to the Mackenzie Valley Land and Water Board for a Class B water license. This included technical assistance with a feasibility study for Nico Mine open pit and underground project. Ongoing work includes supporting an on-site meteorological and air quality monitoring program. Component/Discipline Lead responsible for air monitoring, data analysis, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

## GOVERNMENT

**City of Calgary –  
Remote Detection and  
Quantification of  
Fugitive Emissions**

Calgary, Alberta

The city of Calgary operates the Fish Creek Wastewater Treatment Plant and hired Golder to assist them with managing ongoing area odour complaints. Golder developed a site-wide fugitive emissions identification and quantification program with its partner, Airdar. Emission sources, known and previously unknown were located and quantified and remedied to demonstrate that odours perceived in neighbouring communities originated from locations outside the facility. The target gas in this ongoing project is H<sub>2</sub>S. Mr. Madland was responsible for the development and delivery of this project.

**Government of Canada  
Public Works Air  
Quality Management  
Plan & Review  
Development**

Esquimalt, British  
Columbia

Golder was retained to prepare a review of the air quality management and monitoring systems currently in place at the Esquimalt Graving Dock near Victoria BC. Project Manager responsible for data analysis, emission calculations, environmental management planning modelling, literature review, meteorological data analysis preparation, regulatory guidance, QA/QC, report preparation and client liaison.

**OTHER**

- Catalyst Paper, Powell River Division, Landfill Expansion Environmental Appeal Board Hearing**  
Powell River, British Columbia
- Golder prepared an application for a permit under the B.C. Environmental Management Act for a proposed landfill expansion at Catalyst Paper Corporation's Powell River mill in Powell River, B.C. The B.C. Ministry of Environment approved the expansion; however several local residents and community associations appealed the decision. Mr. Madland participated as an expert witness with matters related to air quality at the Environmental Appeal Board hearing.
- PCL Construction Management Inc. Dust Management Plan**  
Calgary, Alberta
- Golder was retained by PCL Construction Management to provide a dust management plan for the University of Calgary, Health Research Innovation Centre project located at the Foothills Hospital. Project Manager responsible for emission calculations, air monitoring, data analysis, air/environmental management planning and report preparation.
- Redcliff Industries EPEA Renewal**  
Redcliff, Alberta
- Golder was retained to assist Redcliff Industries (a fibreglass manufacturer) with their EPEA approval renewal process. The renewal application required an air quality modelling assessment. Air Component Discipline Lead and Emission Coordinator responsible for emission calculations, QA/QC, data analysis, QA/QC and report preparation.
- Siksika Environmental Ltd. Environmental Training**  
Siksika Reservation, Alberta
- Golder was retained to provide technical training and job shadowing opportunities for selected employees of Siksika Environmental Ltd. Training was provided in the siting, operation and maintenance of ambient air monitoring equipment. Developed and delivered an introduction to air quality monitoring course.
- Norske Skog Inc. Crofton Landfill**  
Vancouver Island, British Columbia
- Golder implemented a dust-fall and meteorological monitoring program at a water reservoir adjacent to the Norske Skog landfill in Crofton, B.C. The objective of the program was to assess the impact of dust emissions from the landfill on the water reservoir. The monitoring program consisted of monthly sampling of two dust-fall canisters, which were analyzed for dust-fall amounts and trace metal concentrations. Responsibilities included support for the field staff and siting process.
- Domtar Canada Ltd. Particulate Monitoring**  
Cochrane, Alberta
- Conducted short-term particulate monitoring services to Domtar Canada using hi-volume sampling devices. The objective of the work was to obtain estimates of airborne total suspended particulate (TSP) levels in the vicinity of an excavation site. Responsibilities included monitoring plan preparation equipment procurement, installation and calibration, and reporting.
- OPTI Canada/ Nexen Canada Air Quality Modelling Course**  
Calgary, Alberta
- Through the Golder Institute, Golder prepared a comprehensive two-day course designed to introduce the concepts of dispersion modelling and air quality assessment in the Oil Sands Region. The course comprised eight modules ranging in topic from oil sands history to hands-on modelling exercises using SCREEN3 and CALPUFF. Designed, constructed and demonstrated a scaled Plume Model.

**Lehigh Inland Cement  
Limited Substitution  
Fuel Project**  
Edmonton, Alberta

Golder was retained to prepare the Environmental Protection and Enhancement Act (EPEA) application for the proposed conversion of the Lehigh Inland Cement facility in Edmonton to allow the use of coal as a primary fuel. The project involved a detailed review of the facility emissions, estimation of resulting off-site concentrations, evaluation of current operations and recommendations for future mitigation. Liaison with regulators during the application process formed an integral part of the air quality assessment. Golder assisted Lehigh Inland through the hearing process and provided expert testimony. Responsibilities included calculation of fugitive emissions, report preparation and technical support of the air quality team that attended the hearings.

**Education**

*Master of Science Geology,  
University of Manitoba,  
2004*

*Bachelor of Science  
Geology (Honors),  
University of Manitoba,  
2001*

**Golder Associates Ltd. - Vancouver**

*Associate - Senior Geochemist*

**Employment History**

***Golder Associates – Vancouver, BC  
Geochemist (2004 to Present)***

Associate and Senior Geochemist with background in environmental and exploration geology. Project experience includes the development and execution of geotechnical baseline studies, including estimates of acid rock generation and metal leaching potential, for a number of projects in North American and abroad. Hydrogeochemical modelling experience generally involves the incorporation of the results of baseline geochemical characterization to predict long term water quality for the purpose of permitting and development of mitigation alternatives. Field investigation activities include sampling at active and abandoned mine sites for the purpose of waste characterization, field oversight of drilling and logging of geologic materials, ground water and surface water sampling, and data analysis.

***New Britannia Mine, Kinross Gold Corp. – Snow Lake, Manitoba  
Core Logging Geologist (September 2001 – April 2002 to August 2003 -  
September 2003)***

Geologic description of diamond drill core for New Britannia Mine for the purpose of gold exploration and mine reserve estimation.

***University of Manitoba – Winnipeg, Manitoba  
Master of Science Candidate (2002 to 2004)***

Responsibilities included acting as a teaching assistant for courses including Introductory Physical Geology, Optical Mineralogy and Mineral Deposits in the Department of Geology at the University of Manitoba.

***EBA Engineering Consultants, Ltd. – Yellowknife, N.W.T  
Environmental Scientist (1) (May 2002 to August 2002)***

Tasks included geotechnical quality control investigations, including supervision and logging of diamond drill core at Diavik Diamond Mine site and aggregate quality control in Fort Smith, NWT.

***DeBeers Canada Exploration Incorporated – Manitoba  
Junior Sampler (May 2001 to July 2001)***

Planned and completed 2 to 4 km traverses for the purpose of bulk till sampling, kimberlite prospecting and reconnaissance mapping.

***Manitoba Industry, Trade and Mines, Geological Survey – Wabowden, Manitoba  
Junior Geological Assistant (May 2000 to August 2000)***

Responsibilities included logging and graphical representation of core retrieved from Bucko core storage site for compilation map of the Thompson Nickel Belt, collaboration and reconnaissance mapping at Sipiwesk Lake, Manitoba.

*University of Manitoba – Winnipeg, Manitoba  
(May 2000 to October 2000)*

Responsibilities included sampling of Central Manitoba Mine Tailings, Nopiming Provincial Park (Manitoba, Canada) for mineralogical and geochemical study of orphaned mine tailings.

## PROJECT EXPERIENCE – MINING

**Fundacao Renova /  
Samarco Project**  
Brazil

Geochemical evaluation of iron ore tailings released as from the Fundao Tailings Dam failure. Scope of work included development of a detailed geochemical characterization report to determine the mechanisms of metal mobility from tailings in the receiving environment. A colloid investigation study design was prepared and implemented to evaluate the composition, source and mechanisms of mobilization of suspended particulates in the receiving environment.

**Walter Energy / EB  
Project**  
British Columbia,  
Canada

Detailed assessment of the geochemical characteristics of mine rock from a proposed coal mine in northern British Columbia. Developed a geochemical testing program to evaluate metal leaching potential in site specific conditions, including specialized long-term leach tests and detailed mineralogical analysis. Data was incorporated into an existing geochemical dataset for the Project.

A geochemical characterization plan was developed to provide recommendations for geochemical classification and monitoring of mine rock during operations.

**Red Chris  
Development  
Corporation / Red  
Chris Mine**  
British Columbia,  
Canada

Assistance in the preparation of a Mine's Act Permit Amendment for the Red Chris Mine. Ongoing support for environmental reporting activities as a component of the Trigger Response Plan for the Mine. Development of a Selenium Source Study for the Mine, as a component of the Permit Amendment.

**Dominion Diamond  
Ekati Corporation / Jay  
Project**  
Northwest Territories,  
Canada

Detailed assessment of the geochemical characteristics of mine rock and processed kimberlite from a proposed diamond mine in the Northwest Territories using existing geochemical dataset with several years of site testing and monitoring data. In addition, a project specific geochemical testing program was developed to confirm the characteristics of materials from the Jay Project.

The results of geochemical testing were used as input to the engineering design for the waste rock storage area design, including the development of geochemical criteria for waste rock management and deposition.

**Eldorado Gold Corp. /  
Mine**  
Romania

Tailings geochemical characterization, evaluation of existing results of geochemical characterization of waste rock, and development of water quality predictions in support of environmental permitting and engineering design.

**De Beers Canada Inc. /  
Gahcho Kue Project**  
Northwest Territories,  
Canada

Detailed assessment of the geochemical characteristics of mine rock and processed kimberlite from a proposed diamond mine in the Northwest Territories. Developed a geochemical testing program to evaluate metal leaching potential in site specific conditions, including specialized long-term leach tests and detailed mineralogical analysis. Tasks also included derivation of mine rock and processed kimberlite runoff and seepage source terms into the water quality model for the project.

A geochemical characterization plan was developed to provide recommendations for geochemical classification and monitoring of waste rock during operations. The geochemical characterization plan is a key component of the mine rock management plan for the project.

**De Beers Canada Inc. /  
Snap Lake Project**  
Northwest Territories,  
Canada

Ongoing evaluation of geochemical issues relating to Acid Rock Drainage (ARD) and metal leaching at an operational underground diamond mine. Bi-annual site visit for the purpose of assessment of construction materials for potential ARD, evaluation of seepage quality and source underground, and evaluation of surface seepage and drainage sources. Additional work includes compilation of information and evaluation of geochemical issues for the yearly Acid Rock Drainage (ARD) monitoring report.

Prepared the Metal Leaching / Acid Rock Drainage Plan for the Water License Update based on the results of baseline (pre-mining) and operational geochemical monitoring data.

**Fortune Minerals Ltd. /  
NICO Project**  
Northwest Territories,  
Canada

Detailed assessment geotechnical characteristics of waste rock and tailings from a proposed cobalt, copper, bismuth and gold underground and open pit mine in the Northwest Territories. Developed and implemented laboratory and field scale studies to assess the acid generation potential and metal leaching potential (specifically arsenic) of waste rock, ore and tailings for the purpose of input to site designs and environmental studies. Developed site water quality predictions for the purpose of evaluating the effect of the mine site on receiving water quality.

