

Dominion Diamond Corporation

Elliot Holland – Vice President of Projects and Business Development

Elliot Holland joined Dominion Diamond in December 2014 as Vice President of Projects and Business Development, and is currently leading the development of the Jay Project. Prior to joining Dominion, Mr. Holland was elected as a partner of McKinsey & Company where he served mining clients, including diamond mines, on operations, strategy and capital projects. Mr. Holland holds a BSE in civil and environmental engineering from Princeton University and an MBA from Stanford University.

Claudine Lee - Superintendent-Environment

Claudine Lee is a Professional Geologist with over 15 years of experience working in northern Canada. Ms. Lee began her career as a student working on diamond exploration programs, her experience ranges from, consulting, site liability and environmental assessment, environmental risk, environmental management and permitting, and compliance. Ms. Lee started at the Ekati Diamond Mine in 2011 as the Advisor - Operations and was promoted to Superintendent – Environment Operations in 2012. Currently, Claudine is the Superintendent – Environment and has responsibilities that include Operations, Permitting and Reclamation and Closure.

Kirsten Berg – Superintendent-Procurement

Kirsten Berg has lived in Yellowknife since 1997, and began working at the Ekati Diamond Mine in 2006. Ms Berg has held various Finance and Supply Chain roles at Ekati, and was promoted to a Superintendent in 2009. Ms. Berg is currently the Superintendent – Procurement, where her responsibilities include strategic sourcing, contractor and supplier management, operational purchasing, and inventory planning and performance. Ms. Berg has a BAH in Psychology from the University of Guelph and a Post-Baccalaureate Diploma in Management (PBDM) from Athabasca University.



Education

Masters (MSc) Coastal Zone Management, University of Ulster, Coleraine, UK, 2014

Masters (MA) Archaeology and Heritage, University of Leicester, Leicester, UK, 2010

Advanced Graduate Diploma Integrated Coastal and Ocean Management with Honours, Fisheries and Marine Institute of Memorial University, St. John's, NL, 2006

Bachelor of Arts Archaeology and English with Honours, Memorial University of Newfoundland and Labrador, St. John's, NL, 2005

Certifications

Mine Health and Safety Act Supervisor Certificate Level II, 2014

Ice Rescue, 2014

Wilderness First Aid & CPR C, 2014

Standard First Aid/CPR, 2013

Construction Safety Training, 2013

WHMIS, 2013

CMC Canada-Essentials of Management Consulting, 2011

70-hour Teaching English as a Foreign Language Certificate, 2011

Canadian Aquatic Bio-monitoring Network (CABIN) Certificate, 2008

Golder Associates Ltd. – Yellowknife

Archaeologist and Environmental Assessment Specialist

Shannon has been working with the environmental regulatory system in the Northwest Territories since 2007. As an employee of a Metis organization, regulator and consultant, Shannon has worked with the community, public, and industry sectors providing assistance in navigating the regulatory system in the review of municipal projects, power developments, oil and gas exploration and development and mining exploration and development projects. As a regulator and consultant, Shannon has worked on all phases of the environmental assessment process from application and project description review and preparation, to land use permit and water licence development, through to the writing of environmental assessment reports, reasons for decision documents, and the submission of conformity documentation. In the past, Shannon had also participated as a representative on several monitoring boards for the diamond mines in the NWT and has completed several Board Forum courses.

Shannon has her Masters in Archaeology and has undertaken archaeological investigations in NWT and Alberta including archaeological overview assessments and archaeological impact assessments with the help of First Nation guides and assistants. She has participated in traditional knowledge studies and has compiled traditional knowledge and traditional land use baseline studies for several regions of the NWT. Shannon also has a Masters in Coastal Zone Management and has undertaken research on the potential impacts of spilled oil and associated clean-up activities on coastal archaeological resources in the Beaufort Sea. Shannon has experience in field work associated with vegetation, fisheries, and wildlife monitoring programs.

Prior to beginning with Golder Associates Ltd., Shannon worked with the Mackenzie Valley Environmental Impact Review Board, the Mackenzie Valley Land and Water Board and the North Slave Metis Alliance.

Employment History

Golder Associates Ltd. – Yellowknife, NT

Archaeologist and Environmental Assessment Specialist (2013 to Present)

Providing advice and recommendations for the planning of activities and preparation and submission of documents and applications for required regulatory review; archaeological overview and impact assessments including research and field work; community engagement and baseline traditional knowledge and land use research.

Mackenzie Valley Environmental Impact Review Board – Yellowknife, NT

Environmental Assessment Officer (2012 to 2013)

Working under the authority of the Mackenzie Valley Resource Management Act, conducted reviews of preliminary screenings and planned and coordinated the environmental assessment process for development projects. This included: management of the public registry; project scoping and issues identification; processing and analysing developer's assessment reports, information requests, and technical reports; communicating with developers and other parties,



Languages

English – Fluent

managing conflict, identifying resolutions and making recommendations to the Board; organizing and hosting technical sessions, community meetings and public hearings; consolidating project-related information, identifying potential mitigation measures, and drafting decision documents such as Environmental Assessment Reports.

Mackenzie Valley Land and Water Board – Yellowknife, NT

Regulatory Officer (2009 to 2011)

Working under the authority of the Mackenzie Valley Resource Management Act, the Mackenzie Valley Land Use Regulations, the Northwest Territories Waters Act and the Northwest Territories Waters Regulations, development of policy, review of municipal, industrial and mining development applications and management plans, and coordination of regulatory reviews, including management of the public registry, preliminary screenings, reclamation security estimates, technical sessions, public hearings, and drafting of land use permits, water licences and reasons for decision documents.

North Slave Metis Alliance – Yellowknife, NT

Environmental Assistant/Heritage Specialist (2007 to 2009)

Researched Metis history, collected information on Metis culture, documented environmental and traditional knowledge, recorded socio-economic impacts, and mapped traditional land use activities. Reviewed and provided comments on environmental annual reports, archaeology permit applications, research permit applications, and development proposals. Ensured proper consultation and communication with community members regarding research and development in the North Slave region. Proposal writing and project management.

Environment Canada – Gatineau, QC

Water Quality Database Manager (2007 to 2007)

Maintained and managed a Microsoft Access database containing the results of water quality analysis from throughout the country and assisted other department staff as necessary.

Centre for Sustainable Watersheds – Portland, ON

Community Capacity Building Coordinator (2006 to 2006)

Conducted research on water quality monitoring programs and activities throughout Canada and helped in the design and development of a portal website that aimed to provide access to all water quality information and programs from around the country.

Crowsnest Pass Ecomuseum Trust/Bellevue Underground Mine – Bellevue, AB

Heritage Interpreter and Collections Management Manager (2005 to 2005)

Conducted interpretive tours through an underground coal mine providing visitors with historic and environmental information related to the coal mining industry and updated and organized the museum's artifact collection record to meet current standards.



PROJECT EXPERIENCE – PROJECT MANAGEMENT

**New Discovery Mines
Ltd. - Mon Gold Mine**
Northwest Territories,
Canada

Managed the drafting of the Archaeological Overview Assessment Report including the compilation of all spatial required for the assessment. Reviewed Project charges and invoices to keep the Project on budget.

**Aurora Geosciences
Ltd./Husky Energy -
Chedabucto
Lake/Whitebeach Point**
Northwest Territories,
Canada

Managed the archaeological field data and drafted the Archaeological Impact Assessment Report including the compilation of all spatial and site data required for timely regulatory submission. Reviewed Project charges and invoices to keep the Project on budget.

**Aboriginal Affairs and
Northern Development
Canada - Outpost
Island, Blanchet Island
and Copper Pass Mine
Sites**
Northwest Territories,
Canada

Managed the archaeological field data and drafted the Archaeological Impact Assessment Report including the compilation of all spatial and site data required for timely regulatory submission. Reviewed Project charges and invoices to keep the Project on budget.

**Government of the
Northwest Territories -
Sahtu Region**
Northwest Territories,
Canada

Managed Task 2 (Traditional Knowledge Baseline) of the Sahtu Surface Water and Groundwater Baseline Study including drafting of the Traditional Knowledge Baseline Report and incorporating and contributing information into other Project tasks to develop final deliverables.

**Northwest Territories
Power Corporation -
Snare Rapids and
Snare Cascades**
Northwest Territories,
Canada

Managed project timelines, staff and deliverables including the completion of a change order increasing the scope of the project in two major ways. This project included a Water Licence renewal application for Snare Cascades including responses to reviewer comments and preparation for a public hearing, if necessary. The public hearings were cancelled due to the successful handling of reviewer comments and the Water Licence was issued. Scope changes for the project included, then, the updating of management plan to meet Water Licence conformity requirements. Golder staff and plan update requirements were identified for the timely submission of the draft updated reports to NTPC. Changes in the Snare system later led to the need to make a request to change criteria in the Snare Rapids Water Licence. Golder staff and change request requirements were identified for the timely submission of a draft assessment to NTPC.

PROJECT EXPERIENCE – CULTURAL SCIENCES

**Government of the
Northwest Territories -
Sahtu Region**
Northwest Territories,
Canada

Completed a review and summary of publically available traditional knowledge and traditional use and values information associated with surface water and groundwater in the Central Mackenzie Valley/Sahtu Region of the NWT. Provided a presentation of the Sahtu Baseline Water Project to community representatives in Tulita, NT during a Research Results Workshop hosted by the Sahtu Renewable Resources Board while seeking feedback on the accuracy and validity of the traditional knowledge identified.



**Dominion Diamonds
Ekati Corporation –
Ekati Diamond Mine**
Northwest Territories,
Canada

Completed a traditional knowledge and traditional land use baseline report for the licencing of the Lynx Project and environmental assessment of the Jay Project. This included the compilation, review and description of existing and available reports produced by communities and the developer.
Participated in the planning, preparation and completion of community engagement workshops for the purpose of providing project-related information and obtaining feedback on potential project alternatives to minimize adverse impacts on the cultural use, value and integrity of resources in the project area. Participated in a social impacts workshop with affected communities to identify potential socio-cultural and economic impacts of the proposed Jay project on local communities.
Drafted responses to cultural Information Requests submitted by reviewers during the environmental assessment process.

**Government of the
Northwest Territories -
Transboundary Waters**
Northwest Territories,
Canada

Completed a review and summary of compiled traditional knowledge and land use information collected in response to transboundary water management agreements between the Northwest Territories and the Yukon Territory, Alberta, Saskatchewan, and British Columbia.

PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

**Dominion Diamonds
Ekati Corporation –
Ekati Diamond Mine**
Northwest Territories,
Canada

Provided advice and input into the development of project applications for the the Lynx and Jay (Cardinal) Projects, participated in community scoping sessions in relation to the proposed Jay (Cardinal) Project, and contributed to components of the baseline information collection and developer's assessment of the Lynx and Jay Projects.

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

Assisted the lead Environmental Assessment Officer in the coordination of the Fortune Minerals' NICO Project environmental assessment, including review of information requests, hosting technical sessions, management of technical reports, planning and hosting of the public hearing, and writing of the Report of Environmental Assessment.

**Aboriginal Affairs and
Northern Development
Canada - Giant Mine
Remediation Project**
Northwest Territories,
Canada

Assisted the lead Environmental Assessment Officer in the coordination of Aboriginal Affairs and Northern Development Canada's Giant Mine Remediation Project environmental assessment, including review of information requests, hosting technical sessions, management of technical reports, planning and hosting of the public hearing, and writing of the Report of Environmental Assessment.
Assisted in the testing and recording of paste backfill characteristics including strength and moisture content of samples.

**Avalon Rare Earth
Metals Inc. -
Nechalacho Rare Earth
Project**
Northwest Territories,
Canada

Assisted the lead Environmental Assessment Officer in the coordination of the Avalon Rare Metals' Nechalacho Rare Earth Project environmental assessment, including review of information requests, hosting technical sessions, management of technical reports, planning and hosting of the public hearing, and writing of the Report of Environmental Assessment.

**Tyhee NWT Corp. -
Yellowknife Gold
Project**
Northwest Territories,
Canada

Managed the public registry, organized information requests and managed times lines as the lead Environmental Assessment Officer for Tyhee NWT Corp.'s Yellowknife Gold Project.



PROJECT EXPERIENCE – LICENCING AND PERMITTING

**Northwest Territories
Power Corporation -
Snare Rapids and
Snare Cascades**
Northwest Territories,
Canada

Provided advice and assistance in the application for a Water Licence renewal for the Snare Cascades power system including the response to reviewer comments which resulted in no delay or public hearing. Once the Water Licence was issued, helped to coordinate updates to project management plans so as to be in conformity with new Licence requirements.

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

Assisted in the writing, review and editing of updated land use permits and water licences for the NICO Project and NICO Project Access Road (NPAR) following Ministerial approval of the proposed NICO Project, this included the writing, review and editing of several environmental management plans such as the Spill Contingency Plan and the Explosives Management Plan.

**Paramount Resources
Ltd. - Cameron Hills
Project**
Northwest Territories,
Canada

Coordinated the regulatory process for the amalgamation of several Type B Water Licences into one project-wide Type A Water Licence for the Paramount Resources' Cameron Hills Project. This included a review and analysis of the existing project as well as potential future scenarios, management of the public registry, organization and presentation of party comments and concerns, planning and hosting technical sessions and public hearings, and the drafting of the final Water Licence and Reasons for Decision.

**Town of Hay River
Municipal Landfill**
Northwest Territories,
Canada

Coordinated the regulatory process renewal of a Type A Water Licence for the Town of Hay River's Municipal Landfill. This included a review and analysis of the existing project as well as potential future scenarios, management of the public registry, organization and presentation of party comments and concerns, planning and hosting technical sessions and public hearings, and the drafting of the final Water Licence and Reasons for Decision.

**Alex Debogorski's
Smitski #1 Claim**
Northwest Territories,
Canada

Processed and coordinated the regulatory review of Alex Debogorski's application to carry out diamond drilling in Drybones Bay near the existing Snowfield Project. The application was referred to environmental assessment based on community concern based on the cultural value of the Drybones Bay area to the Yellowknives Dene First Nation.