In collaboration with a large, multi-disciplinary team of engineers and environmental specialists, assisted with preparation of management plans for the project to support the water license phase of the project. Developed a Mine Rock Management Plan for the project, and provided input to the Conceptual Closure and Reclamation Plan and Co-Disposal Facility Plan.

**Alamos Gold Inc. / Agi  
Dagi and Kirazli  
Projects**  
Turkey

Preparation of water quality source terms for seepage and runoff from mine site facilities for input into a geochemical attenuation model to evaluate the effect of mine site seepage on groundwater. Models were completed for the Kirazli and Agi Dagi project areas, respectively. Multi-disciplinary model reports were prepared for the respective project areas, with input from multiple modeling teams, including unsaturated flow modelling, hydrogeological modelling and water balance modelling for the project. The reports were submitted as a component of the environmental impact assessments for the projects.

**Kinross Gold USA Inc.  
/ Buckhorn Mt. Project**  
Okanogan County,  
Washington, United  
States

Geochemical modelling and authoring of technical documents in support of a proposed project near Republic, Washington. Tasks include synthesis of past studies, compilation of static and kinetic testing results, and geochemical modelling and interpretation in support of engineering studies. The results of geochemical characterization were used to develop the initial rock classification criteria for the Mine. Additional work includes development of soil-metal partition coefficients and assessment of attenuation capacity of soils at proposed mine water infiltration site, and assistance in the development of technical reports and site maps related to geological and hydrogeological conditions. Provided input to the Development Rock Management Plan, and worked closely with the client to amend the Development Rock Management Plan based on the results of operational monitoring.

**Compañía Minera  
Antamina**  
Antamina, Peru

Ongoing assessment of the geochemical characterization of waste rock and tailings at an operating open pit copper zinc mine for the purpose of refinement of operational criteria and input to site designs.

Developed recommendations for the revision of the geochemical classification criteria of waste rock at the Project based on the results of operational monitoring.

Development of pit lake water quality predictions as a component of the Closure Plan update for the Project.

**Aurora Energy  
Resources / Michelin  
Project**  
Labrador, Canada

Design and implementation of a sampling and analysis program for the geotechnical characterization of waste rock and tailings from two open pit at a proposed uranium mine in Labrador, Canada. Results of geochemical characterization were summarized with respect to acid generation and metal / radionuclide leaching potential of waste rock and tailings.

**Khan Resources/  
Dornod Uranium  
Project**  
Mongolia

Design of a waste rock and tailings sample collection and analysis program for the purpose of completing a geochemical characterization study in support of screening studies, pre-feasibility studies, feasibility studies, and the socio-environmental impact assessment (SEIA) for the Dornod Uranium Project. Results of geochemical characterization were evaluated with respect to acid generation potential and metal/ radionuclide leaching potential for the purpose of consideration in site designs.

**Cameco Corp. /  
McArthur River Mine**  
Northern Saskatchewan,  
Canada

Collection of waste rock for static and kinetic testing in order to affirm the geochemical characteristics of stockpiled waste rock intended for reuse for site infrastructure.

**Encana Corporation /  
Larado Uranium  
Tailings Site  
Characterization**  
Uranium City,  
Saskatchewan, Canada

Geochemical site characterization of abandoned uranium mill tailings near Uranium City, Saskatchewan. Project work included extensive sampling of tailings material to delineate the geochemical characteristics of tailings material across the deposit, collection of water samples from the tailings and nearby bodies of water, and interpretation and compilation of this information into technical documents. Recent work includes an assessment of the sources and sinks of contaminants of concern on site, including arsenic, selenium, molybdenum and uranium.

**Eldorado Gold Corp. /  
Efemçukuru Mine**  
Izmir, Turkey

Geochemical characterization and interpretation of acid generation and metal leaching potential of mine waste materials for a proposed underground mine in support of an Environmental Impact Assessment. Project work included compilation and interpretation of static and kinetic testing results, and developing water quality predictions in order to comply with Turkish EIA requirements.

**Eldorado Gold Corp. /  
Kisladag Mine**  
Izmir, Turkey

Selection of samples from a large database to spatially and compositionally represent waste material to be extracted from a proposed open pit mine. Project work also involved support in identifying a laboratory to carry out static and kinetic tests. Samples were selected to comply with recommendations in Price (1997).

**North American  
Palladium /  
Shebandowan Mine**  
Thunder Bay, Ontario

Design of waste rock sample collection and analysis program at a proposed nickel mine. Results of geochemical characterization used to evaluate the acid rock drainage and metal leaching potential of waste rock, and to provide recommendations for ongoing testing.

**Cobre Mining  
Company / Hanover  
Empire Zinc Mine Area**  
Hanover, New Mexico

Collection of waste rock at the historic Hanover Empire Zinc mine site for static and kinetic testing in order to affirm the geochemical characteristics of aged waste rock stockpiles. Work has included mapping and sampling of surficial material in waste rock stockpiles, as well as test-pitting to confirm homogeneity at depth. Interpretation of the geochemical characteristics of stockpiled material will define the usability of this material for site remediation.

**Cobre Mining  
Company / Abandoned  
Shafts and Adits**  
Hanover, New Mexico

Collection of waste rock from waste rock piles associated with abandoned shafts and adits on historic claims owned by the Cobre Mining Company. Sampling was undertaken to confirm geochemical characteristics of aged waste rock stockpiles. Work has included mapping and sampling of surficial material in waste rock stockpiles. Interpretation of the geochemical characteristics of stockpiled material will define the usability of this material for site remediation.

**Minefinders  
Corporation Ltd. /  
Dolores Project**  
Northern Mexico

Geochemical characterization and interpretation of acid generation and metal leaching potential of mine waste materials for a proposed open pit mine. Project work included compilation and interpretation of static and kinetic testing results, and developing a water quality model to determine the final pit lake water quality for permitting and treatment purposes.

**Continental Minerals,  
Xiongkun Project**  
Tibet, China

Pit lake water quality model in support of environmental impact studies for a proposed mine in Tibet. Geochemical modelling was conducted to predict the evolution of pit lake water quality evolution for a number of years post-closure, taking in consideration the effects of secondary mineral precipitation, adsorption and atmospheric interaction on ultimate pit lake water quality. Discharge water quality from the various mine components was assessed for the purpose of development of post-closure mitigative options.

**Newmont Ghana Gold  
Limited / Akyem,  
Subika and Apensu  
Pits**

Pit lake water quality model in support of closure planning for three open pits in Ghana. Geochemical modelling was conducted to predict pit lake water quality evolution on a five year basis, taking in consideration the effects of secondary mineral precipitation, adsorption and atmospheric interaction on ultimate pit lake water quality. Discharge water quality compared predicted discharge quality NGGL standards.

<p><b>Science Advisory Board</b> British Columbia, Canada</p>	<p>Preparation of technical report summarizing development, use and modification of metal-partitioning coefficients for the purpose of generating site specific soil standards.</p>
<p><b>Stimson Lumber / NorPetro Site</b> Anacortes, Washington, United States</p>	<p>Installation of two monitoring wells for the purpose of delineating a contaminant plume at a former refinery using a sonic drill rig.</p>
<p><b>City of Dallas / ASR</b> Dallas, Oregon, United States</p>	<p>Interpretation of the general hydrogeochemistry and geochemical modelling of the effects of mixing source water and ground water in an aquifer storage and recovery system. Geochemical modelling included assessing the effects of metal sorption on aquifer materials.</p>
<p><b>Monsanto Elemental Phosphorus Production Plant</b> Soda Springs, Idaho, United States</p>	<p>Yearly water quality sampling for the Monsanto Elemental Phosphorus Plant NPL facility in Idaho. Tasks included the collection and interpretation of analytical data and authoring of the yearly technical report.</p>

## PROFESSIONAL AFFILIATIONS

Professional Geoscientist, Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (Canada)

Professional Geologist, Association of Professional Engineers and Geoscientists of the Province of British Columbia (Canada)

## PUBLICATIONS

Salzsauler, K., De Vos, K., and Schryer, R. 2012. Use of Exploration, Laboratory and Site-Specific Data for the Purpose of Mine Rock Classification, NICO Gold-Cobalt-Bismuth-Copper Project, Northwest Territories, Canada. Poster presentation at the 9th ICARD, Ottawa, Canada 2012.

Herrell, M.K., Salzsauler, K.A., McRae, C. A Practical Application of Mass-Balance Methods for Predicting Mine Drainage Water Quality – Climate Influences and Best Practices. Poster presentation at the 9th ICARD, Ottawa, Canada 2012.

Vandenberg, J., Lauzon, N., Prakash, S., and Salzsauler, K. 2011. Use of water quality models for design and evaluation of pit lakes. In: McCullough, CD (Ed) 2011 Mine Pit Lakes: Closure and Management, Perth, Australia, Australian Center for Geomechanics. p 63 - 80.

Salzsauler, K. and Verburg, R. 2009. Mine water quality predictions for permitting and engineering design at an underground gold mine. Paper presented at the 2009, Securing the Future and 8th ICARD, June 22-26, 2009, Skelleftea, Sweden.

Herrell, M.K., McRae, C., Salzsauler, K.A., Waples, J.S., 2009. Practical Application of Accelerated Methods of Acid Rock Drainage and Metal Leaching Prediction of Mine Materials. Paper presented at the 2009, Securing the Future and 8th ICARD, June 22-26, 2009, Skelleftea, Sweden.

Salzsauler, K.A., Sidenko, N.V., and Sherriff, B.L. 2005. Arsenic mobility in alteration products of sulfide-rich, arsenopyrite-bearing mine wastes, Snow Lake, Manitoba, Canada. *Applied Geochemistry*. 20: 2303 - 2314.

Flemming, R., Salzsauler, K., Sherriff, B. and Sidenko, N. 2005. Identification of scorodite in fine-grained, high-sulfide, arsenopyrite mine waste using micro X-ray diffraction ( $\mu$ XRD). *Canadian Mineralogist*. 43:1243 - 1254.

Salzsauler, K.A., Sidenko, N.V., Sherriff, B.L. 2004. Arsenic in solution and secondary phases in sulfide mine waste, Snow Lake, Manitoba, Extended Abstracts of Water-Rock Interaction-11 Symposium, Saratoga Springs, New York.



## Michael K. Herrell

### Senior Geochemist

<b>Profession</b>	Geochemistry
<b>Education</b>	M.Sc. in Geology, 2002 B.Sc. in Geology, 2000
<b>Registration and Affiliations</b>	Association of Professional Engineers and Geoscientists of British Columbia Association of Professional Geoscientists of the Northwest Territories and Nunavut

#### Specialization

Michael Herrell is a Senior Consultant (Geochemistry) at SRK's Vancouver office. He has 15 years of experience in academia and geochemical investigations. His main area of focus is conducting geochemical characterization studies for proposed, existing and closed mine site facilities. These studies involve assessing the ARD potential and metal mobility from mine materials (i.e. waste rock, tailings and marginal ore, etc.) and evaluating the results of the geochemical characterization in the context of mine water management strategies to predict site effluent water quality and evaluate potential impacts on the receiving environment surface water and groundwater quality. Michael has extensive experience developing large-scale deterministic and stochastic multi-component models for existing and proposed mines using GoldSim and other geochemical software on several projects.

Michael is also responsible for presenting and defending the results of geochemical characterization and water quality modeling studies to regulators, First Nations and other stakeholders. He has performed as an expert witness nationally and internationally in panel review hearings for environmental assessments and water license applications.

#### Employment

April 2018 – Present	SRK Consulting (Canada) Inc. Senior Geochemist
April 2008 – March 2018	Golder Associates Ltd., Mine Water Management Group Associate, Senior Geochemist
April 2017 – March 2018	Gartner Lee Ltd. Geochemist
September 2004 – March 2007	Golder Associates Ltd., Mine Waste Environmental Group Geochemist

#### Publications

Author or co-author of 10 publications

#### Languages

English and Spanish

## Key Project Experience

<b>Dominion Diamond</b> NWT, Canada	<ul style="list-style-type: none"> <li>Performed as the Project water quality modelling lead responsible for the development of a multi-faceted water quality model developed to predict Project effluent water quality and evaluate the influence of the discharge on Lac du Sauvage and Lac de Gras. Michael was also retained as a Subject Material Expert responsible for presenting and defending the water quality predictions to the MVEIRB, WLWB and other stakeholders as part of the ongoing permitting process.</li> </ul>
<b>Gahcho Kue</b> NWT, Canada	<ul style="list-style-type: none"> <li>Project water quality modelling lead responsible for the projection of surface site and downstream water quality for the Gahcho Kue diamond mine to evaluate project impacts to surface water quality as part of the EIA, Water Licence and subsequent amendments. Michael performed as an expert witness in the environmental assessment and water license application panel review hearings.</li> </ul>
<b>Snap Lake Mine</b> NWT, Canada	<ul style="list-style-type: none"> <li>Responsible for updating the site GoldSim model to incorporate operational data as part of annual water licence reporting requirements and subsequent applications.</li> </ul>
<b>Minas Conga,</b> Cajamarca, Peru	<ul style="list-style-type: none"> <li>Responsible for prediction of tailings facility water quality to support detailed design of a treatment plant using GoldSim®. Also, responsible for meeting with the Peritaje (International Review Panel) to defend the tailings geochemical characterization and water quality predictions when they were retained by the Peruvian Ministry Energy of Mines to perform a third-party review of the Environmental Impact Assessment.</li> </ul>
<b>Mount Polley Mine</b> British Columbia, Canada	<ul style="list-style-type: none"> <li>Responsible for the management of the preparation of a Technical Assessment Report (TAR) for the return of the mine to full operations, including the development of a probabilistic water quality model using GoldSim®. Required to manage a multi-disciplinary team and responsible to ensure the TAR was completed in concordance with BC Ministry of Environment guidelines.</li> </ul>
<b>Teck Highland Valley Copper</b> British Columbia, Canada	<ul style="list-style-type: none"> <li>Water quality modelling component lead responsible for the development of the Bethlehem Extension discharge and receiving environment water quality model using GoldSim® to support a Mine's Act Permit Amendment application. Required to present and defend model results to regulators and First Nations.</li> </ul>
<b>Quinsam Coal</b> Campbell River, BC	<ul style="list-style-type: none"> <li>Responsible for the prediction of surface site and downstream water quality resulting from an expansion to existing operations at the Quinsam Coal Mine. Water quality predictions were developed to support an amendment to the existing environmental permit and Michael was responsible for presenting and defending the water quality predictions to several regulatory bodies and non-governmental organizations as part of the permitting process.</li> </ul>
<b>Antapaccay/Tintaya</b> Espinar, Peru	<ul style="list-style-type: none"> <li>Lead Geochemist responsible for identification and oversight of collection of samples to support geochemical baseline studies for a proposed open pit copper mine at the Antapaccay site. More recently, designed a supplemental geochemical characterization program of existing waste rock and tailings storage facilities at the Tintaya site. Developed a site wide geochemical</li> </ul>

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	model to evaluate effluent water quality from both the Antapaccay and Tintaya sites.
<b>Las Bambas,</b> Apurimac, Peru	<ul style="list-style-type: none"> <li>Lead Geochemist responsible for the development of a supplemental operational geochemical characterization program to supplement the baseline geochemical dataset. Project work included identifying rock core sample intercepts and coordinating testing of tailings materials. Used the results of the geochemical characterization to predict pit lake water quality during post-closure as part of the EIA.</li> </ul>
<b>Certej Project</b> Romania	<ul style="list-style-type: none"> <li>Lead Geochemist responsible for tailings geochemical characterization and development of source term input from tailings facilities. Also responsible for development of a site-wide water quality model to inform treatment design studies.</li> </ul>

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## Key Experience

- Responsible for geochemical characterization and water quality modelling studies in support of mining projects at all stages of the mine life cycle including baseline, scoping, feasibility, operations and closure.
- Managed multidisciplinary water quality modelling and surface water quality assessment teams as part of Environmental Impact Assessments, Water License and *Mine's Act* Effluent Permit and Amendment applications in Canada and internationally.
- Developed probabilistic and deterministic geochemical models using GoldSim® to support mine treatment design, mine waste and water management design studies and permit applications.
- Acted as an expert witness in panel hearings in support of applications to Impact Assessment and Water Boards in the Northwest Territories.
- Responsible for communicating technical results and project status information to clients, local regulators, First Nations and other stakeholders.
- Responsible for proposal development and project implementation including project delivery on budget and schedule for large multidisciplinary and smaller-scale projects.
- Provided health and safety leadership as a member of the High-Risk Travel Group and acted as the group health and safety representative in 2008 and 2009.
- Responsible for preparing health and safety plans, briefing staff on key mine site hazards and following-up to ensure staff were safe during their travels to mine sites.
- Responsible for geochemical and water quality studies in support of mine permit applications and other studies at the various stages of mining including baseline, scoping, feasibility, closure and site reclamation.
- Presented technical results to and discussed mine water and waste management strategies with regulatory agencies.
- Prepared technical reports and memorandums as part of baseline, feasibility, site reclamation and closure studies that included field sample collection, laboratory coordination, and data analysis.
- Developed probabilistic and deterministic geochemical models in support of mine treatment design criteria and water management strategies.
- Conducted field studies including waste rock sample collection, mini-piezometer and piezometer installation, and sampling of various media including soil, surface and groundwater.

- Managed large- and small-scale projects that required budget tracking and supervision of junior, administrative and GIS staff involved in related task work. Responsible for communicating technical results and project status information to clients in a timely manner.
- Prepared proposals, budgets and schedules for large, multidisciplinary and small-scale projects.

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## Publications

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1. **Herrell, M.K.**, Skeries, K., Vandenberg, J., Faithful, J. 2018, Hayward, A., Novy, L. 2018. Influence of Probability Distribution Function Sampling Frequency on Stochastic Water Quality Model Predictions. Paper to be presented at the 2018 ICARD, September 2018, Pretoria, South Africa.
  2. **Herrell, M.K.**, Vandenberg, J., Faithful, J. 2018, Hayward, A., Novy, L. 2018. Long-term Water Management of Saline Groundwater at the Ekati Diamond Mine. Paper to be presented at the 2018 ICARD, September 2018, Pretoria, South Africa.
  3. **Herrell, M.K.**, Vandenberg, J., Faithful, J. 2015. Designing meromictic pit lakes as a mine closure mitigation strategy in northern Canada. Paper presented at the 2015 ICARD, April 20-23, 2015, Santiago, Chile.
  4. **Herrell, M.K.**, Salzsauler, K.A., McRae, C. 2012. A Practical Application of Mass-Balance Methods for Predicting Mine Drainage Water Quality – Climate Influences and Best Practices. Poster presentation at the 9th ICARD, Ottawa, Canada 2012.
  5. **Herrell, M.K.**, McRae, C., Salzsauler, K.A., Waples, J.S. 2009. Practical Application of Accelerated Methods of Acid Rock Drainage and Metal Leaching Prediction of Mine Materials. Paper presented at the 2009, Securing the Future and 8th ICARD, June 22-26, 2009, Skelleftea, Sweden.
  6. **Herrell, M.K.**, Faithful, J., Lee, C. 2015. To be or not to be Conservative – A Water Quality Modelling Case Study in the Northwest Territories. Presented at the Yellowknife Geoscience Forum. November 2015.
  7. **Herrell, M.K.**, Dickin, A.P., Morris, W.A. 2006. A test of detailed Nd isotope mapping in the Grenville Province: delineating a duplex thrust sheet in the Kipawa-Mattawa region. *Can. J. Earth Sci* 43(4): 421- 432.
  8. Beddoes, P., **Herrell, M.K.**, Vandenberg, J. 2013. Role of Professional Judgement and Scaling in Interpretation of Water Quality Model Results. *Reliable Minewater Technology*. IMWA 2013. Wolkersdorfer, Brown and Figueroa (Eds.).
  9. Beddoes, P., **Herrell, M.K.**, Vandenberg, J., Richards, J., Millar, R., McMahan, K. 2016. Validation of Springer Pit Lake Water Balance and Water Quality Model, Mount Polley Mine, British Columbia. IMWA 2016. Wolkersdorfer, Brown and Figueroa (Eds.).
  10. Vandenberg, J. **Herrell, M.K.**, Faithful, J. Snow, A.M., LaCrampe, J., Bieber, C., Dayanni, S., Chisholm, V. 2016. Multiple Modeling Approach for the Aquatic Effects Assessment of a Proposed Northern Diamond Mine Development. *Mine Water and the Environment*. Volume 35, Issue 3, pp 350-368. September 2016.
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**EXPERIENCE SUMMARY**

Mr. Horne is a Senior I Engineer/Principal Consultant in the Edmonton office. He has over 30 years of experience in civil engineering and permafrost engineering for oil and gas facilities, mining, hydrocarbon, and municipal projects in Northwest Territories, Yukon, Alaska, Alberta, Russia, and the Beaufort Sea. Areas of expertise include industrial plant site development, heavy equipment foundations, water and tailings dam designs, tailings deposition management, geothermal and deformation modelling, and project management.

**RELEVANT EXPERIENCE**

**Yamal LNG Facility, Yamal LNG.**

- Yamal LNG Facility, Russia. Yamal LNG, Technip, Chicago Bridge and Iron Works. Senior Project Engineer and Manager for foundation design for the Yamal LNG Terminal in Sabetta, Russia. Large diameter pipe piles were used to support LNG Tanks and plant facilities in warm permafrost. Nineteen full size pile load tests were carried out and interpreted to support the foundation design. The pile load tests measured the pile creep and capacity. Estimates of long term deformation were calculated based on laboratory creep tests and the pile load tests. Over 5000 piles will be used to support the plant site.