**De Beers Canada Inc.
Snap Lake Diamond
Mine**
Northwest Territories,
Canada

Coordinated the review and approval of various management plans required by existing land use permits and water licences for the De Beers Canada Snap Lake Project including the organization and integration of party comments and concerns. Initiated the renewal of the new Type A Water Licence.

**TNR Gold Corp. Moose
Property**
Northwest Territories,
Canada

Processed and coordinated the regulatory review of TNR Gold's application to carry out exploration activities on the East Arm of Great Slave Lake.



PROJECT EXPERIENCE – ARCHAEOLOGY

**New Discovery Mines
Ltd. - Mon Gold Mine**
Northwest Territories,
Canada

Completed an Archaeological Overview and Impact Assessment to assist in the determination of archaeological potential in the vicinity of the proposed Mon Gold Mine at Discovery Lake. This included a significant amount of research on the culture history, mining history and previous archaeological work completed in the vicinity of the project.

**Enbridge - Norlite
Pipeline Project**
Alberta, Canada

The Heritage Resource Assessment included visual inspection of changes proposed in the Norlite Right-of-Way along with the excavation of shovel tests in high potential locations for test for archaeological deposits.

**Aurora Geosciences
Ltd. - Chedabucto
Lake/Whitebeach Point**
Northwest Territories,
Canada

Completed an Archaeological Overview and Impact Assessment to assist in the determination of archaeological potential and record archaeological sites in the vicinity of 100 proposed drill site locations. This included a significant amount of research on the culture history and previous archaeological work completed in the vicinity of the project. Field work included the investigation and documentation of archaeological resources. Post-field reporting involved the completion of the Archaeological Impact Assessment with recommendations for the protection and management of recorded archaeological sites and the compilation of spatial and archaeological site data required for regulatory submission.

**Dominion Diamonds
Ekati Corporation -
Sable Development**
Northwest Territories,
Canada

Carried out an Archaeological Impact Assessment on the proposed Sable Winter Access Road which included the identification and investigation of areas with moderate to high archaeological potential and site re-visits in the vicinity of the proposed development to determine any threats to new or previously recorded sites. Post-field reporting involved the completion of the Archaeological Impact Assessment with recommendations for the protection and management of recorded archaeological sites and the compilation of spatial and archaeological site data required for regulatory submission.

**Dominion Diamonds
Ekati Corporation –
Lynx and Jay Projects**
Northwest Territories,
Canada

Assisted the lead Archaeologist in the writing and completion of an Archaeological Overview Assessments and Archaeological Impact Assessments for the Lynx Project and the Jay Expansion project. This included a significant amount of research on the culture history and previous archaeological work completed in the Ekati area, field visits of recorded sites and new areas of moderate to high potential and determination of impact potential around newly proposed development areas. Post-field reporting involved the completion of the Archaeological Impact Assessment with recommendations for the protection and management of recorded archaeological sites and the compilation of spatial and archaeological site data required for regulatory submission.

**Aboriginal Affairs and
Northern Development
Canada - Copper Pass,
Blanchet Island and
Outpost Island
Remediation Project**
Northwest Territories,
Canada

Completed an Archaeological Overview and Impact Assessment to assist in the determination of archaeological potential in the vicinity of the historic Copper Pass, Blanchet Island and Outpost Island Mines in support of anticipated reclamation activities. This included a significant amount of research on the culture history, mining history and previous archaeological work completed in the vicinity of the project. Field work included the investigation and documentation of archaeological resources. Post-field reporting involved the completion of the Archaeological Impact Assessment with recommendations for the protection and management of recorded archaeological sites and the compilation of spatial and archaeological site data required for regulatory submission.



**Canadian Natural
Resources Ltd. -
Horizon Project**
Alberta, Canada

Participated in the field component of the Archaeological Impact Assessment for expansion areas identified by CNRL-Horizon. Field work includes the investigation and testing of areas deemed to be of moderate to high potential for encountering archaeological resources and includes test pitting and sieving soil samples to identify the presence or absence of archaeological sites.

Old Fort Rae
Northwest Territories,
Canada

Completed a landscape archaeology project on Old Fort Rae and the surrounding area including the role the Hudson's Bay Company post played in the lives of the Metis and Tlicho people who lived or visited there as part of their travels along the Idaa Trail and other communities and posts in the region.

TRAINING

Module 5 - Supervisor Health and Safety Essentials

Golder U, 2014

Module 2 - Hazard Assessment and Control

Golder U, 2013

Module 1 - Health and Safety Basics

Golder U, 2013

eHASEP - Electronic Health and Safety and Environmental Plan

Golder U, 2013

Stop & Think

Golder U, 2013

**Education**

*B.A.Sc. Environmental
(Chemical) Engineering,
University of Waterloo,
Waterloo, Ontario, Canada,
2002*

Languages

English – Fluent

*Chinese (Mandarin) –
Fluent*

Calgary***Component Lead and Discipline Coordinator, Air Quality and Climate***

Mr. Chang is a senior air quality scientist in the Golder Calgary office with over 12 years of industry and consulting-related experience. He has a range of experience in air quality assessment, environmental impact assessment, emissions inventory, dispersion modelling and regulatory reporting.

In the past twelve years, Dennis has led, managed and participated in various air quality assessment projects, including many large-scale environmental impact assessments for oil sands, mining and power projects.

Prior to joining Golder, Dennis worked for Environment Canada, Vancouver International Airport Authority, Greater Toronto Airports Authority and in the petrochemical industry. His past experience includes regulatory permit application, emissions inventory development, hazardous waste management, and regulatory compliance review.

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

Air Quality Scientist (2002 to Present)

Air quality discipline lead and senior reviewer for multi-disciplinary environmental impact assessments for oil sands, mining and other industrial sectors in Canada and internationally. Responsibilities include senior technical review, project management, emission inventory development, dispersion modelling and regulatory consultation for various projects.

Golder Associates – Burnaby, British Columbia

Air Quality Scientist (2002)

Air quality scientist working on numerous large environmental impact assessments, gas well flaring studies and ambient air quality monitoring projects. Responsibilities included atmospheric dispersion modelling, emission calculations, environmental monitoring data analysis and technical report preparation.

Vancouver International Airport Authority – Richmond, British Columbia

Environmental Assistant (Co-operative Work Term) (2001)

Implemented and enhanced hazardous waste management programs. Evaluated contract proposals. Provided support on water quality, aircraft de-icing and air quality programs.

W.C. Wood Company Ltd. – Guelph, Ontario

Environmental Coordinator (Co-operative Work Term) (2000)

Responsible for obtaining emissions permits for two manufacturing facilities. Conducted indoor air quality studies. Collected ambient air quality samples for analysis.



NOVA Chemicals (Canada) Ltd. – Corunna, Ontario

Environmental Specialist (Co-operative Work Term) (2000)

Prepared plant emissions inventory reports. Conducted a feasibility study of plant-wide NOX emissions reduction strategies.

Environment Canada – Ottawa, Ontario

Organic Lab Technician (Co-operative Work Term) (1998)

Analyzed PAH samples for National Air Pollution Surveillance Network (NAPS).
Performed extraction of PCB and dioxin from soil and effluent samples.

Greater Toronto Airports Authority – Toronto, Ontario

Project Engineer Assistant (Co-operative Work Term) (1998)

Co-ordinated Terminal 2 Asbestos Removal Project. Provided support in budgeting for various terminal renovation projects.



PROJECT EXPERIENCE – AIR QUALITY

**Imperial Oil Resources
Ventures Limited Kearl
DeOx Project**

Fort McMurray, Alberta,
Canada

Golder was retained by Imperial Oil to complete an air quality assessment in support of a regulatory approval amendment application for the Kearl Mine. The DeOx project involves the utilization of a new process at the Kearl Mine to remove oxygen from process water to minimize corrosion. The process will result in new sources of venting emissions. Dennis was the senior reviewer for the air quality assessment.

**Total E&P Canada Ltd.
Joslyn North Mine
Project ESA**

Fort McKay, Alberta,
Canada

Golder was retained by Total E&P Canada Ltd. to complete an Environmental Support Assessment (ESA) in support of a regulatory amendment application for the Joslyn North Mine. A full EIA level air quality assessment was conducted in the ESA. Dennis was the air quality component lead on the ESA.

**Cenovus FCCL Ltd.
Christina Lake Thermal
Project - Phase H and
Eastern Expansion EIA**

Christina Lake, Alberta,
Canada

Golder was retained by Cenovus FCCL Ltd. to conduct an air quality assessment for an Environmental Impact Assessment of an expansion at an existing in-situ oil sands project. Responsibilities include management of air quality component, emission inventory development, dispersion modelling, report writing and stakeholder consultation.

**MEG Energy Corp. HI-
Q Field Demonstration
Pilot Project
Application**

Fort Saskatchewan,
Alberta, Canada

Golder was retained by MEG Energy Corp. to prepare an industrial approval application for a bitumen partial upgrading pilot facility. An air quality assessment using dispersion model was prepared as a part of the regulatory approval application. Dennis was the air technical lead on this application.

**Cenovus FCCL Ltd.
Christina Lake Thermal
Project 2nd Stage
OTSG Amendment**

Christina Lake, Alberta,
Canada

Golder was retained by Cenovus FCCL Ltd. to complete an air quality assessment to support its regulatory application to increase the steam generation capacity at the Christina Lake Thermal Project. The assessment was completed using CALPUFF dispersion model. Air quality assessment coordinator responsible for senior technical review.

**Cenovus Energy Inc.
Pelican Lake Grand
Rapids Project EIA**

Pelican Lake, Alberta,
Canada

Golder was retained by Cenovus Energy Inc. to prepare an Environmental Impact Assessment for the commercial expansion of an in-situ oil sands project. The assessment was completed using CALPUFF dispersion model. Responsibilities include emission inventory development, dispersion modelling and report writing.

**Cenovus FCCL Ltd.
Narrows Lake Project
EIA**

Narrows Lake, Alberta,
Canada

Golder was retained by Cenovus FCCL Ltd. to complete an Environmental Impact Assessment for an in-situ oil sands project. Responsibilities include emission inventory development, dispersion modelling, report writing and regulatory consultation.



**EnCana Corp. Foster
Creek Project Phase
1D/1E Expansion**
Cold Lake Weapons
Range, Alberta, Canada

Golder was retained by EnCana to assist in an approval amendment associated with the Phase 1D/ 1E expansion at the Foster Creek commercial plant heavy oil thermal recovery. The Foster Creek Steam-Assisted Gravity Drainage (SAGD) Project was the first commercial plant of its kind in the world. Golder's work included completing the air quality assessment and noise assessment required as part of the approval amendment applications to Alberta Environment and the Alberta Energy and Utility Board. The air quality assessment involved calculating facility emissions and predicting the air quality changes using the CALPUFF dispersion model. Air quality Assessment Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**EnCana Corp.
Christina Lake
Amendment Phase
1C/1D**
Christina Lake, Alberta,
Canada

Golder assisted EnCana with approval amendments associated with proposed development changes at the Christina Lake Thermal Project, Phases 1C/ 1D. The amendments required air assessment, including dispersion modelling and a noise assessment to meet Alberta Energy Utility Board requirements. Air Quality Assessment Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**EnCana Corp.
Consequence
Modelling**
Foster Creek, Alberta,
Canada

As part of the Phase 1E expansion engineering design process, FCCL was considering the potential for flammable vapours to be released from selected tanks at the facility. FCCL retained Golder to determine the extent to which these flammable vapours may be dispersed towards various ignition sources located in the vicinity of the tanks. Hazard modelling was used to predict concentrations of the flammable vapours at these potential ignition sources. Responsibilities included air dispersion modelling.

**MEG Energy Corp.
Surmont Project EIA**
Janvier, Alberta, Canada

Golder was retained by MEG Energy Corp. to conduct an air quality assessment for an Environmental Impact Assessment of an in-situ oil sands project. The assessment was completed using CALPUFF dispersion model. Responsibilities include management of air quality component, emission inventory development, dispersion modelling, report writing and stakeholder consultation.

**MEG Christina Lake
Regional Project Phase
2B and 2B4X
Amendments**
Christina Lake, Alberta,
Canada

Golder was retained by MEG Energy Corp. to conduct air quality assessment in support of a numerous regulatory amendment applications for an in-situ oil sands project. Responsibilities include project management, emission inventory development, dispersion modelling, report writing and regulatory consultation.

**De Beers Gahcho Kué
Project EIS**
Kennady Lake,
Northwest Territories,
Canada

Golder was retained by De Beers Canada Inc. to conduct an Environmental Impact Statement for an open pit diamond mine in northern Canada. The air quality assessment was completed using CALPUFF dispersion model. Responsibilities include management of air quality component, emission inventory development, dispersion modelling, report writing, regulatory consultation and management plans development.



Project Mina de Cobre
Panama

Golder was retained to complete an Environmental Impact Assessment for a copper-molybdenum mine and associated infrastructure, including a coal-fired power plant, transmission line, roads, a pipeline and a marine port facility. The assessment was performed to meet the requirements of the Canadian Environmental Assessment Act. Responsibilities include management of air quality component, emission inventory development, dispersion modelling and report writing.

**Suncor Energy Inc.
Millennium Coker Unit
Assessment**
Fort McMurray, Alberta,
Canada

Golder was retained by Suncor Energy Inc. to aid in the preparation of the application for construction and operation of the Millennium Coker Unit (MCU) Project. The air quality component of this application involved the quantification of SO₂ and NOX emissions from the proposed Project. A dispersion modelling assessment of SO₂ emissions was performed using the CALPUFF model run in dynamic (3-D) mode. The assessment considered normal operations and two flaring scenarios. Results of the assessment were discussed in comparison with air quality criteria and in terms of likelihood of occurrence. Specific responsibilities included technical support and report preparation.

**Suncor Energy Inc.
Firebag SAGD
Compliance**
Fort McMurray, Alberta,
Canada

Golder Associates was retained by Suncor Energy Inc. to provide an ambient air quality monitoring plan for the Firebag Steam Assisted Gravity Drainage (SAGD) Project. The monitoring plan involved evaluating potential sites passive monitoring stations based on maximum ground level concentrations predicted by dispersion modelling. Responsibilities included technical support and report preparation.