**Red Dog Mine, Alaska, Teck - Cominco**

- Project Engineer for providing geotechnical input to foundation designs for mill site and port site facilities. Rock socketed piles, spread footings, thrust blocks, and retaining walls were designed. Finite element thermal analyses were carried out to evaluate the performance of a ventilated pad foundation.
- Project Engineer for design components of the water diversion dam and tailings dam. Review the seepage and thermal performance post construction.

**Lik Lead Zinc Deposit, Alaska, Zazu Metals Corp.**

- Project Manager for a pre-feasibility study for the Lik Lead Zinc Project. Tetra Tech provided the plant site foundation design, tailings dam design, water diversion structures design, open stability assessment, permafrost mapping, and permafrost/geotechnical investigation.

**EDUCATION**

B.Sc., Civil Engineering,  
University of Calgary,  
Calgary, AB, 1983

M.Sc., Geotechnical Engineering,  
University of Alberta,  
Edmonton, AB, 1987

**AREA OF EXPERTISE**

Civil and Permafrost Engineering, foundation analysis and design, earth dam designs, numerical modelling, and construction drawings and specifications for variety of mining and hydrocarbon projects

Site investigation, foundation and earth embankment designs

**REGISTRATIONS/  
AFFILIATIONS**

Member, Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Licensee, Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (NAPEG)

Member, Canadian Geotechnical Society (CGS)

Member, Geotechnical Society of Edmonton (GSE)

**OFFICE**

Edmonton, AB

**YEARS OF EXPERIENCE**

30

**CONTACT**

Bill.Horne@tetrattech.com

### **Gahcho Kue Diamond Mine, De Beers Canada Inc.**

- Gahcho Kue Diamond Mine, NWT, De Beers Canada, Tetra Tech Project Manager for components of a feasibility study, permitting, detailed design and construction. Responsible for plant site foundations, permafrost issues, geotechnical investigations, waste and water management plan, tailings management, waste rock dumps, and geotechnical design of plant site and civil infrastructure components. The project included an elaborate water management scheme to drain the lakes for three open pits under the lake. A total of 15 dykes were designed to control the water.

### **Diavik Diamond Mine – Tailings Facility Review.**

- Diavik Diamond Mine, NWT. Principal Consultant for an independent review of the processed kimberlite containment facility, management, emergency preparedness, dyke design and construction, and performance. The dykes are constructed on a permafrost foundation.

### **Jericho Diamond Mine – Closure Plan.**

- Jericho Mine, Nunavut, AANDC. Principal Consultant preparing the Jericho Mine Closure Plan. Responsible for overseeing the plan development for infrastructure removal, demolition, pit stability, permafrost issues, waste and water management plan, tailings management closure, waste rock dump closure. Remedial action plan and environmental site assessment in preparation.

### **Ruth – Bullmoose Mines Closure**

- Project Manager for the closure and reclamation planning for seven abandoned mines east of Yellowknife, NWT. Geo-environmental sampling was carried out to determine the level of contamination in tailings, soils and lakebed sediments. Portal and mine shaft closure designs were provided. The underground mines were in permafrost conditions. A remedial action plan and Class I costs estimates were prepared to define the clean-up.

### **Mayskoye Gold Mine**

- Mayskoye Gold Mine, Russia. Principal Consultant for foundation components of a new gold mine in northern Russia. Facilities were placed on bedrock and ice rich permafrost. A large ventilated pad was designed for the plant site and power house to maintain the permafrost condition. Involved in the project through feasibility design, detailed design and construction.

### **Jericho Diamond Mine – Development and Operation 2006 – 2008, Care and Maintenance July 2008 – September 2009, Reopening. Sept 2010 – Sept 2012**

- Jericho Mine, Nunavut, Tahera Diamond Corporation – Principal Engineer for the design and construction of the tailings facility. Dams and dykes were designed to retain fine processed kimberlite tailings. Both frozen core and geomembrane dams were constructed on a permafrost foundation. A tailings management operation guideline document was prepared. A water balance for the tailings facility was developed, along with guidelines for process water discharge.

- Jericho Mine, Nunavut, Public Works Government Services Canada – Consultant for mine Care and Maintenance. Prepared specifications for the care and maintenance contract. Dealt with ongoing issues relating to tailings, water management and mine infrastructure.
- Jericho Mine, Nunavut, Shear Diamonds. Principal Consultant for Water License Renewal and Permitting. Responsible for permafrost issues, waste and water management plan, tailings management, waste rock dumps. Prepared management plans, and provided support during the water license renewal process.

### Vankor Central Processing Facility

- Senior Project Engineer for the foundation design of the Vankor Central Oil Processing Facility, Russia. Foundations were designed for processing modules and pipe racks founded warm permafrost. A combination of steel pipe piles and thermosyphons were used.

### Landfill Design Guidelines

- Developed Landfill Design Guidelines for the INAC Northern Contaminated Sites program. The guideline included siting criteria, fill material specifications, geomembrane selection, permafrost and thermal considerations and the effects of climate change on landfill designs and risk analysis.

### DEW Line Clean Up – Closure

- Project Manager for providing the geotechnical design for the clean-up of 21 DEW Line sites in Yukon, NWT and Nunavut. The designs include remediation of existing landfills, and construction of new landfills. Thermal analyses are used to design frozen containment structures to contain landfill leachate. Geophysics is used to delineate the extent of existing landfills. The majority of construction was carried out from 2004 to 2012. Currently responsible for review monitoring data.

### Ekati Diamond Mine, BHP Diamonds Inc.

- Geotechnical Engineer, Foundations design for the plant site, constructed on permafrost conditions. Tailings (Processed Kimberlite) Management and Dam and Dyke and Design for Canada's first diamond mine. The tailings management scheme and details were developed for the 25 year mine life. A combination of filter dykes and frozen core dams were developed to retain the tailings and maintain annual discharges from the tailings facility.

### Kubaka Water Dam and Tailings Dam, Magadan Russia, Kinross 1996 - 2004

- Project Engineer for the design and construction of a tailings facility for the Kubaka Gold Mine, Magadan, Russia. A thickened tailings deposition scheme was developed. A water retention dam was constructed downstream of the tailings area. A design brief was prepared for submission to regulators to obtain permitting. Construction drawings and specifications were developed. Construction monitoring annual inspection and closure design was provided.

### Polaris Mine, NT, Cominco

- Project Engineer for the design of the first frozen core dam in Canada. The dam was for the tailings facility. The thermal behaviour was modelled to evaluate the thermal regime during construction and over the long term. Recommendations for the shore protection and construction materials were provided. A reclamation and abandonment plan was developed. Construction monitoring, and annual inspections were provided.

## Publications

- Kubaka Mine Tailings Design, Construction and Operation of Frozen Core Dam: A Case Study, ASDSO West Regional Conference 2001.
- DEW Line Landfills, IWCSE 2002 Conference, Edmonton, AB
- Permafrost Containment Landfills at Arctic DEW Line Sites, 56<sup>th</sup> Canadian Geotechnical Conference, 2003.
- DEW Line Landfill Design and Construction, ASCE Conference, Edmonton, Alberta, 2004.
- Performance Measures of Arctic Landfills, Assessment and Remediation of Contaminated Sites in Arctic and Cold Climates, (ARCSACC), 2005.
- Rationalizing Climate Change for Design of Structures on Permafrost: A Canadian Perspective, Ninth International Conference on Permafrost, Fairbanks, 2008.

### EXPERIENCE SUMMARY

Dr. Xia is a Senior Geotechnical Engineer with more than 10 years of consulting experience in geotechnical and permafrost engineering through design and construction projects in Canada and Russia. His areas of technical expertise include geothermal design and evaluation, mine waste rock, tailings, water management, and associated earthwork structure design, northern mine permitting, piled and shallow foundation design in permafrost. He also gained extensive experience in numerical modelling and analytical analysis through the eleven years of university study and research.

### RELEVANT EXPERIENCE

Some geotechnical projects that Dr. Xia has been involved in include:

- Project Engineer for Gahcho Kué Diamond Mine Engineering Detailed Design and Permitting, De Beers Canada Inc.
- Project Manager for Thermal Evaluation of Closure Cover for Diavik Waste Rock Pile, Diavik Diamond Mines (2012) Inc.
- Lead Engineer for Thermal Foundation Design for Various Buildings for Meliadine Gold Project, Agnico Eagle Mines Ltd.
- Lead Engineer for Thermal Evaluation of Waste Rock Storage Areas at Ekati Mine, Dominion Diamond Ekati Corporation.
- Project Engineer for Meliadine Gold Project Engineering Detailed Design, Agnico Eagle Mines Ltd.
- Project Engineer for Thermal Evaluation of Till Cover of Pigeon Pit Waste Rock Storage Area at Ekati Mine, Dominion Diamond Ekati Corporation.
- Project Engineer for Geotechnical and Permafrost Consultant Work for Yamal LNG Processing Facilities Detail Design, Technip-JGC Consortium, Paris, FR.
- Project Engineer for Thermal Foundation Design of HP Flare Stack, Yamal-LNG Detailed Design; Technip-JGC Consortium, Paris, FR.
- Project Engineer for Thermal Foundation Design of BOG Stack, Yamal-LNG Detailed Design; JGC Corporation, Japan.
- Project Engineer for Waste and Water Management Feasibility Study for Meliadine Gold Project, Agnico-Eagle Mines Ltd.
- Project Engineer for Tailings Management Scoping Study for Meliadine Gold Project, Agnico-Eagle Mines Ltd.
- Geotechnical Engineer for Yamal LNG Third Party Design Review Project, Chicago Bridge & Iron Company, London, UK.
- Geotechnical Engineer for Prefeasibility Study for Courageous Lake Project, Seabridge Gold Inc.

### EDUCATION

Ph.D., Civil Engineering, Queen's University, Kingston, ON

M.Sc., Geotechnical Engineering, Tongji University, Shanghai, China

B.Sc., Engineering Geology, China Ocean University, Qingdao, China

### AREA OF EXPERTISE

Mine Rock, Tailing and Water Management and Earthwork Structure Design

Northern Mine Water Licence Permitting  
Permafrost Foundation Design and Evaluation

Thermal Design and Evaluation

Slope Stability and Seepage Evaluation

Construction Monitoring and Quality Control

2D and 3D Numerical Modelling

Civil 3D and Rift Tailings Desposition Modelling

Water Managemnt Modelling via Goldsim software

### REGISTRATIONS/ AFFILIATIONS

Member, Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Licensee, Association of Professional Engineers and Geoscientists of Northwest Territories and Nunavut (NAPEG)

Member, North American Society for Trenchless Technology (NASTT)

### OFFICE

Edmonton, AB, Canada

### YEARS OF EXPERIENCE

10+

### CONTACT

Hongwei.Xia@tetrattech.com

- Geotechnical Engineer for Feasibility Study for Roche Bay Iron Ore Project, Advanced Explorations Inc.
- Geotechnical Engineer for EIS Supplement Study and Permitting (Technical Section) for Gahcho Kue Diamond Mine, De Beers Canada Inc.
- Geotechnical Engineer for LIK Project Mine Waste Management Prefeasibility Study, JDS Energy & Mining Inc., British Columbia.
- Geotechnical Engineer for EKATI Dyke C Raise Design for BHP Billiton Diamonds Inc.
- Geotechnical Engineer for Water Management Plan for Minto Mine Project, Minto Explorations Ltd., British Columbia.
- Geotechnical Engineer for Updated Water and Tailings Management Plan for Cantung Mine, North American Tungsten Corp. Ltd.
- Geotechnical Engineer for Thermal Evaluation and Thermosyphon Foundation Design for the IBC studio, FSC Architects & Engineers, Iqaluit, NU.
- Geotechnical Engineer for Thermal Evaluation of Open Pit Infilling with Thickened Tailings for Minto Mine Project, Minto Explorations Ltd., British Columbia.
- Geotechnical Engineer for Thermal Design and Evaluation for the Parking Lots and Access Road of the Legislative Assembly in Yellowknife, NT., FSC Architects & Engineers, Iqaluit, NU.

## Jamie Van Gulck, Ph.D., P.Eng.

Principal

Ph: 867 446 4129 x18; Fax: 1 866 475 1147

E-mail: vangulck@arktissolutions.com

### EDUCATION

- J Ph.D., Geotechnical and Geoenvironmental Engineering, Department of Civil Engineering, Queen's University
- J B.E.Sc., Civil and Environmental Engineering University of Western Ontario

### EMPLOYMENT HISTORY

- J ARKTIS Solutions Inc., Principal (08/2007 to present)
- J ARKTIS Piusitippaa Inc., Chief Technical Officer (04/2010 to present)
- J VGQ Consulting Inc., Director (04/2004 to present)
- J University of Manitoba, Department of Civil Engineering, Adjunct Professor (08/2007 to 08/2010)
- J University of Manitoba, Department of Civil Engineering, Assistant Professor (05/2003 to 08/2007)
- J Queen's University, Research Assistant (09/2000 to 04/2003)
- J Geotechnical Research Centre, University of Western Ontario, Research Contractor (04/1997 to 07/2000)

### PROFESSIONAL SOCIETIES

- J Member, Association of Professional Engineers, Geologist & Geophysicists of NWT & Nunavut
- J Member, Professional Engineers Ontario
- J Member, Canadian Dam Association
- J NSERC 1509 Committee Member

### SUMMARY OF EXPERIENCE

Prior to being a co-founder for Arktis Solutions Inc., Jamie worked as an Assistant Professor in the Department of Civil Engineering at the University of Manitoba. Jamie left academia to become a private consultant to link business and research opportunity to the science and engineering sectors and resulted in the development of VGQ Consulting Inc.

Jamie is a Principal and founding partner with Arktis Solutions Inc. and lead engineer within the organization. Jamie's roles include contributing to the strategic, business and financial operations of the organizations, as well as, lead technical resource and project management.

Jamie has eighteen years of experience in the following areas: geotechnical and environmental engineering; mining; hydrogeology; northern infrastructure development; policy and regulatory review and development; land and environment management, and research and development. He has authored and co-authored numerous technical papers in various refereed journals and conferences. Additionally, he has contributed to the development of regulations and guidance documents for Government and Aboriginal organizations in the sectors of mining and municipal infrastructure.

Jamie specializes in cross-disciplinary design and analysis which has led to fluid collaborations with multi-disciplinary and multi-sector teams. He has acted as an expert technical reviewer of: northern mining and site remediation projects; contaminated site clean up projects; and municipal infrastructure design and construction projects. Additionally, Jamie has been: a lead designer and project manager for municipal infrastructure projects; and, instructor for drinking water treatment, waste water treatment and solid waste management courses for community operators.

## MINING

- ) **Aboriginal Affairs and Northern Development Canada (NT)** – Expert technical reviewer of the Tyhee Gold Project environmental impact assessment. Review focused on geotechnical and hydrogeological aspects of the project, as well as, water quality and quantity of surface water and groundwater from the mine site and tailings containment facility. Assisted in the development of information requests for submission to Mackenzie Valley Environmental Impact Review Board.
- ) **Government of the Northwest Territories (NT)** – Expert technical reviewer of Dominion Diamond Corporation's Ekati Diamond Mine Jay-Pipe Environmental Assessment report and Water Licence application. Review focused on geotechnical design of the open pit and surrounding dykes and hydrogeology. Assisted in the development of information requests and the intervention for submission to Mackenzie Valley Environmental Impact Review Board (2015) and Mackenzie Valley Land and Water Board (2016/17). Expert witness at the public hearing.
- ) **Government of the Northwest Territories (NT)** – Expert geotechnical technical reviewer of Diavik Diamond Mine Corporation's Diavik Diamond Mine A-21 Pit Dyke engineering design and construction specifications (2015).
- ) **Government of the Northwest Territories (NT)** – Expert geotechnical technical reviewer of Diavik Diamond Mine Corporation's Processed Kimberlite containment facility dam design and water management (2018).
- ) **Government of the Northwest Territories (NT)** – Expert technical reviewer of Avalon Rare Metals Inc.'s Nechalacho Rare Earth Metals Project Type A Water Licence application. Review focused on tailings management, tailings pond design, geochemistry, closure and reclamation and financial security. Assisted in the development of information requests and the intervention for submission to Mackenzie Valley Land and Water Board.
- ) **Government of the Northwest Territories (NT)** – Expert technical reviewer of North American Tungsten Corporation's Cantung Mine Type A Water Licence amendment application. Review focused on tailings management, tailings pond design and geochemistry. Assisted in the development of information requests and the intervention for submission to Mackenzie Valley Land and Water Board. Expert witness at the public hearing.
- ) **Qikiqtani Inuit Association (NU)** – Project lead in the development of the annual financial security assessment (2013 to 2018) for the Baffinland Iron Mines Corporation Mary River project on behalf of the land owner. Expert technical lead in regulatory and lease negotiations and workshops pertaining to financial security.
- ) **Qikiqtani Inuit Association (NU)** – Technical resource and lead in the completion of an annual environmental inspection and audit (2009 to 2017) of the Baffinland Iron Mines Corporation Mary River project. Development of a site inspection protocol to evaluate site conditions in relation to environmental and lease requirements.
- ) **Qikiqtani Inuit Association (NU)** – Environmental impact assessment and regulatory expert technical reviewer for the Baffinland Iron Mines Corporation proposed iron mine (2011 to 2013). Project manager of the Environmental Assessment team in the topics of socio-economics, terrestrial, marine, aquatic resources, engineering and regulatory. Assisted in the development of information requests and the intervention for submission to Nunavut Impact Review Board. Expert witness at the public hearing.
- ) **Qikiqtani Inuit Association (NU)** – Expert technical reviewer of the abandonment and restoration plan and security estimate for Baffinland Iron Mines Corporation Mary River Bulk Sampling Program. Development of the 2010 financial security estimate for the landowner.
- ) **Qikiqtani Inuit Association (NU)** – Expert technical and regulatory review of the Baffinland Iron Mines Corporation Type A and Type B water licence applications (2008 to 2015). Assisted in the development of information requests and the intervention for submission to Nunavut Water Board. Expert witness at the public hearing.

- J) **Qikiqtani Inuit Association (NU)** – Expert technical and regulatory review of the Baffinland Iron Mines Corporation Aquatic Effects Monitoring Program, Interim Closure and Reclamation Plan, Annual Report, Annual Work Plan and Quarry/Borrow Management Plans. Reviews submitted to the Nunavut Water Board (2013 to 2017).
- J) **Qikiqtani Inuit Association (NU)** – Project manager and technical lead in the development of the annual Quarry Concession Report (2014 to 2017) that determines the royalty payments associated with borrow and quarry material used by Baffinland Iron Mines Corporation. Assessment of material usage and methodology for quantification on behalf of the land owner.
- J) **Qikiqtani Inuit Association (NU)** – Project manager and technical lead in the development of an Operations Guide that is used by the Baffinland Iron Mines Corporation to ensure fulfillment of their obligations under the Commercial Production Lease with the Qikiqtani Inuit Association.
- J) **Kivalliq Inuit Association (NU)** – Comprehensive review and benchmarking to establish fees applied to Regional Inuit Owned Lands and Specified Substances designated through the Nunavut Land Claim Agreement.
- J) **Parks Canada Agency (NT)** – Expert technical reviewer of the Canadian Zinc Corporation, Prairie Creek environmental impact assessment. In 2011, the review focused on winter road construction and geotechnical stability, spill contingency and risk, geochemistry of tailings predictions, and mine water management and treatment. Assisted in the development of information requests on behalf of Parks Canada Agency for submission to Mackenzie Valley Environmental Impact Review Board. Expert witness at the public hearing.
- J) **Parks Canada Agency (NT)** – Expert technical reviewer of the Canadian Zinc Corporation, Prairie Creek environmental impact assessment addendum. In 2015-2017, the review focused on the all-weather road construction and geotechnical stability, spill contingency and risk, and quarry/borrow source management. Assisted in the development of information requests on behalf of Parks Canada Agency for submission to Mackenzie Valley Environmental Impact Review Board. Expert witness at the public hearing.
- J) **Parks Canada Agency (NT)** – Contracted to complete an expert technical reviewer of Selwyn Chihong’s environmental impact assessment for the Howard’s Pass Access Road Upgrade Project. The review is to focus on the all-weather road construction and geotechnical stability, spill contingency and risk, and quarry/borrow source management.
- J) **DeBeers Canada (NT)** – Engineering lead in the development of a closure and reclamation plan (2011, 2013, 2016, 2018) for the Snap Lake mine in Northwest Territories. Expert witness at the water licence public hearing. Organized and facilitated community engagement workshops regarding mine closure planning.
- J) **DeBeers Canada (NT)** – Engineering lead in the development of mine closure financial liability estimate (2011, 2013, 2016, 2018) for the Snap Lake mine in the Northwest Territories. Assessment of closure cost implications resulting from updates the Metal Mines Effluent Regulations (2017). Expert witness at the water licence public hearing.
- J) **DeBeers Canada (NT)** – Research and development engineering lead associated with closure and reclamation of the Snap Lake mine in Northwest Territories (2010 to 2018). Focus of research and development is associated with cover performance for the waste rock/tailings pile, progressive reclamation of impacted land, revegetation and contaminated site investigations and reclamation action plans.
- J) **DeBeers Canada (NT)** – For the Snap Lake mine, project manager and technical resource in the completion of various environmental agreement and water licence annual reports, including: Annual Closure and Reclamation Plan Progress Report (2011 to 2018); Air Quality and Emissions Reporting (2016 to 2018); Vegetation Monitoring (2016 to 2019), Geotechnical Instrumentation Monitoring Data Report (2016 to 2018); Seepage Survey Report (2016 to 2018); Acid Rock Drainage and Geochemical Characterization Report (2016 to 2018); Hydrology Report (2015 to 2018); Environmental Agreement Annual Report (2015 to 2018), Wildlife Effects Monitoring Plan (2016 to 2018), Wildlife and Wildlife Habitat Protection Monitoring Plan (2016 to 2018).