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

Golder Associates 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 for submission to the Nunavut Impact Review Board. Responsibilities included dispersion modelling and report preparation.

**Paramount Resources
Ltd. Cameron Hills
Extension Project**
Fort Liard, Northwest
Territories, Canada

The Cameron Hills project is an oil and gas development that straddles the Alberta/ NWT border. Golder Associates was retained to complete the Developer Assessment Report (DAR) for the project. The DAR included the assessment of additional gas wells and potential future development. The air quality assessment included the preparation of a facility emissions inventory and the completion of refined dispersion modelling to determine ground-level concentrations of specific criteria compounds. Responsibilities included dispersion modelling and report preparation.

Nimbus Projects Ltd.
Stettler, Alberta, Canada

Nimbus Projects, acting on behalf of Tiverton Petroleum, retained Golder Associates to assess ambient SO₂ concentrations resulting from the expansion of an oil battery located northeast of Stettler, AB. The air quality assessment was prepared to support an approval application. Responsibilities included emission calculation, ISC3 dispersion modelling and report preparation.



**Saputo Inc. Air Quality
Assessment of the
Armstrong Cheese
Facility**
Glenwood, Alberta,
Canada

Golder Associates was retained by Saputo Inc. to conduct an air quality assessment of the Armstrong Cheese Facility. This assessment was completed to support the Alberta Environment (AENV) Industrial Approval Application for the facility. The assessment included an evaluation of predicted ground-level concentrations of nitrogen dioxide and particulate matter in the vicinity of the site. Responsibilities included emission calculation, dispersion modelling and report preparation.

**Quesnel Waste
Incinerator**
Quesnel, British
Columbia, Canada

Golder was retained to conduct an air quality assessment of Particulate Matter (PM) from a proposed wood waste incinerator in the town of Quesnel, B.C., as part of a Phase II assessment. The PM emissions were modelled with a regional set of emissions and 3-D CALMET data set. Responsibilities included emission calculation and dispersion modelling support.

**Greater Vancouver
Regional District
Ashcroft Ranch
Landfill EIA**
Ashcroft Ranch, British
Columbia, Canada

Golder was retained by the Greater Vancouver Regional District to provide technical support for the development of the proposed Ashcroft Ranch Landfill. The support included site design engineering and an environmental impact assessment including a comprehensive air quality and noise assessment. The air assessment included a climate and meteorological data summary, reporting of air monitoring data, assessment of criteria air pollutants, dustfall and odour assessment, as well as green-house gas emission estimates. The noise assessment included a field baseline survey and model predictions of continuous and impulsive noise sources. Specific responsibilities included dispersion modelling using the CALPUFF model and report preparation.

**Paramount Resources
Ltd. Sunset Battery**
Alberta, Canada,
Canada

Golder was retained by Paramount Resources Ltd. to complete an air quality assessment of the Sunset Battery. As part of this assessment Golder calculated the emissions of SO₂, NO_x, CO₂ and ECO₂ from the on-site combustion sources and completed dispersion modelling of the SO₂ and NO_x emissions. Responsibilities included emission calculation, ISC3 dispersion modelling and report preparation.

**Cargill Ltd. National
Pollutant Release
Inventory**
High River, Alberta,
Canada

Completed National Pollutant Release Inventory reporting for a rendering plant in High River, Alberta.

**Saskatchewan
Highways and
Transportation
Highway Twinning
Project**
Hwy 16, Southeastern
Saskatchewan, Canada

Golder was responsible for the completion of the Canadian Environmental Assessment Act Screening Report for a twinning project on a section of Highway No. 16 in Saskatchewan. The air quality component of this project included a qualitative assessment of the air and noise emissions from current and future traffic levels as well as during the construction phase. Responsibilities included vehicle emission estimation using MOBILE5C modelling software and report preparation.



**Saskatchewan
Highways and
Transportation
Highway Twinning
Project**

Wolsley, Saskatchewan,
Canada

Golder was responsible for the completion of the Canadian Environmental Assessment Act Screening Report for the Trans Canada East Twinning Project. The project included the twinning of a 132 km section of roadway between Wolsley Saskatchewan and the Manitoba border. The air quality component of this project included a qualitative assessment of the current and future air emissions and noise from traffic as well as the air emissions and noise from the construction phase. Responsibilities included vehicle emission estimation using MOBILE5C model and report preparation.

**Anadarko Canada
Corporation Well Test
Flaring Assessment**

Fort Liard, Northwest
Territories, Canada

Conducted a well-test flaring assessment of the P-16 well near Ft. Liard, NWT. The project involved the estimation of emissions from the well during the testing period and a dispersion modelling assessment to determine the resulting ground-level SO₂ concentrations. The well was located in complex terrain and the dispersion modelling was completed using the ISC3 model. As a result of the dispersion modelling results, a management plan was developed to determine the optimal conditions and timeframe within which the well test could proceed with minimal environmental impacts. Responsibilities included dispersion modelling and management plan development.

**Pangea Minerals
Tuluwaka Gold Mine
EIA**

Tanzania

Conducted an air quality assessment to estimate the ambient air concentrations of criteria air compounds resulting from the operation of the Tuluwaka Gold Project in Tanzania, Africa. Responsibilities included CALPUFF dispersion modelling and report preparation.

**Cogema Resources
Inc. Monitoring Data
Review and Analysis**

McLean Lake,
Saskatchewan, Canada

Golder Associates was retained to conduct a review and analysis of the ambient air quality data collected in the vicinity of the Cogema McLean uranium mine. Responsibilities included data evaluation and report preparation.

**EnCana Corp.
Christina Lake Project
Debottlenecking and
Expansion**

Christina Lake, Alberta,
Canada

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 for the project, as well as determining the air quality impacts using the CALPUFF dispersion model. Air Quality Assessment Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**Syncrude Canada Ltd.
Modelling Assessment
of FGD Options**

Fort McMurray, Alberta,
Canada

As part of the ongoing modifications and design considerations at the Syncrude Mildred Lake facility, Golder Associates was retained to provide an assessment of the Syncrude Emissions Reduction Project. This assessment involved modelling a variety of emission scenarios to determine the benefits associated with the installation of a Flue Gas Desulphurization (FGD) unit. Specific responsibilities included dispersion modelling and report preparation.



**Paramount Resources
Ltd. Oil Well Battery
Dispersion Modelling
Assessment**
Northwestern Alberta,
Canada, Canada

Paramount Resources Ltd. (Paramount) is proposing to install a single well oil battery at the Valhalla 4-20 site, in Northwestern Alberta. The combustion equipment to be installed at this site would consist of a flare and a Waukesha engine to run the pumpjack. For this site Golder calculated the overall site emissions for SO₂, NO_x, CO₂, and ECO₂, completed dispersion modelling for the SO₂ emissions and conducted a screening level dispersion modelling study to assess the ambient H₂S concentrations for two venting scenarios at the proposed 4-20 Oil Well Battery. Responsibilities included ISC3 dispersion modelling and report preparation.

**Lehigh Inland Cement
Limited Substitution
Fuel Project, Appeal
Board Hearings**
Edmonton, Alberta,
Canada

Golder was retained by the proponent to provide expert witness testimony in the Environmental Appeals Board hearing of the Lehigh Inland Cement substitution fuel project approval. The work included the completion of supplementary responses and hearing preparation for the air quality component of the hearing. Specific responsibilities included hearing preparation and technical support.

**Cimarron Engineering
Ltd. Well Test Flaring
Assessment**
Fort Liard, Northwest
Territories, Canada

Performed an air quality assessment for a proposed well test and subsequent facility operations of the P-66B gas well. Facility emissions were quantified and dispersion modelling was conducted using the Industrial Source Complex (ISC3) model. Air quality predictions were compared to vegetation effects levels and ambient air quality guidelines. A flare management plan was also developed. Responsibilities included ISC3 dispersion modelling and flare management plan development.

**Paramount Resources
Ltd. Air Quality
Assessment**
Cameron Hills,
Northwest Territories,
Canada

Conducted a modelling assessment of proposed changes to equipment at the Cameron Hills facility. This work part of ongoing support to Paramount for an EIA that was submitted to NWT regulator in 2001. Responsibilities included ISC3 dispersion modelling and report preparation.

**Weyerhaeuser Canada
Limited Environmental
Monitoring Program
Review**
Prince Albert,
Saskatchewan, Canada

Conducted a review of air quality and meteorological monitoring data collected over a 10 year period at the Prince Albert pulp and paper facility. The review objective was to identify parameters that could be monitored less frequently or be eliminated from the program completely. Responsibilities include monitoring data analysis and report preparation.

**W.C. Wood Company
Ltd. Comprehensive
Certificate of Approval
(Air) Application**
Guelph, Ontario, Canada

Co-ordinated an emissions permit application project for two freezer manufacturing plants and one humidifier/ de-humidifier manufacturing plant. Responsibilities included project management, regulatory review, regulatory liaison, emission calculations, environmental compliance history review, and application preparation.

**NOVA Chemicals
(Canada) Ltd. National
Pollution Release
Inventory (NPRI)
Reporting**
Corunna, Ontario,
Canada

Participated in the 1999 NPRI reporting for NOVA Chemical's refinery and petrochemical complex. The complex supplies 30% to 40% of Canada's total requirement for primary petrochemicals. Responsibilities included project management, emission calculations, and report preparation.



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

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. Emission and Modelling Coordinator responsible for emission calculations, air dispersion modelling, QA/ QC, data analysis, hearing preparation and report preparation.

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

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. Responsibilities included emission calculations, air dispersion modelling and data analysis.

**CEMA/ TMAC Fort
McKay Exposures**
Fort McKay, Alberta,
Canada

Golder was retained by the Trace Metal and Air Contaminant (TMAC) Working Group of the Cumulative Effects Environmental Management Association (CEMA) to perform a review of a previous air dispersion modelling assessment that determined potential exposures for Fort McKay. The review included further assessment of the modelling and monitoring data. Responsibilities included data analysis.

**Syncrude Canada Ltd.
Modelling 14-2**
Fort McMurray, Alberta,
Canada

Golder was retained by Syncrude to conduct a dispersion modelling assessment of sulphur dioxide (SO₂) and nitrogen dioxide (NO₂) emitted from a diesel production facility (14-2) using the CALPUFF model (3D-mode). The assessment was completed to support an Amendment Application for the Syncrude Emissions Reduction (SER) Project. Responsibilities included air dispersion modelling.

**Suncor Energy Inc.
Firebag Co-Gen
Assessment**
Fort McMurray, Alberta,
Canada

Suncor Energy developed amendment applications for two proposed stages at the Firebag SAGD Project. Golder was retained to assist the applications, preparing air and noise assessments for both the Stage C&E and Stage 3 applications. Responsible for air dispersion modelling.

**Suncor Energy Inc.
Voyageur Project EIA**
Fort McMurray, Alberta,
Canada

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). 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 emission calculations, air dispersion modelling and data analysis.



**Shell Canada Muskeg
River Mine Expansion
Project**

Fort McMurray, Alberta,
Canada

Golder was responsible for the completion of the Environmental Impact Assessment (EIA) for the Muskeg River Mine Expansion Project for Shell Canada Limited. 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. Responsibilities included emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**Canadian Natural
Resources Ltd. CNRL
Primrose East Oil
Sands Project**

Cold Lake, Alberta,
Canada

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 emission calculations, air dispersion modelling, QA/ QC, data analysis and report preparation.

**OPTI/Nexen Long Lake
Project EIA and Update**

Anzac, Alberta, Canada

Golder was responsible for the preparation of the Environmental Impact Assessment (EIA), the subsequent project update and additional amendments for the Long Lake Project, which included an integrated Steam-Assisted Gravity Drainage (SAGD) facility and upgrading complex. The air quality assessment included an evaluation of the cumulative air concentrations and acid deposition using the CALPUFF dispersion model (3-D mode). The project update made use of the Golder regional emissions database and 3-D meteorological data set. Responsibilities included project coordination, emission calculations, air dispersion modelling, data analysis and report preparation.

**Varco International Inc.
Tuboscope Nisku Plant
NPRI Reporting**

Nisku, Alberta, Canada

Golder was retained to complete the 2004 National Pollutant Release Inventory (NPRI) reporting for Tuboscope's pipe coating plant in Nisku, Alberta. Project Manager responsible for emission calculations, QA/ QC, data analysis and report preparation.

**Plains Marketing
Joarcam Truck
Terminal**

Joarcam, Alberta,
Canada

Plains Marketing applied to construct a truck terminal facility located on a five hectare site in Central Alberta. The facility is required to provide a collection point for locally produced crude oil for shipment through the Joarcam Pipeline system to markets in Edmonton and elsewhere. Golder was retained to provide technical input to Plains Marketing for the EUB permit. As part of this, a Noise Impact Assessment (NIA) and an air quality assessment were completed. Responsibilities included emission calculations and QA/ QC.

**Syncrude Canada Ltd.
Syncrude Assessment**

Fort McMurray, Alberta,
Canada

Golder was retained by Syncrude to complete a dispersion modelling assessment of hydrogen sulphide and ammonia releases during an emergency at the Mildred Lake Upgrader complex. Responsible for QA/ QC.



Enbridge Inc. Stonefell Terminal

Strathcona County,
Alberta, Canada

Enbridge was developing the Stonefell Terminal to provide terminal and pipeline services to BA Energy's Heartland Upgrader, which is also under development in the Heartland Industrial Area in Strathcona County near Fort Saskatchewan. This project consisted of a noise impact assessment and an air quality assessment for the AEUB application. Responsible for emission calculations.

Suncor Energy Inc. Firebag Odour Assessment

Fort McMurray, Alberta,
Canada

Suncor requested Golder 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. Responsibilities included data analysis.

Golder Associates Ltd. Emissions Database

Calgary, Alberta,
Canada

Golder developed an air emissions database containing emission sources from north-eastern Alberta. The data includes hundreds of sources and covers general air quality and health assessment related compounds. This database is used for environmental assessments for the projects in the Oil Sands Region. Project Manager responsible for emission calculations and QA/ QC.