- J **DeBeers Canada (NT)** – Project manager and engineering lead in the completion of closure revegetation research for the Snap Lake mine (2014 to 2018). Development of a Final Revegetation Plan for the mine (2018).
- J **DeBeers Canada (NT)** – Project manager and engineering lead in the completion of the following air quality assessments for the Snap Lake mine: updates to the Air Quality and Emissions Reporting and Management Plan for C&M (2017) and Final Closure (2018), air dispersion modelling for the care and maintenance phase (2017), air dispersion modelling for the final closure phase (2018).
- J **DeBeers Canada (NT)** – Project manager for the 2013 implementation assessment of the four separate impact benefit agreements in place between De Beers and the local First Nations for the Snap Lake mine.
- J **DeBeers Canada (NT)** – Project manager and design engineer for the development of a new hazardous material containment facility and the expansion of an existing hazardous material containment facility at the Snap Lake mine.
- J **DeBeers Canada (NT)** – Project manager and technical resource to complete a dam feasibility study, and the engineering design and construction tender documents for two water retention dams at the Snap Lake mine.
- J **DeBeers Canada (NT)** – Project manager and technical lead for the preliminary design of a quarry and water retention sump, as well as, a water balance and chemical load balance model for the sump at the Snap Lake mine.
- J **DeBeers Canada (NT)** – Project manager for the development of emergency preparedness and emergency response plans for two dams at the Snap Lake mine.
- J **DeBeers Canada (NT)** – Project manager and technical resource for the development of the Gahcho Kue mine’s Interim Closure and Reclamation Plan (2016 to 2018), Reclamation Research Plan (2016 and 2017) and Annual Closure and Reclamation Report (2015, 2017) for submittal to the Mackenzie Valley Land and Water Board. Completed a community engagement workshop (2015) and regulator workshop (2016, 2017) regarding mine closure planning.
- J **DeBeers Canada (NT)** – Engineering lead in the development of mine closure financial liability estimate (2016, 2018) for the Gahcho Kue mine’s Land Use Permit amendment applications.
- J **DeBeers Canada (NT)** – Engineering lead in the development of mine closure financial liability estimate (2017 to 2018) for the Gahcho Kue mine. Expert witness at the water licence public hearing.
- J **DeBeers Canada (NT)** – Engineering lead in the completion of closure revegetation research for the Gahcho Kue mine (2017 to 2018).
- J **DeBeers Canada (ON)** - Engineering lead in the development of mine closure financial liability estimate for the Victor mine in Ontario (2018).
- J **Huckleberry Mines Ltd (BC)** – Project manager in the evaluation of mine water quality and sources of nutrients in mine water.
- J **Yellowknives Dene First Nation (NT)** – Expert technical reviewer in the evaluation of the Giant mine’s environmental impact assessment. Technical review focused on water quality, waste management, and site closure conditions. Assisted in the development of information requests and the intervention for submission to Mackenzie Valley Environmental Impact Review Board.
- J **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Bullmoose Area Mine Sites, NWT Remedial Action Plan.
- J **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Seven Mines Sites, NWT Remedial Action Plan.
- J **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Great Slave Lake Mines, NWT Remedial Action Plan. Participated in community engagement workshop regarding mine closure planning.
- J **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Tundra Mine, NWT Remedial Action Plan.

- J **Yellowknives Dene First Nation (NT)** – Expert technical reviewer for the Hidden Lake Mine, NWT Remedial Action Plan.
- J **Tlicho Government (NT)** – Technical resource development consultant and contributed to the regulatory and technical review of Proponent information in their advancement towards entering into an environmental assessment.
- J **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer for the Phase II Remedial Action Plan for the Tundra Mine Site that included reclamation and closure of: tailing containment area for ARD/ML tailings and waste rock, site water management and treatment, petroleum hydrocarbon contaminated soil and rock. Lead engineer in technical/regulator meetings with proponent and participant in the public hearing. Assisted in the development of the water licence.
- J **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer for the Miramar Northern Mining Ltd. Con Mine closure plans for backfill and cover of the tailings containment ponds and hazardous waste areas.
- J **Mackenzie Valley Land and Water Board (NT)** – Project manager for a team of scientist and engineers in the water licence review of the North American Tungsten Corporation mine in the NWT. Technical lead in the review of surface infrastructure, hydrologic, hydrogeologic, geochemistry, abandonment and reclamation, and security components. Lead engineer in technical/regulator meetings with proponent and participant in the public hearing. Assisted in the development of the water licence.
- J **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer of the following De Beer’s Snap Lake mine engineering documents pertaining to the waste rock, ore storage and tailings management.
- J **Lutsel K’e Dene First Nation (NT)** – Expert technical reviewer for following BHP Billiton Diamonds Inc. – EKATI diamond mine engineering documents pertaining to adaptive management, closure and reclamation, financial security, waste rock and tailings management.
- J **Lutsel K’e Dene First Nation (NT)** – Expert technical reviewer for the following Diavik Diamond Mine Inc. – management documents pertaining to hazardous materials and spill contingency.
- J **Lutsel K’e Dene First Nation (NT)** – Participated in Deze Energy Corporation Taltson Hydroelectric Expansion Project, Environmental Impact Assessment technical sessions organized by the Mackenzie Valley Environmental Impact Review Board.
- J **Mackenzie Valley Environmental Impact Review Board (NT)** - Project manager for the socio-economic review of the proposed Gahcho Kué diamond mine in the NWT.
- J **Saskatchewan Environment Resource Management (SK)** – Expert technical reviewer of groundwater and brine migration model predictions below the Cory, Mosaic, Mosaic K1, Mosaic K2, and Patience Lake, Saskatchewan potash mines during operation and post-closure.
- J **Nunavut Water Board (NU)** – Expert technical reviewer and licence compliance assessor for the Miramar Hope Bay Limited Windy Lake and Boston Exploration Camps, specifically, the water monitoring program, QA/QC plan, annual reporting, and abandonment and restoration plan.
- J **Nunavut Water Board (NU)** – Technical reviewer of the following Tahara Diamond Corporation- Jericho Diamond Mine application documents for water licence consideration.
- J **Nunavut Water Board (NU)** - Technical reviewer of the following Miramar Hope Bay Limited- Doris North Gold Mine application documents for water licence consideration.
- J **UMA Engineering Ltd. (MB)** - Chemical treatment of mine water effluent at the closed Fox Lake, Manitoba.
- J **INCO LTD. (MB)** - Contributed to the characterization and trial revegetation of mine tailings at INCO Ltd., Thompson, Manitoba.
- J **INCO LTD., Manitoba Sustainable Development Innovation Fund, and University of Manitoba (MB)** - Field and laboratory measurement of unconsolidated and cemented (hard-pan) tailings hydraulic properties and implications on metal leachate and acid mine drainage.

- J **Manitoba Mines Branch, Manitoba Sustainable Development Innovation Fund, and University of Manitoba (MB)** - Assessment of attenuation and potential mobility of arsenic at the abandoned New Britannia Mine, Manitoba.
- J **Federal University of Rio Grande do Sul, Brazil and University of Manitoba (MB and Brazil)** – Project manager and engineering advisor in the assessment of contaminant transport properties through compacted soil liners subjected to acid mine drainage percolation.
- J **Federal University of Rio Grande do Sul, Brazil and University of Manitoba (MB and Brazil)** - Project manager and engineering advisor in the measurement of geotechnical strength characteristics of residual soils, with and without cement additives, subjected to acid mine drainage percolation.

## OIL AND GAS

- J **Government of the Northwest Territories (NT)** – Expert technical reviewer of Imperial Oil Limited's Norman Wells Production Facility Interim Closure and Reclamation Plan (2015).
- J **Government of the Northwest Territories (NT)** – Expert technical reviewer of Imperial Oil Limited's Norman Wells Production Facility security estimate (2014 and 2018).
- J **Government of the Northwest Territories (NT)** – Development of a RECLAIM Oil and Gas user manual to complete reclamation liability estimates (2017).
- J **Aboriginal Affairs and Northern Development Canada (NT)** – Review and update of the existing RECLAIM model used in the NWT for estimating reclamation liabilities at oil & gas sites through to oil & gas production sites (2013).
- J **Inuvialuit Water Board (NT)** – Expert technical and regulatory assessment of Imperial Oil Limited's Type B water licence application pertaining to the reclamation of Bar-C in the Inuvialuit Settlement Region.
- J **Inuvialuit Water Board (NT)** – Expert technical and regulatory assessment of Shell Canada's Closure and Reclamation Plan for the Camp Farewell site.
- J **Government of Northwest Territories – Environment and Natural Resources (NT)** – Expert technical reviewer of Oil & Gas Drilling Waste Disposal Practices for the Proposed Type A Water Licence in the Cameron Hills, NWT Region. Expert technical witness during the water licence public hearing.
- J **Mackenzie Valley Land and Water Board (NT)** – Expert technical reviewer for Paramount Resources Ltd. water licence and land use permit application materials to support their Cameron Hills extension project.
- J **Department of Indian Affairs and Northern Development (NT)** – Technical and regulatory reviewer for the Paramount Resources Ltd. Cameron Hills Type 'B' Water Licence Application that included aspect to evaluate impacts on surface water quality and quantity.
- J **Northwest Territories Water Board (NT)** - Preliminary technical review of Shell Canada Ltd. Camp Farewell, NT Environmental Site Assessment.
- J **Northwest Territories Water Board (NT)** - Preliminary technical review of MGM Energy Corporation 2D, 3D, and seismic drilling operations and review of draft water licence conditions.

## REGULATORY

- J **Government of the Northwest Territories (NT)** – Completed a state of knowledge report for groundwater resources within the transboundary reaches of the NWT to support the bi-lateral water agreements with the Yukon, British Columbia, Alberta, and Saskatchewan.
- J **Government of the Northwest Territories (NT)** – Expert technical reviewer of the draft solid waste facility design and operation guidelines developed by the Mackenzie Valley Land and Water Board.