Federated Cooperative Ltd. Refinery Expansion

Regina, Saskatchewan,
Canada

Federated Cooperative Ltd. retained Golder to conduct an air quality assessment of its refinery outside of Regina, Saskatchewan in support of a regulatory application for expansion. The refinery is operated by a subsidiary company called Consumers' Cooperative Refineries Ltd (CCRL) and presently processes approximately 90,000 barrels of crude per day. Project Manager responsible for report preparation, air dispersion modelling, emission calculations, QA/ QC and senior review of emissions.

Nexen Long Lake Project

Long Lake, Alberta,
Canada

Nexen retained Golder to conduct an air quality assessment of the cogeneration units at Long Lake Phase 1 project. During the cogen start-up period, which was expected to last for three months, the units were expected to be run near their maximum load without any steam injection for NOX control. Nexen wanted to know if the higher NOX emission rates would result in non-compliance of the Alberta Ambient Air Quality Objectives. Project Manager and Emission Coordinator responsible for air dispersion modelling, emission calculations and report preparation.

Canadian Natural Resources Ltd. CNRL Kirby Project

Cold Lake, Alberta,
Canada

Golder was retained by Canadian Natural Resources to provide an update to baseline data and conduct an Environmental Impact Assessment (EIA) for the Kirby Steam-Assisted Gravity Drainage (SAGD) project. Due to the proposed changes to the project, an updated air quality assessment was prepared in support of the updated EIA. In addition, a noise impact assessment was added to the EIA. Emission Coordinator responsible for emission calculations, QA/ QC, Senior Review and report preparation.

OPTI Canada Inc. Long Lake H2S Modelling

Anzac, Alberta, Canada

Golder provided air quality emissions and modelling support to OPTI Canada for various design modifications at the Long Lake SAGD Upgrading complex. Responsibilities included emission calculations.



Canadian Natural Resources Ltd. CNRL Primrose East Follow-up
Cold Lake, Alberta, Canada

Golder prepared an Environmental Impact Assessment (EIA) for the Canadian Natural Primrose East Oil Sands Project. The project is an expansion of the existing Canadian Natural Primrose and Wolf Lake development. Golder provided on-going support to regulator and stake holder inquiries. Responsibilities included emission calculations.

Shell Canada Energy Athabasca Oil Sands Project EIA
Fort McMurray, Alberta, Canada

Shell Canada is expanding their Athabasca Oil Sands Project in four phases. Each expansion will include new mining areas and produce 90,000 bbl/d of bitumen per expansion. Expansions 2 and 3 are expansions of Jackpine Mine. Expansions 4 and 5 are a separate project located north of Muskeg River Mine. Golder was retained to prepare the Environmental Impact Assessment (EIA) for all expansions as well as AENV and ERCB application documents. Emission Coordinator responsible for report preparation, emission calculations, QA/ QC and senior review of emissions.

Regional Issues Working Group (RIWG) NOX BATEA Assessment
Fort McMurray Region, Alberta, Canada

AENV is currently undertaking a process to review the BATEA technologies for NOX emissions from stationary sources in the region North of Fort McMurray. The Golder Air Team was retained by RIWG to assess the effects of different NOX control technologies on ground level NOX and PAI predictions. Responsibilities included emission calculations.

Suncor Energy Inc. Firebag 1 to 4 SRU Redesign Project

Golder was retained to perform an air quality in support of an engineering study for the Firebag Stages 1 to 4 sulphur recovery unit (SRU). This involved emissions determination and modelling of normal operations and upset conditions. Responsibilities included emission calculations, QA/ QC and senior review of emissions.

Canexus Chemicals Canada Limited Partnership Chlor-Alkali Plant Transportation Emissions Inventory
Vancouver, British Columbia, Canada

Golder was retained to prepare transportation emission inventories for the Canexus Chlor-Alkali Plant Technology Conversion Project, located on the Burrard Inlet in Vancouver. This involved two emission inventories, a current operation emission inventory and post conversion emission inventory. This report was a supplement to the emissions information already provided to the Vancouver Port Authority. Responsibilities included emission calculations and report preparation.

Advantage Oil and Gas Ltd. Sweetgrass Assessment
Sweetgrass, Alberta, Canada

Advantage Oil and Gas retained Golder to provide air dispersion modelling predictions of ground-level sulphur dioxide (SO₂) concentrations from the proposed operation of the Sweetgrass sour gas facility flare. The modelling was requested to provide information to interested stakeholders during the application process. Emission and Modelling Coordinator responsible for QA/ QC and data analysis.

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

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. Responsibilities included emission calculations, air dispersion modelling and data analysis.



**TransAlta Utilities
Corp. Keephills
Approval Renewal**

Wabamun Lake, Alberta,
Canada

Golder was retained by TransAlta Utilities Corp. to prepare an Environmental Enhancement and Protection Act (EPEA) renewal application for the Keephills Generating Station. The air component included a review of all air quality monitoring and pollution control equipment at the facility in support of the renewal application. Assistance in developing the project description was also provided. Responsibilities included QA/ QC.

**Fossil Water Catalyst
Facility Air
Assessment**

Fort Saskatchewan,
Alberta, Canada

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. Responsibilities included emission calculations, air dispersion modelling, data analysis and report preparation.

**Varco International Inc.
Tuboscope Coating
Plant NPRI**

Nisku, Alberta, Canada

Golder was retained by Varco to complete the 2005 National Pollutant Release Inventory (NPRI) reporting for the Tuboscope Nisku coating plant near Edmonton. Project Manager responsible for emission calculations and report preparation.

**Riverside Forest
Products Ltd. National
Pollutant Release
Inventory**

Various Locations,
British Columbia,
Canada

Completed 2002 and 2003 National Pollutant Release Inventory reporting for five wood processing facilities throughout British Columbia.

**Riverside Forest
Products Ltd. Air
Permit Amendment**

Armstrong, British
Columbia, Canada

Golder was retained by Riverside Forest Products Ltd. to complete an air quality assessment for the addition of a new veneer dryer at the Armstrong veneer/ plywood plant. The work included the preparation of a facility emission inventory and dispersion modelling using the SCREEN3 dispersion model. Project Manager responsible for emission calculations, air dispersion modelling, data analysis and report preparation.



TRAINING

CALPUFF Training Course

Earth Tech Inc., 2004

Greenhouse Gas Verification Using ISO 14064

Canadian Standards Association, 2011

Verifying Greenhouse Gas Intensity Baselines

Canadian Standards Association, 2007

Communication

Golder U, 2011

Health & Safety Module 2

Golder U, 2006

Health & Safety Module 1

Golder U, 2006

Project Management

Golder U, 2005

Technical Writing

Golder U, 2004

**Education**

*M.Sc., Hydrogeology,
University of Waterloo,
Waterloo, Ontario, 1976*

*B.Sc. (Honours), Geology ,
University of Alberta,
Edmonton, Alberta, 1974*

Golder Associates Ltd. – Vancouver**Employment History*****Golder Associates Ltd. – Burnaby, BC***

Principal (2003), Senior Hydrogeologist (1986 to Present)

Engaged in hydrogeological investigations throughout North America, Europe, Asia, and South America. Provides senior technical review for hydrogeological aspects of mining and dewatering, water resource management, computer modelling of groundwater flow, design and assessment of groundwater dewatering/depressurization systems.

Independent Consulting Hydrogeologist – Vancouver, BC

Principal (1985 to 1986)

Emphasis on groundwater resource evaluation, groundwater remedial studies, evaluation of proposed mining scenarios, computer modelling of groundwater regimes, and contaminant hydrogeology.

SIMCO Ground Water Research Ltd. – Vancouver, BC

Principal (1980 to 1985)

Emphasis on resource evaluation, environmental assessment, and computer modelling of groundwater flow and mass transport. Responsibilities included management and technical supervision of hydrogeological projects, client representation at environmental hearings, and business development.

Golder Associates Ltd. – Vancouver, BC

Hydrogeologist (1979 to 1980)

Engaged in hydrogeological investigations in mining, geotechnical, and nuclear energy industries.

Alberta Research Council and University of Alberta – Edmonton, AB

Research Hydrogeologist (1973 to 1979)

Provided technical assistance in research projects at the Alberta Research Council and at the University of Alberta. Duties included characterisation of hydrogeological regimes, conducting and analysing pumping tests to assess aquifer properties, numerical modelling of groundwater flow in deep sedimentary basins and coal aquifers and analyses of drill stem tests.



PROJECT EXPERIENCE – GROUNDWATER DEWATERING AND SEEPAGE ANALYSIS

Greenhills
SE British Columbia

Developed a numerical model of an open pit coal mine to predict pore pressures in the pit slopes and to assess dewatering options. Assisted in the design of deep dewatering wells to lower the pressures in the pit walls to acceptable levels for slope stability.

La Colorada
Mexico

Undertook hydrogeological investigations in an underground silver mine. Testing included pumping tests and measurement of hydraulic heads in probe holes. A numerical hydrogeological model was developed to predict future mine inflows and to assess dewatering options.

TransLink
Lower Mainland, BC

Acted as senior technical review of the hydrogeological aspects of the Evergreen rapid transit line. Project consisted of characterization of groundwater regime in the tunnel portion of the rapid transit line. Instrumental in developing the hydrogeological aspects of the Geotechnical Baseline Report and Project Specifications.

BC Hydro John Hart Project
Campbell River, BC

Acted as senior technical review of the hydrogeological aspects of the John Hart penstock replacement project. Project consisted of replacing on ground penstock with a 1.2 kilometre tunnel. It consisted of an assessment of groundwater inflows during construction and outflow during operations and potential effects to nearby slopes and dam. Assisted with the development of Specifications and Geotechnical Baseline Report.

TransCanada Highway
Revelstoke, BC

Groundwater investigations to assess the design of drainage galleries for slope stability purposed on TransCanada Highway. Investigations included installation of piezometers, groundwater modelling to assess optimum location of drainage tunnels and assistance in the design of the tunnels and drains.

Metro Vancouver
Coquitlam, BC

Senior technical review of hydrogeological aspects of an excavation for the Coquitlam UV facility on the Coquitlam River. Included instrumentation, hydrogeological testing and numerical modelling to assess excavation slope stability and dewatering requirements. Provided preliminary design of dewatering system for technical specifications.

Endako Mines
Prince George, BC

Hydrogeological testing and instrumentation to evaluate current water pressures in the walls of an open pit mine and to predict future water pressures. Developed remedial measures consisting of horizontal drainholes to improve slope stability conditions.

Huckleberry Mines
Smithers, BC

Involved in the hydrogeological assessment of a proposed open pit expansion that would intersect a historical tailings disposal areas. Involved in the design of dewatering/depressurization systems to assist in the stabilization of the pit slopes. Included hydrogeological testing and the development of a numerical model.



Ivanhoe Mines Mongolia	Senior technical review of hydrogeological aspects of the Oyu Tolgoi Project. Developed numerical hydrogeological model to predict seepage into a proposed open pit and to predict hydraulic heads to assess future slope stability conditions in the pit walls. Assisted in the preliminary design of dewatering/depressurization systems to improve slope stability.
Diavik Diamond Mine Lac De Gras, NT	Senior technical review of the hydrogeological aspects of an open pit mine. Included the instrumentation and hydrogeological testing of pit slopes to evaluate the current slope stability and groundwater seepage conditions and to predict future conditions. Where required, developed dewatering/depressurization methods to improve stability of the slopes. Providing on-going support to dewatering design for the underground mine.
Metro Vancouver North Vancouver, BC	Senior technical review of the hydrogeological aspects of the Seymour Capilano Filtration Project (SCFP). Project consisted of the installation of twin tunnels, 7 km in length, in bedrock between the Capilano Dam and the Seymour River drainage for the conveyance of raw and treated water. Estimated groundwater inflow quantities during excavation of the tunnels and groundwater outflow and cross-flow between tunnels when at full operating pressures. Assessed the potential effects to seepage and slope stability to the East Abutment of the Cleveland Dam and the west slope of Lynn Creek during construction and operations of the twin tunnels.
GVRD North Vancouver, BC	Designed dewatering measures required to prevent uplift in the floor of a Digester during cleaning and to prevent ground settlement at a GVRD water treatment plant.
BC Hydro Castlegar, BC	Designed and provided specifications for a drain collection system for slope stability of dam abutments at the Kootenay Canal Power Plant. Specified pre-packed screens to drain a silt slope.
Highland Valley Copper Kamloops, BC	Provided on-going monitoring and evaluation of dewatering program at an open pit mine. There are two components to the dewatering program – deep high capacity wells to dewater highly permeable alluvial fans and vacuum assisted low capacity wells to depressurize silt and clays for slope stability purposes.
Newmont Gold Company Indonesia	Assessed the dewatering requirements and the effects of dewatering, pit lake formation, and waste rock on groundwater and surface waters.
GVRD Annacis Island, BC	Developed contractor specifications and reviewed the dewatering plans for installation of permanent flow monitoring stations.
Cominco Ltd. Pine Point, NT	Conducted computer modelling of the groundwater regime. Assessed dewatering schedule and procedures. Included training of mine staff in model utilisation
PetroCanada Ltd. Chetwynd, BC	Modelled the groundwater flow regime at a proposed open pit mine to assess groundwater inflow and dewatering requirements.
Polygon Development Coquitlam, BC	Assessed excavation inflows at a condominium development, designed the underdrain and the dewatering plan for excavation.



**Mine
Decommissioning**
Whitehorse, YT

Developed computer models to assess groundwater flow following decommissioning of an underground mine. Included evaluation of changes in groundwater discharge volumes as a result of decommissioning of mine tailings and rock waste dump.

**Tar Sands
Development**
Fort McMurray, AB

Assessed the groundwater regime at a proposed tar sands development in Northern Alberta. Included computer model to estimate mine inflow and to develop mine dewatering strategies.

Uranium Mine
Northern Saskatchewan

Developed computer model of groundwater regime at a proposed underground uranium mine. Analyses included assessment of mine inflows to various mine works scenarios and the effect of grouting on mine inflow and water pressures.

Open Pit Coal Mine
Wabamum Lake, AB

Modelled the groundwater regime at an open pit coal mine to evaluate the impact of the mine on the regional groundwater system and supply.

**Coal Washing
Reservoir**
Gravelbourg, SK

Characterised the groundwater regime beneath a proposed coal washing reservoir. Included computer model analysis to determine the effect of high water levels in lagoon on the regional groundwater flow system and on groundwater supply.

Potash Mine
Esterhazy, SK

Carried out model analysis of groundwater regime to determine approximate location and chronology of leaks at a potash mine. Included analysis of several hundred drill stem tests to determine formation transmissivities.

Coal Aquifers
Alberta

Conducted a study to characterise the hydraulic parameters of coal aquifers in Alberta. Included analyses of hundreds of pumping tests to determine effect of fracturing on transmissivity and storativity of coal seams.

PROJECT EXPERIENCE – HYDROGEOLOGICAL ASPECTS OF ENVIRONMENTAL ASSESSMENTS AND PERMITTING

Snap Lake
Northwest Territories

Provided technical assistance on hydrogeology components of an environmental assessment and in hearings relate to project approvals and permitting. Included characterization of the regional groundwater flow regime and the prediction of the direction, travel time and contaminant transport of dissolved metals originating from the mine following closure of the mine. The environmental assessment was approved in late 2003.

Jay Pit Project
Northwest Territories

Senior technical review of hydrogeological baseline and the groundwater section of the Environmental Assessment. Field investigations included hydraulic conductivity measurements in deep boreholes and installation of a multi-level groundwater well to assess the salinity/depth profile. Single well pumping tests were undertaken in two of the ports in the multi-level well. The Environmental Assessment included prediction of groundwater inflow quantity and quality to the proposed Jay pit; predicted effects to groundwater quality and flow; and predicted effects to surface water bodies.



**BC Hydro John Hart
Project**
Campbell River, BC

Acted as senior technical review of the hydrogeological aspects of the John Hart penstock replacement project. Project consisted of replacing an above ground penstock with a 1.2 kilometre tunnel. Included an assessment of groundwater inflows during construction and outflow during operations and potential effects to nearby slopes and dam. Assisted with the development of Specifications and Geotechnical Baseline Report and Groundwater Section of an Environmental Assessment.

**Diavik Diamond
Project**
Northwest Territories

Providing on-going hydrogeological investigations to determine groundwater inflows to a mine located near Yellowknife. Duties have included conducting permeability tests in deep exploratory boreholes and conducting pumping tests in the underground mine. Numerical hydrogeological modelling was undertaken to assess mine inflows, dewatering systems, dewatering strategies and remedial measures. Drainage galleries consisting of 4 to 6 drainholes were designed and installed at approximately 75 m depth intervals in the underground mine. Acted as expert witness during project approval process and water licence renewal.

Meliadine
Nunavut

Hydrogeological Lead in the Environmental Assessment for several open pits and one underground mine for mining of gold deposits near Baker Lake. Included characterization of groundwater for baseline environmental conditions and development of effects assessment.

Turnbull
Elkford, BC

Hydrogeological Assessment for permitting of groundwater flow and quality from proposed tailings storage within an open pit coal mine. Included prediction of groundwater flow paths and groundwater quantity and quality.

McNab Cr.
British Columbia

Hydrogeological Lead in an Environmental Assessment for an aggregate extraction project in Howe Sound. Included characterization of the groundwater regime and effects assessment of the project and assessment of measures to mitigate effects to freshwater aquatic habitat.

Gahcho Kue
Northwest Territories

Hydrogeological Lead in an Environmental Assessment for a diamond mine. Included the development of characterization of groundwater regime for baseline conditions and numerical modelling to assess environmental effects. Options were examined to mitigate effects to the environment. Acted as Expert Witness at MacKenzie Valley Environmental Impact Review Board hearings.

Meadowbank
Nunavut

Hydrogeological Lead in the Environmental Assessment for open pit mines installed in a former lake bottom. Included characterization of the baseline groundwater quality and quantity and numerical hydrogeological model to assess potential effects to groundwater and other values ecosystem components.



PROJECT EXPERIENCE – HYDROGEOLOGICAL ASPECTS OF OPEN PIT MINE DEVELOPMENT

Snap Lake Northwest Territories	Provided technical assistance on hydrogeology components of an environmental assessment and in hearings relate to project approvals and permitting. Included characterization of the regional groundwater flow regime and the prediction of the direction, travel time and contaminant transport of dissolved metals originating from the mine following closure of the mine. The environmental assessment was approved in late 2003.
Jay Pit Project Northwest Territories	Senior technical review of hydrogeological baseline and the groundwater section of the Environmental Assessment. Field investigations included hydraulic conductivity measurements in deep boreholes and installation of a multi-level groundwater well to assess the salinity/depth profile. Single well pumping tests were undertaken in two of the ports in the multi-level well. The Environmental Assessment included prediction of groundwater inflow quantity and quality to the proposed Jay pit; predicted effects to groundwater quality and flow; and predicted effects to surface water bodies.
Rea Gold Company Uruguay	Characterised the groundwater regime prior to mine development. Numerical modelling was conducted to assess mine inflows and depressurisation for slope stability purposes and the potential impacts of mine development of nearby surface water and groundwater supply.
Highland Valley Copper Kamloops, BC	Provided on-going monitoring, evaluation, and design of dewatering program for slope stability purposes at an open pit mine in south-central British Columbia. Presently, the dewatering system pumps a total of over 28,000 m ³ /day from overburden materials. Modelling conducted to assess future dewatering requirements.
Newmont Gold Company Batu Hijau Project, Indonesia	Assessed dewatering requirements and the effects of dewatering, pit lake formation; and waste rock, on groundwater and surface waters. Conducted numerical modelling of groundwater regime to evaluate mine inflows over life of mine.
Diavik Diamond Project NWT	Providing on-going hydrogeological investigations to determine groundwater inflows to a mine located near Yellowknife. Duties included conducting permeability tests in deep exploratory boreholes, design of deep groundwater sampling device, conducting a pumping test in an exploratory decline, and modelling to assess mine inflows, dewatering systems and strategies, and remedial measures. Acted as expert witness during project approval process.
Cominco NWT	Conducted feasibility level investigations to determine hydrogeological regime and to estimate flows to proposed open pit mine. Conducted modelling investigations to estimate inflows to proposed open pit and design preliminary dewatering process.
Newmont Gold Company Mesel Project, Indonesia	Provided recommendations on well installations and testing, to be conducted by the owner to characterise the hydrogeology at a mine site. Conducted numerical modelling to assess mine depressurisation for slope stabilisation.



Cominco Ltd. Smithers, BC	Evaluated the groundwater inflows and groundwater pressures following installation of proposed remedial measures at a closure of an open pit mine. Included numerical modelling to assess proposed closure measures.
Meadowbank Nunavut	Hydrogeological Lead in the Environmental assessment for gold deposit in Nunavut. Included development of Baseline studies, numerical modelling to assess effects of project on groundwater regime and pathways to other receptors.
Royal Oak Mines NWT	Modelling to assess pit lake formation and groundwater flow conditions under long term equilibrium conditions.
Armenonic Ecuador	Assessed the existing tailings pond dam and proposed additions. Included recommendations for monitoring and slope stability improvements.
Teck Corporation Chile	Modelling to predict pit lake formation and long-term groundwater flow conditions.
Cominco Ltd. Pine Point, NWT	Computer modelling of groundwater regime. Assessment of dewatering schedule and procedures. Included training of mine staff in model utilisation.
PetroCanada Ltd. Chetwynd, BC	Modelling of groundwater flow regime at a proposed open pit mine to assess groundwater inflow.
Fording Coal Elkford, BC	Assessed tailings dam leakage and designed leakage retrieval system.
Effects of Open Pit Mine on Groundwater Supply Fife Lake, SK	Evaluated the impacts of an open pit coal mine in Southern Saskatchewan on the quality and quantity of groundwater at a nearby town. Conducted domestic water well survey and collected water samples over two years to assess impacts.
Tar Sands Development Fort McMurray, AB	Assessed the groundwater regime at a proposed tar sands development in Northern Alberta. Included computer model to estimate mine inflow and to develop mine dewatering strategies.
Open Pit Coal Mine Wabamun, AB	Conducted modelling of the groundwater regime at an open pit coal mine, to evaluate the impact of the mine on the regional groundwater system and resource.
Coal Washing Reservoir Gravelbourg, SK	Characterised the groundwater regime beneath a proposed coal washing reservoir. Included computer model analysis to determine the effect of high water levels in lagoon on the regional groundwater flow system and on groundwater supply.
Coal Aquifers Alberta	A study to characterise the hydraulic parameters of coal aquifers in Alberta. Included analyses of hundreds of pumping tests to determine effect of fracturing on transmissivity and storativity of coal seams.



PROJECT EXPERIENCE – HYDROGEOLOGICAL ASPECTS OF UNDERGROUND MINE DEVELOPMENT

Teck Corporation
Alaska

Conducted studies to estimate mine inflow and to assess dewatering and grouting strategies at a proposed underground mine. Included packer testing, installation of monitoring wells, water sampling, pumping tests and numerical modelling. Designed wells for the injection of treated mine water during the development of exploration decline. Providing on-going hydrogeological assessment for full mine development.

Giant Mine
Northwest Territories

Conducted hydrogeological investigations related to an existing and a recently excavated arsenic stope. Conducted permeability testing and hydraulic head measurements in the pillar between stopes. Recommended the installation of a drainage galley beneath the two stopes to promote dewatering of the stopes. Drainage galley was nearing completion when the mine was shut-down.

Winspear
Northwest Territories

Provide hydrogeological services to the EIS and Feasibility mine plan. Investigations have included the installation of piezometers, permeability testing and water sampling. Computer modelling was undertaken to estimate mine inflows during the exploration decline and at the planned full mine development.

Pend Oreille
Washington

Hydrogeological investigations related to mine expansion. Investigations included permeability testing and hydraulic head measurement of proposed shaft development. Computer modelling was undertaken to estimate inflows to shaft development. Provide recommendations on mine dewatering strategies and grouting procedures.

Turquoise Ridge
Nevada

Hydrogeological investigations to develop dewatering strategies to improve trafficability in production areas. Included 3-D visualization of underground development, geology, structure and measurements of groundwater inflow during drilling of long exploration holes. The structure and geology were correlated to high inflows in order to identify major groundwater pathways that can be intercepted and drained prior to mining.

Asia Pacific
Thailand

Conducted pre-feasibility and feasibility hydrogeological investigations of a proposed underground potash mine. Including pumping tests, installation of monitoring wells, water sampling and numerical modelling. Estimated mine inflows and water supply potential and provided conceptual dewatering strategies.

Polaris Mine
Cornwallis, NWT

Provided testing procedures to determine hydrogeological properties at a proposed underground mine expansion. Numerical modelling was conducted to assess mine inflow at a planned expansion.

Raglan
Northern Quebec

Undertook and groundwater benchmark study that examined potential groundwater issues that could result if underground mining progressed below the permafrost zone. The quantity of inflow to this mine was of a particular concern as the ventilation in the underground is not heated. All previous mining was within the permafrost. Studies included review of thermal regime data, groundwater inflows to boreholes drilled below the permafrost, regional water level elevations of large lakes in area, geology and hydrogeologic projects with similar hydrogeologic and thermal regimes.



Red Mountain Smithers, BC	Conducted hydrogeological investigations to assess hydrogeological conditions and to estimate mine inflows to proposed underground mine.
Westmin Resources Myra Creek, BC	Characterised the groundwater regime and determined the source of acid rock drainage. Investigation included installation of wells, permeability testing and water sampling. Assisted in the design of remedial measures.
Uranium Mine Northern Saskatchewan	Developed a computer model of the groundwater regime at a proposed underground uranium mine. Analyses included assessment of mine inflows to various proposed mine plans and the effect of grouting and/or dewatering on mine inflow and water pressures.
Potash Mine Esterhazy, SK	Model analysis of groundwater regime to determine approximate location and chronology of leaks at an underground potash mine. Included analyses of several hundred drill stem tests to determine formation transmissivities and numerical modelling.
Hudson Bay Mining and Smelting Manitoba	A study to estimate groundwater inflow and recommend dewatering strategies in underground mines at Photo Lake and Kunoto Lake.
Eldorado Gold Corporation Turkey	A study to estimate groundwater inflow to a proposed underground mine and to assess the effects of mining on the groundwater and surface water regime.
Homestake British Columbia	Hydrogeological study including pumping tests, inflow mapping, structural modelling and packer testing. Groundwater inflow was estimated for the life of the mine. Dewatering wells were designed and installed. Dewatering strategies were determined.
Snap Lake Northwest Territories	Provided technical assistance on hydrogeology components of an environmental assessment and in hearings relate to project approvals and permitting. Included characterization of the regional groundwater flow regime and the prediction of the direction, travel time and contaminant transport of dissolved metals originating from the mine following closure of the mine. The environmental assessment was approved in late 2003.
TVX Gold Eastern Europe	Assessment of groundwater inflow to a proposed underground mine. Included the development of a computer model that was calibrated to measured inflows to preliminary mine development.
Diavik Diamond Project Northwest Territories	Providing ongoing hydrogeological investigations to determine groundwater inflows to a mine located near Yellowknife. Duties have included conducting permeability tests in deep exploratory boreholes and conducting pumping tests in the underground mine. Numerical hydrogeological modelling was undertaken to assess mine inflows, dewatering systems, dewatering strategies and remedial measures. Drainage galleries consisting of 4 to 6 drainholes were designed and installed at approximately 75 m depth intervals in the underground mine. Acted as expert witness during project approval process.
Jullietta Former U.S.S.R	Groundwater investigations at a proposed underground mine to assess groundwater inflows. Groundwater model was developed and calibrated to inflows to advanced exploration program.



Curriculum Vitae

DON CHORLEY

T'Sable River British Columbia

Groundwater investigations to assess groundwater inflows to an exploration decline. Investigations included flow meter testing, permeability testing, piezometer installation and computer modelling. The potential for saline water intrusion will be assessed.