- J **DeBeers Canada (NT)** – Provided expert technical reviewer of the draft guidelines for closure and reclamation cost estimates for mines developed by the Mackenzie Valley Land and Water Board (2015, 2017).
- J **Northwest Territories Water Board (NT)** – Expert technical reviewer for the Inuvik to Tuktoyuktuk all-weather highway project. Acted as regulatory officer throughout the licensing process, and prime expert witness during the water licence public hearing (2013). Post hearing activities involved review of the Type A water licence submittals (as needed, 2013 to 2018).
- J **Wek’eezhii Land and Water Board (NT)** – Project manager in the jurisdictional review of land and water use permits in Saskatchewan, Yukon, Alberta, Alaska, British Columbia, and Ontario. Focus of review was focused on the following resource sector activities: waste disposal sumps, diamond drilling on land and ice, camp waste management, on-land seismic activities, and winter road activities on land and ice.
- J **Qikiqtani Inuit Association (NU)** – Contributed to the development of a lands resource security policy in conjunction with this landowner.
- J **Plan Review Process & Guideline Working Group – Mackenzie Valley Land and Water Boards (NT)** – Lead engineer and technical resource consultant in the completion of a guideline for waste management practices that proponents seeking a water licence can use to ensure that their plans and designs capture elements necessary to understand waste management and the expectations that the Water Boards within the Mackenzie Valley. The guideline is applicable to the mining, oil and gas, exploration, industrial, and municipal sectors, and includes all sources of waste ranging from tailings, construction & demolition waste, hazardous waste, contaminated soil, and municipal refuse.
- J **Environment Canada (YK, NT, NU)** – Project manager and lead engineer to evaluate the legal obligations (e.g., permitting, compliance promotion, and enforcement) and authorities of governments and Boards within the Canadian North responsible for environmental legislation and protection. Also, evaluated the potential implementation issues for the new CEPA Storage Tank regulation in the North and the proposed federal Clean Air Regulatory Agenda for the Northern Oil and Gas Sector.
- J **South Australia Environmental Protection Authority (Australia)** - Contributed to the development of the landfill standards, specifically, barrier system design and contaminant transport, test methods for organic matter and calcium content for leachate collection drainage materials, leachate collection system design and service life predictions, and expert review of draft standards.
- J **Nunavut Water Board (NU)** – Lead engineer responsible for the development of draft guidance document for northern waste and water containment facilities, specifically, landfills, landfarms, lagoons, and water retention structures. Document provides proponents involved in these facilities of the hydrology, hydrogeologic, geotechnical, design, operation, monitoring, and maintenance issues that may be considered and detailed in an application for the purposes of obtaining a water licence.
- J **Nunavut Water Board (NU)** - Contributed to the development of application guidelines for Miramar Hope Bay Ltd.- Doris North Gold Mine and Cumberland Resources Ltd.- Meadowbank Gold Mine.
- J **Nunavut Water Board (NU)** - Technical review and licence compliance assessment for monitoring program, QA/QC plan, annual reporting, and abandonment and restoration plan for the following Distant Early Warning (DEW) line sites: DYE-M- Cape Dyer; CAM-2- Gladman Point; FOX-2- Longstaff Bluff; FOX-5- Qikiqtarjuaq; BAF-5- Resolution Island; and, CAM-1- Jenny Lind Island.
- J **Ontario Ministry of Environment (ON)** - Contributed to the review of state-of-the-art of landfill design, specifically pertaining to leachate characteristics for municipal solid waste landfills, leachate collection system design, and geosynthetic use in leachate collection system and cover applications.

## MUNICIPAL INFRASTRUCTURE

- J **City of Iqaluit (NU)** – Project manager and technical lead in the contract administration support for various water, wastewater, and solid waste infrastructure projects, including: solid waste facility fence design (2016 to 2017), water and sewer inventory update and model development (2017), supplementary water supply pipeline (2017), construction contractor support package (2017). As needed (2016 to 2017).

- J **City of Iqaluit (NU)** – Project manager for the construction administration of the city’s solid waste and wastewater treatment facility (2016).
- J **City of Iqaluit (NU)** – Project manager for the structural and electrical evaluation of the City of Iqaluit’s Fire Station back-up generator (2016).
- J **Inuvialuit Water Board (NT)** – Expert technical review of the Hamlet of Aklavik’s water licence application materials (2016).
- J **Environment Canada (YK, NT, NU)** – Expert technical reviewer of draft guidance document “Solid Waste Facilities in Northern Climate”.
- J **Environment Canada (YK, NT, NU)** – Expert technical support for the development of the document “Modern Municipal Solid Waste Facilities in Northern Climate”. Performed consultation activities between Environment Canada and various Territorial Government departments.
- J **Environment Canada (YK, NT, NU)** – Project lead in the development of a foundation report for a technical document on municipal solid waste landfills in northern conditions: engineering design, costing, construction, and operation.
- J **Environment Canada (YK, NT, NU)** – Project lead in the review of the state of waste management practices for community solid waste within the three territories. The focus of the study was on regulatory requirements, territory wide solid waste profiles and challenges, as well as, community scale operations and challenges.
- J **Government of Nunavut (NU)** – Project manager and technical lead in the completion of best management practices for landfills in Nunavut. Analysis includes strategic planning, options analysis, and cost-benefit analysis.
- J **Government of Nunavut, Hamlet of Sanikiluaq (NU)** – Technical resource in the design, construction, and costing of the community’s wastewater lagoon expansion cell. Evaluation of the existing lagoon and wetland treatment capabilities and design of modifications to the current system to achieved effluent water quality criteria.
- J **Government of Nunavut, Hamlet of Igloolik (NU)** – Project manager and technical resource in the design and construction of a new drinking water containment structure and associated infrastructure / piping for water treatment/delivery.
- J **Government of Nunavut, Hamlet of Resolute Bay (NU)** – Project lead and engineer in the development of a new solid waste facility and decommission of the existing solid waste site (municipal landfill, recycling area, and bulky metals site) in Resolute Bay, Nunavut. Core activities included: siting and design of a new solid waste disposal facility; waste audit and development of waste management plan for the new disposal facility; construction costing; closure and reclamation plan; and, provision of tendering services upon acceptance of design including tender documents, construction specifications and QA/QC plan, drawings, and contract administration during construction.
- J **Government of Nunavut, Hamlet of Grise Fiord (NU)** – Technical resource in the development of a new solid waste facility and decommission of the existing solid waste site (municipal landfill, recycling area, and bulky metals site) in Grise Fiord, Nunavut. Core activities included: siting and design of a new solid waste disposal facility; construction costing; closure and reclamation plan; and, provision of tendering services upon acceptance of design including tender documents, construction specifications and QA/QC plan, drawings, and contract administration during construction.
- J **Government of Nunavut, Hamlet of Pangnirtung (NU)** – Project manager and lead environmental and geotechnical designer and engineer in the optimization of the hamlet’s water supply facility and completion of a Comprehensive Performance Evaluation report. Activities include: assessment and repair of water retention structure and associated infrastructure; geotechnical and geothermal modelling of the water reservoir slopes; and, design of an improved water supply facility to meet current and future community needs.
- J **Government of Nunavut, Hamlet of Arviat (NU)** – Lead geotechnical designer in the geothermal modelling of the water retention structure slopes and foundation.
- J **Mackenzie Valley Land and Water Board (NT)** – Project manager for a technical team to technically review the City of Yellowknife’s water licence application and supporting documents. Topics covered

included review of the proponent's landfilling and wastewater treatment practices and future expansion plans. Participant in technical /regulatory meetings with the proponent. Assisted in the development of the water licence.

- J) **Mackenzie Valley Land and Water Board (NT)** – Technical reviewer of the Town of Hay River's water licence application and supporting documents. Topics covered included review of the proponent's landfilling and wastewater treatment practices and future expansion plans. Participant in technical /regulatory meetings with the proponent. Assisted in the development of the water licence.
- J) **Department of Indian Affairs and Northern Development (NT)** – Lead geotechnical engineer in the completion of a desktop study for a leased land in Ft. Simpson, NT that is proposed for two storage facilities.
- J) **Department of Indian Affairs and Northern Development (NT)** – Project manager and geotechnical engineer in the completion of a geotechnical field investigation for a leased land in Ft. Simpson, NT that is proposed for two storage facilities.
- J) **Wekweeti Community Government – Tlicho (NT)** – Project manager for a community energy audit.
- J) **Gameti Community Government – Tlicho (NT)** – Project manager for a community energy audit.
- J) **Infrastructure Canada- Knowledge-building, Outreach, and Awareness Program (Canada)** - Assessment of national incidence of water well infrastructure deterioration in Canada, life-cycle cost analysis of groundwater extraction wells with consideration given to operations and maintenance, and characterization of water quality, hydrogeology, and well design and operation impacts on water well deterioration.
- J) **Grundfos Management A/S (Denmark)** – Grundfos is the world leader in the manufacturing of pumps. Acted as an expert participant in a workshop in Denmark to review mechanisms and process leading to biological, chemical, and physical clogging mechanisms and process for groundwater wells and pumps.
- J) **Agriculture and Agri-Foods Canada Water Supply and Expansion Program and City of North Battleford (SK)** – Project lead and engineer to complete a groundwater capture zone study. The capture zone objectives were to: establish the causes of well and water quality deterioration and formulate methods of predicting long term well performance and service life.
- J) **Nunavut Water Board (NU)** – Expert technical reviewer of the geotechnical, construction specifications, containment function, and water quality impact, for the following:
  - o Hamlet of Qikiqtarjuaq- lagoon, landfill, landfarm hazardous waste storage area, and water reservoir
  - o Hamlet of Kugluktuk- lagoon, landfill, and landfarm
  - o Hamlet of Kugaaruk- lagoon
  - o Hamlet of Taloyoak- landfarm
- J) **Deline Land Corporation (NT)** - Lead geotechnical engineer in the investigation of the Grey Goose Lodge foundation evaluation and repair.
- J) **UMA Engineering Ltd. (MB)** – Field engineer to completed aquifer pump tests at Keewatin and PTH 59 North locations.
- J) **City of Winnipeg, Manitoba Waste Reduction and Pollution Prevention (MB)** – Project manager and engineering advisor for the field measurement of refuse hydraulic properties and efficiency of leachate extraction wells to reduce leachate levels in municipal solid waste landfills.
- J) **City of Winnipeg, Manitoba Waste Reduction and Pollution Prevention (MB)** – Engineering advisor for the bench top assessment of submerged membrane bioreactor to aerobically treat landfill leachate.

## ENVIRONMENTAL ASSESSMENTS AND SITE REMEDIATION

- J) **Public Works and Government Services Canada (NU)** – Project manager and construction contract administrator for the demolition and reclamation of a building in Baker Lake, NU. Environmental engineer responsible for soil and water reclamation requirements.

- J **Inuvialuit Water Board (NT)** – Expert opinion on water licence sampling and reporting with regards to the Prince Patrick Island reclamation project.
- J **Wekweeti Community Government – Tlicho (NT)** – Environmental engineer responsible to complete a fuel spill investigation that occurred adjacent to a community building in Wekweeti, NT. In addition to an assessment of the physical site characteristics, soil samples were collected and analyzed for total petroleum hydrocarbon levels. General recommendations for site restoration were provided.
- J **Smiths Landing First Nation (AB)** – Lead engineer to complete a Phase 1 Environmental Site Assessment of a transfer land from the Crown to the Band through the provisions set in the Treaty Lands Entitlement framework.
- J **Smith Landing First Nation (AB)** – Expert review the findings of Hay Camp, Wood Buffalo Park Phase 1, 2, and 3 Environmental Site Assessment, and remediation action plan, to understand environmental and human health risk for the First Nation. Participant in technical meetings with consultant and government organizations regarding clean up strategies and proposed remedial action.
- J **Smith Landing First Nation (AB)** – Expert technical and regulatory support pertaining to risk management and remedial actions associated with uranium and radiation contamination on Reserve lands. Participant in technical discussions on behalf of First Nation with various government organizations with regards action plans.
- J **Government of Northwest Territories – Transportation: Policy, Planning, and Environment (NT)**  
– Phase 1 Environmental Site Assessment of leased land within the First Simpson, NT airport.