PROFESSIONAL AFFILIATIONS

Member, Association of Professional Engineers and Geoscientists of the Province of British Columbia

Member, Association of Professional Engineers, Geologists & Geophysicists of Alberta

Member, Association of Professional Engineers, Geologists & Geophysicists of the Northwest Territories

Member, International Association of Hydrogeologists

RESUME FOR GRAEME CLINTON

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Internet: www.impacteconomics.ca

ACADEMIC QUALIFICATIONS

MA (Economics), Simon Fraser University
(1995)
B. Commerce (Finance and Economics,
Honours), University of Saskatchewan
(1994)

EMPLOYMENT HISTORY

Principal

Impact Economics, Yellowknife
(January 2004 – Present)

Senior Economist

Economic Services
The Conference Board of Canada,
Ottawa/Yellowknife
(February 1999 – December 2003)

Research Associate

Economic Forecasting
The Conference Board of Canada, Ottawa
(May 1996 - January 1999)

SUMMARY

Mr. Clinton has built a wide variety of skills working as a professional economist for the past 18 years. Graeme is the Principal at Impact Economics offering economic services in a range of areas including resource development, socio-economic impact assessments, regional economic analysis and reporting, economic modelling, Aboriginal economic development, and custom research in such areas as housing, poverty, tourism, demographics, and labour.

Previously, Graeme held the position of Senior Economist at the Conference Board of Canada.

Graeme comes to his work with a strong, theoretical, knowledge base, enhanced by an outstanding academic record in quantitative analysis, development economics, and international finance.

CURRENT PROJECTS

Economic research for the Government of Nunavut Housing Action Plan

Authoring the Nunavut Economic Development Strategy

Research for the Building a Northern Evidence-based Approach to Crime Prevention

Economic Assessment for the Ekati Diamond Mine expansion (the Jay Project)

RECENT INDUSTRY AND BUSINESS RELATED WORK

Preliminary Economic Assessment of the Izok Corridor Project

NWT Major Projects Reports and Analysis

Project Description for the Izok Corridor Project

Environmental Impact Statement for the Gahcho Kue Project

Arctic Communications Infrastructure Report: A Matter of Survival, Arctic Communication Infrastructure in the 21st Century

Snap Lake Diamond Mine Employment Report (2008 to 2013)

Economic Impact Report for the Gahcho Kué Mining Project

Socio-economic Baseline Study for the Courageous Lake Gold Project

Socio-Economic Impact Assessment for the Prairie Creek Mine

Economic impact of northern airlines in the NWT and Nunavut

RECENT ECONOMIC DEVELOPMENT WORK

2013 Nunavut Economic Outlook: Turning Growth into Prosperity

Inuvialuit Economic Development Research Project

Preparing the Municipality of Rankin Inlet for the Impact and Benefits of the Meliandine Gold Project

Understanding and Measuring Development in Inuit Nunangat

Economic and Demographic Future for Denendeh

2010 Nunavut Economic Outlook: Nunavut's Second Chance

Understanding Development in Inuit Nunangat

2008 Nunavut Economic Outlook: Our Future to Choose

CUSTOM RESEARCH, ADVISORY, AND ADVOCACY

Economic Advisor to the Government of the Northwest Territories' Steering Committee for Economic Development and Investment

Advisory services to the Nunavut Economic Forum with its Roundtable for Nunavut Economic Development Strategy Renewal

Understanding Poverty in Nunavut

GN Long-Term Comprehensive Housing and Homelessness Strategic Framework

The Impediments to Economic Growth in the NWT

The Merits of Economic Growth in the North

GENERAL APPLIED MACRO-ECONOMICS

Tourism Economic Impact Model

Nunavut Demographic Projection Model

NWT Economic Impact Model

NWT Oil and Gas Exploration Impact Model

**Education**

Ph.D. Biology, University of Saskatchewan, Saskatchewan, 2009

B.A. Communication, University of Toledo, Ohio, 1992

Certifications

Bear Safety, May, 2009

Arctic Survival Skills, February, 2009

Wilderness First Aid, March, 2008

CPR, April, 2012

Firearms Possession and Acquisition, July, 2013

Languages

English – Fluent

Golder Associates Ltd. – Yellowknife, NT**Wildlife Biologist**

Dan Coulton has been a Wildlife Biologist with the Golder Yellowknife office since January 2009. Dan's role is to develop project field investigations, analyse data, and communicate results and to provide technical support, in the area of wildlife ecology, to clients. Dan has also been a project manager and technical lead for several northern environmental baseline and monitoring programs, has experience with environmental assessment, public hearings and presentations, designed and implemented wildlife monitoring plans, and completed literature reviews. In addition to formal theoretical and modern analytical training, Dan has over 13 years of field experience in North American wildlife research projects including studies in Canadian prairie, boreal forest, and arctic environments. He has collaborated with both governmental and non-governmental organizations such as the U.S. Fish and Wildlife Service, Canadian Wildlife Service, Government of the Northwest Territories, Ohio Division of Wildlife, Ducks Unlimited Canada and Delta Waterfowl Foundation. Dan has lived in Yellowknife part-time since 2003 and full-time since June, 2008.

Employment History**University of Saskatchewan – Saskatoon, Saskatchewan**

Graduate Research Assistant (2002 to 2008)

Conducted original research in population ecology. Responsibilities included literature review, writing research proposals, securing funding, collecting and analyzing data and communicating results through presentations, reports, and scientific journals.

Canadian Wildlife Service – Yellowknife, Northwest Territories

Contracted Biology Analyst (2008)

Analyzed data sampled from 1907-2007 literature sources to delineate critical reproductive periods for migratory birds in the Northwest Territories and Nunavut.

Environment Canada – Cardinal Lake, Northwest Territories

Contracted Research Technician (Spring to 2008)

Conducted population and mark-recapture surveys of lesser scaup (*Aythya affinis*) and white-winged scoter (*Melanitta deglandi*) ducks in a remote boreal location southeast of Inuvik, Northwest Territories.

Ohio Division of Wildlife – Oak Harbor, Ohio

Seasonal Research Technician (Fall to 2001)

Conducted telemetry and visual surveys of laser-harassed urban Canada geese (*Branta canadensis*) at locations throughout the greater Cleveland area, Ohio.

Delta Waterfowl Foundation – Egeland, North Dakota

Seasonal Research Technician (Summer to 2001)

Conducted waterfowl population and nest surveys and monitored nests to determine productivity.



Ducks Unlimited Inc. – Minot, North Dakota

Seasonal Research Technician (Summer to 2000)

Located and monitored nests of upland nesting waterfowl to determine productivity.



PROJECT EXPERIENCE – PROJECT EXPERIENCE

Dominion Lynx/Jay Projects	Planned, managed and reported on baseline wildlife monitoring activities. Component lead for environmental effects on wildlife for the Jay Project Developer's Assessment Report. July 2012 to present.
Snap Lake Diamond Mine Northwest Territories, Canada	Completed statistical analysis of and reported on stable isotope analysis of large-bodied fish at Snap Lake. July 2013 to March 2014.
Snap Lake Diamond Mine Northwest Territories, Canada	Planned, managed and reported on wildlife monitoring for caribou, grizzly bear, and wolverine. January 2010 to present.
Diavik Diamond Mine Northwest Territories, Canada	Comprehensive analysis report of environmental effects on wildlife in the Lac De Gras Region. March 2011 and February 2013.
NICO Cobalt, Copper, Gold Bismuth Project, Northwest Territories, Canada	Planned, managed and reported wildlife baseline studies and supported the environmental assessment in the Projects Developer's Assessment Report. February 2009 to present.
Gahcho Kué Diamond Project Northwest Territories, Canada	Planned, managed and reported on wildlife baseline studies for caribou, grizzly bear, wolverine, raptors, and water birds supporting the Project's Environmental Impact Statement. November 2010 to present.
Bluefish Hydroelectric Northwest Territories, Canada	Provided technical support for the fish mercury study design. Work included power analysis to determine sample size requirements.
Taltson Hydroelectric Expansion Project Northwest Territories, Canada	Provided technical support for the environmental assessment of the proposed Taltson Hydroelectric Expansion Project. Work included information requests, design of monitoring for water birds along Trudel Creek.
Migratory Bird Incidental Take Permit Applications Northwest Territories, Canada	Served as Project Manager for study for the Canadian Wildlife Service on the potential number of industry proponents and activities in Canada expected to apply for a migratory bird Incidental Take Permit. June, 2010.
Diavik Diamond Mine Northwest Territories, Canada	Review and assessment of wildlife impact predictions for the Diavik Diamond Mine using monitoring results from 1998 to 2008. March, 2010.



L-68 Well Re-entry Northwest Territories, Canada	Terrestrial environmental setting survey and assessment for Canadian Forest Oil for well re-entry west of Fort Liard, NWT. December, 2009.
Lutsel K'e Mini Hydro Northwest Territories, Canada	Terrestrial environmental setting survey and assessment for Northwest Territories Energy Corporation's mini hydro project on the Snowdrift River near Lutsel K'e, NWT. December, 2009.

SUPPLEMENTAL SKILLS

Analytical software

R, version 3.0.1, *SAS*, version 9.2, *JMP* version 8.0, *SPSS*, *Statistica*, *Programs MARK*, *PRESENCE* and *DISTANCE*

PROFESSIONAL AFFILIATIONS

American Ornithologists Union

PUBLICATIONS

Refereed Journal Articles

Coulton, Daniel W., John A. Virgl, and Colleen English. Falcon Nest Occupancy and Hatch Success Near Two Diamond Mines in the Southern Arctic, Northwest Territories. *Avian Conservation and Ecology* 8 (2013), 14.

Coulton, Daniel W., Robert G. Clark, David W. Howerter, Leonard I. Wassenaar, and Michael G. Anderson. Costs and benefits of natal dispersal in yearling mallards *Anas platyrhynchos*. *Journal of Avian Biology* 42 (2011), 123-133.

Coulton, Daniel W., Robert G. Clark, Leonard I. Wassenaar, David W. Howerter and Michael G. Anderson. Social and habitat correlates of immigrant recruitment of yearling female Mallards to breeding locations. *Journal of Ornithology* 152 (2011), 781-791.

Coulton, D. W., R. G. Clark and C. E. Hebert. Determining natal origins of birds using stable isotopes ($\delta^{34}\text{S}$, δD , $\delta^{15}\text{N}$, $\delta^{13}\text{C}$): Model validation and spatial resolution for mid-continent mallards. *Waterbirds*, 33 (2010), 10-21.

Coulton, D. W., R. G. Clark, K. A. Hobson, L. I. Wassenaar and C. E. Hebert. Temporal sources of deuterium (δD) variability in waterfowl feathers across a boreal-to-prairie gradient. *Condor*, 111 (2009), 255-265.

Conference Proceedings

Dagenais, L., D. W. Coulton, J. A. Virgl, and C. English. 2012. Raptor nest occupancy and productivity near two barren-ground diamond mines, Northwest Territories. North American Ornithological Conference, August. Vancouver, Canada.



Coulton, D. W., J. A Virgl, and C. English. 2011. Raptor nest occupancy and productivity near barren-ground diamond mines, Northwest Territories. 39th Annual Geoscience Forum, November. Yellowknife, Canada.

Coulton, D. W. and R. G. Clark. 2009. Reproductive experience and nest tunnel use by female mallards. 5th North American Duck Symposium, August. Mississauga, Canada.

Coulton, D. W., R. G. Clark, D. W. Howerter, M. G. Anderson and L. I. Wassenaar. 2008. Testing the site familiarity hypothesis by assessing consequences of natal dispersal decisions in yearling female mallards. 126th meeting of the American Ornithologists Union, August. Portland, USA.

Coulton, D. W., R. G. Clark, C. E. Hebert, D. W. Howerter and M. G. Anderson. 2006. Social and environmental cues influencing immigration rates of Parkland mallards. 4th North American Duck Symposium, August. Bismarck, USA.

Coulton, D. W., R. G. Clark, C. E. Hebert and K. A. Hobson. 2006. Sources of recruits in two prairie mallard breeding populations. 4th North American Duck Symposium, August. Bismarck, USA.

Coulton, D. W., R. G. Clark, K. A. Hobson and S. Larivière. 2004. Sources of yearling recruits to local parkland mallard populations: identifying natal origin using δD , $\delta^{13}C$, and $\delta^{15}N$ values in feathers. 122nd meeting of the American Ornithologists Union, August. Quebec, Canada.

Coulton, D. W., R. G. Clark, K. A. Hobson and S. Larivière. 2004. Recruitment to local parkland mallard populations: identifying natal origin using δD , $\delta^{13}C$ and $\delta^{15}N$ values in feathers. 4th International Conference on Applications of Stable Isotope Techniques, April. Wellington, New Zealand.

Coulton, D. W., R. G. Clark, K. A. Hobson and S. Larivière. 2003. Exploring sources of immigrants to mallard populations by identifying natal origins of yearling birds using stable-hydrogen, -carbon and -nitrogen isotopes. 3rd North American Duck Symposium, November. Sacramento, USA.

**Education**

M.Sc. Geotechnical Engineering, University of Alberta, Edmonton, Alberta, 1994

B.Sc. Civil Engineering, University of Alberta, Edmonton, Alberta, 1991

Golder Associates Ltd. – Vancouver***John Cunning, P.Eng.***

Principal, Senior Geotechnical Engineer

Mr. Cunning is a Principal with over 20 years of experience as a geotechnical engineer working on projects related to mining development and mine waste management. Projects have ranged from carrying out geotechnical field investigations, directing laboratory testing programs, geotechnical design, analysis and construction for tailings impoundments, water retaining dam structures and mine rock waste dumps.

Employment History***Golder Associates Ltd. – Burnaby, BC***

Senior Geotechnical Engineer, Principal (2013) (1994 to Present)

Engineering Manager for the design and construction of tailings and mine waste management and mine infrastructure development projects. Experience includes site selection and design studies of tailings and mining waste storage areas, waste management planning, site water management, closure of waste storage areas, detailed design of tailings and water retaining dams, construction material specifications, preparation of construction drawings, schedules and cost estimates and assignments as Resident Engineer during dam construction. Overseeing geotechnical field investigations and laboratory testing programs, including data collection, interpretation, and analyses and reporting, and overseeing geotechnical modelling for stability, seepage, thermal, and water balance analyses, and specialty laboratory testing programs on tailings and dam fill soils for use in liquefaction analyses.