## AGRICULTURAL

- J **Prairie Farm Rehabilitation Association- Agriculture and Agri-Foods Canada (Canada)** - Clogging of agricultural tile drains, impacts on performance, and field crop revenue loss.
- J **Prairie Farm Rehabilitation Association- Agriculture and Agri-Foods Canada (Canada)** - Review of impressed current systems to mitigate biofouling clogging effects in groundwater extraction wells.
- J **Manitoba Conservation and University of Manitoba (MB)** - Measurement of contaminant and nutrient migration below earthen manure storage lagoons in southern Manitoba. Evaluation of contaminant transport parameters for inorganic and nutrient constituents in various aquitards below manure lagoons.

## EDUCATION AND TRAINING

- J **Saskatchewan Ministry of Environment (SK)** – Developed and delivered a workshop to the Ministry of Environment on the topics of: groundwater flow and contaminant transport, site remediation, and porous media flow and transport modelling.
- J **Tlicho Government (NT)** – Developed and delivered a workshop to the Tlicho Assembly on the proposed NICO mine development.
- J **Nunavut Arctic College (NU)** - Developed and instructed a five day course for municipal operators and foremen in the areas of drinking water treatment, wastewater treatment, and solid waste management. The course was held in Rankin Inlet, NU in January, 2014.
- J **Nunavut Municipal Training Organization (NU)** – Developed and instructed a translation workshop to assist translators in communicating scientific and construction terms, common in municipal infrastructure activities, from English to Inuktitut.
- J **Nunavut Municipal Training Organization (NU)** – Developed and instructed a five day course for municipal operators and foremen in the areas of drinking water treatment, wastewater treatment, and solid waste management. The course was held in Iqaluit, NU and Rankin Inlet, NU in May, 2009, and in Iqaluit, NU in October, 2009.
- J **Building Environmental Aboriginal Human Resources –BEAHR (Canada)** – Developed student manual, instructor manual, and instructor presentation materials for a solid waste coordinator course.

Curriculum materials are to be licenced by BEAHR to instructors to train Aboriginals in topics relevant to operate and manage a solid waste facility.

- J) **Environmental Monitoring Advisory Board – EMAB (NT)** – Developed and facilitated a mining closure and reclamation workshop in Yellowknife, NT. EMAB is a consensus board of ensuring the protection of Lac De Gras environment where the Diavik Diamond Mines is located. Workshop participants included members of Aboriginal communities and regulators who ensure compliance with licences and leases, and Diavik personnel.
- J) **Government of Northwest Territories – Municipal and Community Affairs** – Managed, developed, and instructed an eight day Introduction to Environmental Management course in Inuvik, NT in 2008 and 2011. Course topics included: general environmental awareness; roles and responsibilities of regulators and legislation that helps protect the environment; Mackenzie Valley Resource Management Act and associated Boards; Inuvialuit Land Administration; challenges of waste disposal and community infrastructure such as sanitary landfills and wastewater lagoons; contaminants in the North and their effects; site inspection; remediation technologies; and understanding of Government of Northwest Territories and Indian and Northern Affairs Canada programs.
- J) **Government of Northwest Territories – Municipal and Community Affairs (NT)** – Managed, developed, and instructed a five day Class 1 Drinking Water Treatment Plant Operator course in Inuvik, NT in 2008. Hay River, NT in 2010, and Inuvik, NT in 2011.
- J) **Government of Northwest Territories – Municipal and Community Affairs (NT)** – Managed, developed, and instructed a five day Class 2 Drinking Water Treatment Plant Operator course in Norman Wells, NT in 2010 and Fort Smith, NT in 2010.
- J) **University of Manitoba – Department of Civil Engineering (MB)** – Managed, trained, and operated an independently funded research program to support the completion of 2 Ph.D, 6 M.Sc., and 2 B.Sc. student theses.
- J) **University of Manitoba – Department of Civil Engineering (MB)** – Developed curriculum and instructed the following undergraduate and graduate student courses:
  - o Groundwater hydrology
  - o Hazardous waste management
  - o Fluid mechanics
  - o Groundwater contamination
  - o Solid waste engineering
  - o Physical and chemical hydrogeology
  - o Geoenvironmental engineering

## BOOK CHAPTERS

1. VanGulck, J. and Rowe, R.K. 2010. Landfilling: Geotechnology. Chapter 10, Solid Waste Technology and Management, eds. Christensen, Wiley-Blackwell.
2. Clark, R., Koda, E., Lipinski, M., Wolski, W., Rowe, R.K., and VanGulck, J. 2005. Environmental Geotechnics- Chapter 1: Design Basics and Performance Criteria. Report for International Technical Committee No. 5 (ITC5) on Environmental Geotechnics of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE).

## ARTICLES IN REFEREED PUBLICATIONS

3. Lozecznik, S., Oleszkiewicz, J., Clark, S., Sparling, R., and VanGulck, J. 2012. Effects of Turbulence and Temperature on Leachate Chemistry. Journal of Environmental Engineering, **138**(5): 562-569.
4. Lozecznik, S., Sparling, R., Clark, S.P., VanGulck, J.F., and Oleszkiewicz, J.A. 2012. Acetate and propionate impact on the methanogenesis of landfill leachate and the reduction of clogging components. Bioresource Technology, **104**: 37-43.

5. Sherriff, B.L., Etcheverry, D.J., Sidenko, N.V., and VanGulck, J. 2011. Spatial and temporal evolution of Cu-Zn tailings during dewatering. *Applied Geochemistry*, **26**(11): 1832-1842.
6. Simpson, S., Sherriff, B.L. VanGulck, J., Khozhina, E., Londry, K., and Sidenko, N. 2011. Source, attenuation and potential mobility of arsenic at New Britannia Mine, Snow Lake, Manitoba. *Applied Geochemistry*, **26**(11): 1843-1854.
7. Lozecznic, S., Sparling, R., Oleszkiewicz, J.A., Clark, S., and VanGulck, J.F. 2010. Leachate treatment before injection into a bioreactor landfill: clogging potential reduction and benefits of using methanogenesis. *Waste Management*, **30**(11): 2030-2036.
8. Lozecznic, S. and VanGulck, J.F. 2009. Full-scale laboratory study into clogging of pipes permeated with landfill leachate. *ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management*, **13**(4): 261-269.
9. VanGulck, J., Lozecznic, S., and Murdock, J. 2009. Hydraulic design tables for horizontal liquid injection systems in bioreactor landfills. *ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management (special edition)*, **13**(3): 147-155.
10. Sherriff, B.L., Ferguson, I., Gupton, M.W., VanGulck, J.F., Sidenko, N., Priscu, C. 2009. A Geophysical and geotechnical study to determine the hydrological regime of the Central Manitoba gold mine tailings deposit. *Canadian Geotechnical Journal*, **46**: 1-12.
11. Knop, A., VanGulck, J., Heineck, K.S., and Consoli, N. 2008. Transport of contaminants through a compacted soil liner subjected to acid mine drainage (AMD) percolation. *Journal of Hazardous Materials*, **155**(1): 269-276.
12. VanGulck, J.F. and Rowe, R.K. 2008. Parameter estimation for modeling clogging of granular medium permeated with leachate. *Canadian Geotechnical Journal*, **45**(6): 812-823.
13. Sadri, S., Cicek, N., and VanGulck, J. 2008. Aerobic treatment of landfill leachate using a submerged membrane bioreactor – prospects for on-site use. *Environmental Technology*, **29**: 889-907.
14. Sherriff, B., Salzsauler, K.A., Simpson, S., Sidenko, N.V., and VanGulck, J. 2008. Arsenic mobility from arsenopyrite-rich gold mine waste in Snow Lake, Manitoba, Canada. *Chinese Journal of Geochemistry*, **25**(1): 29-30.
15. Cooke, A.J., Rowe, R.K., VanGulck, J.F. and Rittmann, B.E. 2005. Application of the BioClog model for landfill leachate clogging of gravel-packed columns, *Canadian Geotechnical Journal*, **42**: 1600-1614.
16. VanGulck, J.F., Rowe, R.K. 2004. Influence of landfill leachate suspended solids on clog (biorock) formation. *Waste Management*, **24**: 723-738.
17. VanGulck, J.F. and Rowe, R.K. 2004. Evolution of clog formation with time in columns permeated with synthetic landfill leachate. *Journal of Contaminant Hydrology*, **75**: 115-139.
18. VanGulck, J.F., Rowe, R.K., Rittmann, B.E., and Cooke, A.J. 2003. Biogeochemical calcium precipitation in landfill leachate collection systems. *Biodegradation*, **14**: 331-346.
19. Rowe, R.K., VanGulck, J.F. and Millward, S.C. 2002. Biologically induced clogging of a granular medium permeated with synthetic leachate. *Canadian Journal of Environmental Engineering and Science*, **1**(2): 135-156.
20. Cooke, A.J., Rowe, R.K., Rittmann, B.E., VanGulck, J.F. and Millward, S.C. 2001. Biofilm growth and mineral precipitation in synthetic leachate columns. *ASCE Journal of Geotechnical and Geoenvironmental Engineering*, **127**(10): 949-856.

## CONTRIBUTIONS TO INDUSTRIAL RESEARCH AND DEVELOPMENT

21. VanGulck, J.F. and Dwyer, R. 2012. Solid waste survey in the territories. *Journal of the Northern Territories Water and Waste Association*.
22. Sherriff, B., Hozhina, E., Sidenko, N., and VanGulck, J.F. 2006. The characterization and trial revegetation of mine tailings at Inco Ltd., Thompson, Manitoba. Report submitted to Inco Ltd. 107 pages.

23. VanGulck, J.F. 2005. Landfill barrier system contaminant fate and transport modeling. Report submitted to South Australia Environmental Protection Authority. 27 pages.
24. VanGulck, J.F. 2005. Review of test methods for organic mater and calcium carbonate content in soil. Report submitted to South Australia Environmental Protection Authority. 11 pages.
25. VanGulck, J.F. 2005. Sensitivity analysis of leachate collection system design and service life. Report submitted to South Australia Environmental Protection Authority. 16 pages.
26. VanGulck, J.F. 2005. Implications of leachate collection system clogging to the South Australia draft landfill standards. Report submitted to South Australia Environmental Protection Authority. 18 pages.
27. VanGulck, J.F. 2005. Review of impressed current systems to mitigate the clogging effects of biofouling in water wells. Report submitted to Agriculture and Agri-Food Canada-PFRA. 28 pages.
28. VanGulck, J.F. and Novy, L. 2005. Clogging of agricultural tile drains due to iron ochre. Report submitted to Agriculture and Agri-Food Canada-PRFA. 68 pages.
29. Hettiaratchi, J.P.A., Perera, M.D.N., Richards, N., and VanGulck, J.F. 2004. Methane emissions from landfills: opportunities and challenges. CSCE Magazine, Summer 21.3.
30. Rowe, R.K., Southen, J., VanGulck, J.F., Moore, I.D., Sangam, H.P. and Krol, M. 2001. Review of the state-of-the-art of landfill design. Report submitted to Ontario Ministry of the Environment, Waste Management Policy Branch. 533 pages.