Klohn Leonoff Ltd. – Richmond, BC

Geotechnical Engineer (1991 to 1992)

Site Engineer for the construction monitoring on a hydraulic fill tailings dam facility, for the construction monitoring of an earth fill tailings dam, and for the geotechnical investigation, interim construction design, and monitoring procedures for a tailings facility failure.

Fugro McLelland Ltd. – Hemel Hempstead, UK

Co-op Student Geotechnical Engineer (1990 to 1990)

Field Engineer on a site investigation project for a proposed 400-km-long underground pipeline in the northwest of England.

Nova, Alberta Gas Transmission Division – Edmonton, AB

Co-op Student Engineer (1989 to 1989)

Provided project management of capital and operational expenditure projects for natural gas pipelines throughout Alberta.



PROJECT EXPERIENCE – MINING AND GEOTECHNICAL

**Dominion Diamond
Corporation
Northwest Territories,
Canada**

Technical Director of Engineering for Dominion Diamond's proposed development of the Jay kimberlite pipe (Jay Project) which is an extension to the existing Ekati Diamond Mine. The Ekati Mine site is located north of the tree line, 300 km northeast of Yellowknife, in a continuous permafrost zone.

Overseeing Engineering studies including the conceptual design of the project including the Jay only project and an earlier conceptual design for the inclusion of the Cardinal pipe in the Jay-Cardinal project. Conceptual design and permitting support for the Lynx Project; an additional small kimberlite pipe scheduled for construction in 2016. Large scale geotechnical and hydrogeological site investigation programs carried out during winter of 2014 and 2015 for both the Jay and Cardinal Pipes and potential dike locations (2014) and to support the next stage of design for the Jay Project (2015). Completed baseline permafrost reports and a Pre-feasibility Level Design with Construction Cost Estimate and Schedule to support the Developers Assessment Report (DAR) required for the Project permitting, and assisted Dominion Diamond in producing a Pre-feasibility Study (PFS) and updating the existing Ekati mine NI 43-101 technical report to include the Jay Project.

**Diavik Diamond Mines
Inc.
Northwest Territories,
Canada**

Engineering manager for ongoing PKC Facility projects including dam raise design and construction, deposition planning, Phase 7 construction planning and long term operations planning. The Diavik Mine site is located just north of the tree line, 300 km northeast of Yellowknife, in a continuous permafrost zone.

Project Manager for the design and construction of the Phase 4 raise for the Diavik Processed Kimberlite Containment (PKC) facility dams. The PKC facility contains both the fine- and coarse-processed kimberlite, with the Phase 4 dams are being raised by 5 m using a Coletanche bituminous liner system. Project duties included preparation of the construction tender package, drawings, and specifications. Coordinated the construction quality assurance field program during the construction.

Project Manager for the design and construction of the Phase 5 raise for the Diavik Processed Kimberlite Containment (PKC) Facility dams. The PKC Facility provides permanent storage for both the fine and coarse processed kimberlite materials. The Phase 5 raise was carried out over four-year construction period and raised the dams by 15 m using a Coletanche bituminous liner system. Responsible for the preparation of the design, construction drawings and specifications, and the construction as-built report. Coordinated the construction quality assurance field program during the construction.

Designed and provided construction quality assurance services for the construction of Pond No. 2, 13, and 14 dams for runoff water collection.



Meadowbank Gold Project
Nunavut, Canada

Lead Engineer during construction of the East Dike at the Meadowbank Gold Project in Nunavut. The East Dike was constructed in the wet to divide a lake on the project site and following dewatering will allow development of the main open pit and for construction of the tailings storage facility. Working with the Owners construction manager and contractor, prepared modifications to the design which were implemented during construction, and coordinated the construction quality assurance field program during the construction. Working with Owner, monitored dike performance during dewatering. Prepared construction as-built report.

Teck Coal Ltd.
Elk Valley Area, British Columbia, Canada

Engineering Manager for a number of geotechnical projects support ongoing mining operations and for planned mine expansions at the Teck Coal mine sites in the Elk Valley area of BC. Provided senior technical review for a number of waste rock spoil geotechnical assessment programs including oversight of the geotechnical investigations and slope stability assessments.

Provided senior technical review for the design and construction of the South Tailings Pond dam raise and for the annual Dam Safety Inspection at the Fording River Operations (FRO) between 2008 and 2014.

Provided senior technical review for the geotechnical investigations into the coal tailings deposits and for the planned 2014 tailings dredging program from STP to the 3 Pit area at the FRO site.

Senior technical review on the proposed Swift Project waste rock spoils and geotechnical support to the water management planning. Included and support to develop geotechnical considerations to support the safe work plan for the proposed mining of coal tailings deposits from in-pit and waste dump disposal at the Fording River Operations.

Quinsam Coal
Campbell River, British Columbia, Canada

Project Engineer for the design of the 2 South Pit Potentially Acid Generating (PAG) Coarse Coal Rejects (CCR) storage facility. Developed design of a suitable liner system to provide for permanent flooded storage of the PAG CCR material in the mined out 2 South Pit. Assisted Quinsam with geotechnical aspects related to the overall permit application for 7 South Mine development.

Areva Kiggavik Project
Nunavut, Canada

Project Engineer for the conceptual design of a shallow lake dewatering dike to support proposed open pit mining at the Kiggavik Project Andrew Lake site. Prepared conceptual design for the ore and special waste pads and sediment ponds for this proposed uranium mine site.

Diavik Diamond Mines Inc.
Northwest Territories, Canada

Project Manager for the A21 Mine feasibility study. The A21 mine will include construction of a dewatering dike in the lake to allow for open pit and underground mining of the A21 kimberlite pipe at the at the Diavik Diamond Mine in the Northwest Territories. Project duties include directing the geotechnical and hydrogeological site investigation programs, pit design studies, and the alternative mining studies. Participated on the Owner's Team, providing engineering support services to review of the A21 Dike design. Planned the Winter 2007 detailed design site investigation program.



**Minas Conga Mill
Sands Laboratory
Testing**
Peru

Directed a specialty geotechnical laboratory testing program on samples of the Minas Conga Mill sands to measure the critical state properties. The laboratory testing program also included the measurement of shear wave velocity over a range of sample densities in conjunction with the laboratory strength testing programs. Laboratory results were used in the design and liquefaction analyses under seismic loading of the proposed mill sands containment system.

**Faro Mine, Rose Creek
Tailings Liquefaction
Assessment**
Faro, Yukon, Canada

Conducted a Cone Penetration Test (CPT) investigation program to characterise the Rose Creek Tailings Facility impoundment at the Faro Mine. Analysed the investigation results to determine the liquefaction potential of the tailings facility and made recommendations on the facility closure remediation options.

**Guindon Tailings Dam
Laboratory Testing**
Sudbury, Ontario,
Canada

Directed a geotechnical laboratory testing program on samples of the Guindon tailings to measure the critical state properties. The laboratory testing results were used in the design and subsequent tailings blast densification project carried out by Golder Associates Innovative Applications (GAIA) Inc. (now Golder Construction) as part of the foundation preparation for the construction of the new Guindon Tailings Dam.

**Coquitlam Dam Final
Design Laboratory
Testing**
Coquitlam, British
Columbia, Canada

Directed a geotechnical laboratory testing program for BC Hydro in support of the final design stage of the seismic remediation for the Coquitlam Dam. In addition to index testing on the proposed dam fill and foundation soils, specific testing included triaxial tests on reconstituted and undisturbed samples, and filter compatibility tests. Designed the filter testing equipment and conducted the required tests of the dam core and foundation soils against the proposed filters.

**Bennett Dam
Laboratory Testing**
Hudson's Hope, British
Columbia, Canada

Conducted laboratory testing programs on the Bennett Dam core and transition soils in support of the ongoing Dam Safety surveillance evaluation programs. The first laboratory testing program measured the critical state properties on three different gradations of the core soil in an effort to understand the effect of fines loss on the in situ strength of the core soils. The second laboratory program tested the core and transition soils and incorporated state-of-the-art Bender Element Systems in the critical state triaxial testing equipment in order to measure the small strain elastic properties in each sample. Shear and compression wave velocities were determined over a range of both density and pressure. Results of this program were used to predict trends in the elastic properties of the in situ soils, and these predictions were found to compare well with the field-measured elastic properties.

**Compañía Minera
Antamina S.A.**
Peru

Prepared the Stage 2, 3, and 4 (final dam) raise construction drawings and specifications for raising the rockfill tailings dam at the Antamina Mine in Peru to a height of 240 metres. Provided ongoing engineering support during Stage 2 dam construction. Prepared a life of mine tailings deposition plan for the 563-Mt tailings facility. Engineering Task Leader for the Middle Catchment Diversion project involving design and construction of a polishing pond, 3-km diversion channel, and Stage 2 decant and 400-m connector tunnel. Prepared design of the permanent seepage collection system pond.



**Compañía Minera
Antamina S.A.**
Peru

Prepared Stage 1 Raise construction drawings and specifications for raising the starter tailings dam at the Antamina Mine in Peru. The starter tailings dam is a 130-m-high, concrete-faced rockfill dam, which will be raised to a 240-m-high rockfill tailings dam throughout the life of mine. The Stage 1 Raise involves a crest height increase of 30 m.

**Snap Lake Diamond
Project**
Northwest Territories,
Canada

Carried out finite element seepage and thermal modelling for planning the PKC facility for the Snap Lake Diamond Project in the Northwest Territories. The proposed PKC containment facility is to be located in an area of continuous permafrost and to be constructed using the PKC materials.

Fort Nelson Airport
Fort Nelson, British
Columbia, Canada

Resident Engineer for contract administration on a CDN \$3,500,000 environmental remediation project involving a DDT-contaminated landfill site at the Fort Nelson Airport. Oversaw work carried out by the contractor, reported on progress to the client, confirmed quantity measures, and confirmed compliance with contract specifications. The project involved the disposal of over 40,000 tonnes of DDT-contaminated soil, which was excavated from a steep landfill site of about 1.5 ha. Following removal of contaminated soil, the slope was regraded, surface drainage works constructed, and the area revegetated.

Omai Gold Mines Ltd.
Guyana

Resident Engineer for QA/QC activities, inspections, and testing related to the construction of the No. 2 Tailings Dam at the Omai Gold Mines Ltd. mine site in South America. Dam fill materials included residual soil for cores, sand filter zones, and rockfill shells. Coordinated dam construction materials concurrent with mining activities, directed labour forces in construction of filter zone details, installed instrumentation, carried out weekly instrumentation readings, and prepared weekly reports for client. The Omai No. 2 tailings basin consists of six dam structures with a combined crest length of over 4 km.

Fording Coal Mountain
Southeastern British
Columbia, Canada

Conducted site investigations and carried out geotechnical slope stability assessments for both the Phase 2 and 3 expansions of the Middle Mountain spoil. Prepared reports for submission to the BC Mines Inspector for permitting, assisted the client in developing construction practices documents, and participated in workshop to train operators on good construction practices. The Phase 3 Middle Mountain spoil is planned to be built over 20 years, and will contain about 35 million m³, with a maximum height over 150 m from crest to toe.

**Compañía Minera
Antamina S.A.**
Peru

Carried out finite element seepage modelling using SEEP/W for the starter (130 m height) and ultimate (250 m height) concrete-faced rockfill tailings dam during detailed design work on the Antamina Project.

Milpo Mine
Peru

Carried out geometric layout modelling using SURPAC and finite element seepage modelling using SEEP/W for a 30-m-high raising design of an existing 100-m-high rockfill tailings dam.

Kumtor Mine
Kyrgyz Republic

Carried out a confirmatory finite element thermal modelling for the actual operating conditions of the Kumtor Mine tailings facility. Carried out thermal modelling for the Lower Facilities building as part of the assessment of building settlement due to thawed permafrost foundation. Analyses included calculation of time to re-freeze foundation using the underslab chilling system.



Quebrada Blanca Mine
Chile

Developed a scheduling plan for the removal of spent ore from the heap leach pads into two new spent ore waste dumps. This scheduling was carried out together with the mine engineering group using the on-site software MineSight. Provided recommendations on dump development and underdrain system for the spent ore waste dump.

Las Cruces Project
Spain

Carried out general arrangement layout, annual sequencing, stability analyses, and water management assessment for the paste tailings storage facility for feasibility study.

Pogo Project
Alaska, United States of
America

Provided layout and quantity calculations for site infrastructure. Member of a team that developed the site facilities drawings for the advanced exploration of the Pogo deposit, including airstrip, site access roads, portal development road, and development of waste rock and ore storage pads.

Julietta Gold Project
Russia

Provided layout, quantity calculations, water balance, stability and thermal analyses, and input into the tailings deposition planning for feasibility-level through to detailed engineering design for surface tailings facility. Prepared construction drawings and technical specifications for construction of tailings facility. The Julietta Mine is an underground mine operation located in an Arctic environment in a region of continuous permafrost. Assisted in planning for the use of paste tailings as backfill underground and provided geotechnical input into the mine infrastructure development.

Miramar Con Mine
Yellowknife, Northwest
Territories, Canada

Carried out an assessment of existing tailings and water management practices at the Con Mine. Developed a 10-year tailings and water management plan. Provided design details for the various tailings dam raisings required in the implementation of the 10-year plan. In connection with the 10-year plan, worked with a geotechnical and environmental team to develop a closure plan for the mine site.

Kudz Ze Kayah Project
Yukon, Canada

Member of the team providing geotechnical design for the feasibility study for the Kudze Kayah Project. Carried out an assessment of the waste dumps, including layout and stability analyses. Worked on design details for a large tailings dam, including site investigation, and stability and seepage analyses. Carried out geotechnical field investigation work for dam foundations, waste dump foundations, and locating borrow area for dam core material.

Pend Oreille Mine
Washington, United
States of America

Conducted a geotechnical site investigation for the closed tailings facility and carried out a stability and liquefaction assessment of the facility. Prepared recommendations on remedial construction measures to minimise risk of loss of tailings containment.

Mount Polley Mine
Likely, British Columbia,
Canada

Performed review of existing waste dump development and submitted recommendations for future dump development.

Voisey's Bay
Labrador,
Newfoundland, Canada

Carried out layout and stability analyses and water management plan for the proposed waste dumps for mining the Voisey's Bay ovoid pit including overburden storage, waste rock, and acid generating waste rock dump sites.



Kumtor Gold Project
Kyrgyz Republic

Conducted a site investigation for geotechnical input into the mine infrastructure design for Kumtor Golder Project development. Compiled field data and prepared a data report. Oversaw the stability, seepage, settlement, and thermal analyses for the tailings management facility, foundation design for mill facilities founded on piles in permafrost, and for mill facilities founded on rock. Prepared report for the overall project geotechnical design studies report.

Endako Mine
British Columbia,
Canada

Prepared the storage volume elevation curves for the estimated ultimate configuration for the two tailings ponds in order to prepare conceptual closure spillway recommendations.

Aginskoye Project
Russia

Provided stability analyses for tailings dams for the proposed tailings facility as part of the Aginskoye Project feasibility study.

Quinsam Coal
British Columbia,
Canada

Carried out site investigation for a new tailings disposal facility and as-built construction report preparation for the initial stage of construction for this new facility.

Kubaka Gold Project
Russia

Provided thermal modelling of tailings deposition thaw penetration in a frozen core tailings dam as part of the design studies for the Kubaka Mine.

Golden Sunlight Mine
Montana, United States
of America

Conducted field investigation of a slope failure, including geotechnical drilling and buttress berm construction preparation.

**Armenonic Del
Ecuador S.A.**
Ecuador

Performed stability analysis for an existing tailings dam at the San Bartolome Mine.

Cominco Sullivan Mine
British Columbia,
Canada

Carried out site investigation for back analyses of a tailings dam failure and the analyses of the remaining intact tailings dams using both conventional geotechnical drilling and extensive CPT methods. Provided field support on interim construction design and monitoring.

**Cheni Resources Gold
Mine**
British Columbia,
Canada

Site Engineer for the construction coordination and monitoring of the raising of an earth-fill tailings dam.

**Highland Valley
Copper**
British Columbia,
Canada

Site Engineer for the construction monitoring and reporting for the annual raising of the L-L hydraulic fill tailings dam. This included in situ compaction and laboratory testing of fill materials, excavation monitoring, foundation inspection, instrument data collection and reduction, and weekly summary reporting.

PROFESSIONAL AFFILIATIONS

Professional Engineer, Association of Professional Engineers and Geoscientists of BC

Professional Engineer, Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists

Member, Canadian Institute of Mining, Metallurgy and Petroleum



PUBLICATIONS

Cunning, J., Isidoro, A., Apaz, C., and Kinakin, C., 2011. Deposition Planning at the Diavik Diamond Mine. Tailings and Mine Waste 2011, Vancouver, Pending

Cunning, J., Eldridge, T., Isidoro, A., and Reinson, J., 2008. Dam Construction at Diavik using Bituminous Geomembrane Liners. Proceedings of the 61st Canadian Geotechnical Conference, GeoEdmonton'08, Edmonton, Alberta. September 21-24, 2008.

Cincilla, W.A., Cunning, J.C., and Van Zyl, D.J.A. "Geotechnical Factors Affecting The Surface Placement Of Process Tailings in Paste Form". Sixth International Symposium on Mining with Backfill, Brisbane, Australia, 1998.

Cunning, J.C. and Eldridge, T.L. "Surface Disposal with Paste Tailings". Presented at the 17th CIM District 6 Meeting, Kamloops, British Columbia, 1996.

Robertson, P.K., Sasitharan, S., Cunning, J.C., and Sego, D.C. "Shear-Wave Velocity to Evaluate In Situ State of Ottawa Sand," Journal of Geotechnical Engineering, 1995, ASCE, 121(3): 262-273.

Cunning, J.C., Robertson, P.K., and Sego, D.C. "Shear-Wave Velocity to Evaluate In Situ State of Cohesionless Soils", Canadian Geotechnical Journal, 1995, 32(3): 848-858.

Cunning, J.C. "Shear-Wave Velocity of Cohesionless Soils for Evaluation of In Situ State", M.Sc. Thesis, Department of Civil Engineering, University of Alberta, Edmonton, Alberta, Canada, 1994.

Cunning, J.C. and Jefferies, M.G. "On Applying Liquefaction Case History Experience to Tailings", Canadian Dam Association 2004 Annual Conference, Ottawa, Ontario, September 2004.

Clayton, C.J., Cunning, J.C., Haynes, A.J., Hickson, D.H., and Thiele, B. "Design Considerations for Mine Waste Management at the Meadowbank Gold Project". CIM, Edmonton, Alberta, 2004.

Shuttle, D. and Cunning, J.C. "Liquefaction Potential of Silts from CPTu". Canadian Geotechnical Journal, 2007, 44 (1): 1-19.

**Education**

M.A.Sc. Geotechnical Engineering, University of British Columbia, Vancouver, 2002

B.A.Sc. Geological Engineering, Water Resources Option, University of Waterloo, Waterloo, Ontario, 1995

Golder Associates Ltd. – Burnaby**Employment History*****Golder Associates Ltd. – Burnaby, BC***

Associate, Geotechnical Engineer – Mine Waste Management Group (May 2005 to Present)

Senior geotechnical Engineer and project manager for mine waste management and construction projects. Work has included tailings dam and dike design entailing: tailings dam and dike site selection evaluation, conducting geotechnical investigations, dam design and analysis, material selection, geomembrane selection, preparation of construction drawings, specifications and bid packages, QA monitoring of geomembrane installation, QA monitoring of dike and dam construction, as built reporting, preparation of OMS manuals and emergency response plans. Heap leach pad design entailing: site characterization and selection, heap layout and design for pad and valley fills, overseeing laboratory testing programs, liner system design, piping layout, and preliminary stacking plan development. Work has also included, conducting back-analyses for slope failures and participating in a multi-disciplined team assessing a case of mine subsidence. Additional work has comprised conducting geotechnical investigations, slope stability assessments, and acting as the construction manager for a landfill expansion project including installation of geosynthetic liners. Project work was conducted in Canada, Australia, Chile, Peru, and Mexico.

BGC Engineering Inc. – Vancouver, BC

Geotechnical/Environmental Engineer (June 2001 to May 2005)

Project engineer for mining, geotechnical and environmental projects: conducted investigations; performed analyses; prepared designs and reports. Conducted natural hazard risk assessments which involved identification, relative ranking, quantification of hazards, determining remedial measures and/or monitoring systems to reduce potential risk posed for linear facilities (pipelines and railways). Performed slope stability assessments, conducted landslide investigations, and environmental site assessments. Project work was conducted in Canada, Brazil, Bolivia, Argentina, and Chile.

BC Hydro/University of British Columbia – Vancouver, BC

Professional Partnership Student and Soil Mechanics Teaching Assistant (August 1999 to June 2001)

Collected and analyzed thermal monitoring data and performed seepage and thermal modeling for Coquitlam Dam. Served as a teaching assistant in the soil mechanics laboratory for second and third-year civil engineering students.

Conestoga-Rovers & Associates Ltd. Conestoga-Rovers & Associates Inc. – Waterloo, ON and Detroit, MI

Environmental Engineer (1995 to July 1999)

Conducted geotechnical and environmental investigations, analyses, and design. Resident engineer for earthworks and environmental remediation projects. Conducted environmental site assessments, designed landfills, and prepared designs for landfill closures and remediation projects, designed and oversaw the construction of wetlands. Project work was conducted in Canada and USA.



PROJECT EXPERIENCE – MINING

**Jay Project, Dominion
Diamond Ekati Mine,**
Northwest Territories,
Canada

Design Engineer for the dewatering dike to permit open pit development, associated with the proposed Jay Project, at the Ekati Mine. Work has included geotechnical investigation and laboratory testing, dike design and analysis, preparation of conceptual and pre-feasibility design reports, and drawings. Work has also included participation in a series of community engagement workshops and meetings associated with the Jay Project, and accompanying elders to the Ekati mine for visits. Participated in the preparation of responses to the Information Requests associated with the Developer's Assessment Report for the Jay Project. Work carried out for Dominion Diamond Corporation.

Coal Mine Acquisition
Alberta and
Saskatchewan, Canada

Organized team to undertake inspections and reviews of six operating coal mines as part of a potential acquisition. Participated in the inspection of two of the mines. Geotechnical and environmental risks and potential liabilities at each facility were to be identified and documented. A risk workshop was held to review and rank the various facilities. Work was conducted and report was prepared on a very short time line. The client is confidential.

Gold Mine
Chihuahua, México

Senior engineer for back-analysis of slope instability which occurred within the valley heap leach facility, including conducting slope stability analysis and laboratory testing program. Work also included preparing revised design for the Phase 2 component of the heap leach facility including: stability assessment, construction drawings, and design report. Conducted a stability assessment and updated the water balance for the Phase 3 component of the facility. Conducted site inspection of failure and periodic inspections of restoration works. The client is confidential.

La India Project
Sonora, México

Provided senior review for valley heap leach facility design and stability assessment. Conducted periodic site inspections during construction. Work carried out for Agnico Eagle Mexico, S.A. de C.V.

**Shahuindo Gold
Project,**
Cajamarca, Peru

Provided senior geotechnical review and recommendations for the proposed mine components associated with the project, including the: heap leach facility (pad and ponds), water supply dams and reservoirs, waste rock storage area, open pit, and sedimentation ponds. Work carried out for Sulliden Gold Corporation Ltd.

Gold Mine
Quebec, Canada

Provided third party engineering review of subsidence issues at the mine that led to decision to halt extraction from an underground deposit and temporarily shutdown the mine. Following this, conducted a back-analysis of subsidence in combination with underground rock mechanics specialists to assess mechanisms that led to the subsidence. Data from the following was assessed: cone penetration testing, drill holes, piezometers, survey data, inclinometers, sinkholes, water injection, grout injection, and hydrogeologic modelling. Work included assessment of potential implications from mining of other satellite deposits to result in further surface impacts (subsidence) including using CPT data to estimate ultimate settlement caused by continued dewatering and phreatic drawdown. Presented work to an external review board. The client is confidential.



Meadowbank Gold Project
Nunavut, Canada

Design Engineer for dewatering dikes to permit open pit development, including preparation of design reports, construction drawings, specifications, and tender package. QA site engineer for dike construction. Performed annual geotechnical inspections for the mine. Prepared OMS manual and emergency response plan for dikes and tailings facility. Project engineer for tailings site selection and technology evaluation. Critically reviewed and analyzed the water quality component of the environmental assessment report prepared for the proposed mine, including construction, operation, and post-closure phases of mine life, and prepared a report documenting the results. Presented work to an external review board. Work carried out for Agnico-Eagle Mines Ltd., and Cumberland Resources Ltd.

Diavik Mine
Northwest Territories,
Canada

Prepared feasibility design for the proposed A21 dewatering dike to permit open pit development, including preparation of a design report, and drawings. Presented work the review board. Work carried out for Rio Tinto.

Carmacks Copper Project
Yukon, Canada

Project Manager and Design Engineer for a proposed open pit copper mine in the Yukon, which included a heap leach facility. Work began with updating the geotechnical aspects of the Feasibility Design (NI 43-101) for the heap leach facility and waste dumps. Additional work has been conducted to advance the design including additional site characterization, foundation assessment, coordination of laboratory testing on site materials and in particular components of the liner system (permeability consolidation, interface shear, liner load), and preliminary stacking plan development. In addition, coordinated a multidiscipline team that conducted: surface water management planning and design; groundwater assessment and modeling; water balance; open pit slope design; geochemical assessment of the waste rock and leached ore residue; and waste rock storage facility design for the project. Provided support for Quartz Mining and Water Use License applications and for discussions with first nations. Work carried out for Western Copper Corporation and Copper North Mining Corp.

Sulfolix Project
Chile

Project Engineer for the geotechnical design components of a 400 million tonne copper heap leach pad, in coordination with the EPCM firm. Work included: liner system design, investigation and selection of site materials for the underliner and overliner components, field tests for construction methods, landfill investigation and characterization, settlement assessment, and static and seismic stability assessment. Coordination of laboratory testing including: permeability, consolidation, liner load, interface shear, and overliner degradation. Work also included preparation of construction drawings and specifications. Coordinated QA review of liner manufacturer quality control certificates. Work carried out for Freeport-McMoRan



Antamina Mine
Peru

As Project Engineer, prepared pre-feasibility study for raising the current tailings facility dam by an additional 45 m, for an ultimate height of more than 270 m. Prepared liner selection evaluation for tailings dam. Prepared geomembrane liner specifications and drawings for the installation of a HDPE dam face liner and tailings beach liner. Performed QA monitoring for the liner installation and prepared the QA as-built report for the work. Designed plinth layout and construction drawings for the Stage 2 dam raise. Prepared design drawings, specifications, scheduling, and cost estimate for Stage 3 dam raise. Updated OMS manuals for the tailings facility. Assisted with various tasks associated with the project management. Work carried out for Compañía Minera Antamina.

La Arena
Peru

Project Engineer for the pre-feasibility site selection study for containment of cyanide and non-cyanide tailings facilities. Work included conducting a site reconnaissance, identification of potential storage locations, preliminary design for each facility, and relatively ranking facilities based on an array of parameters (environmental, economic, and operability), and report review. Work carried out for Sociedad Minera Cambior Peru S.A.

Mineração Onça Puma
Pará, Brazil

As Project Engineer, conducted a geotechnical investigation program and data analysis to obtain geology and groundwater information and to assess foundation conditions in tropical residual soils and saprolite for the feasibility-level design of mine facilities (process plant, tailings facility and dams, water supply dam, access roads, and ore stockpiles). Field program included supervision of two drill rigs, logging, and sampling; piezometer installation, development, hydraulic testing, and groundwater monitoring; test pit excavation, logging, sampling, and collection of undisturbed samples for geotechnical testing; and conducting plate load test. Worked in coordination with local field staff and trained technicians. Work carried out for Canico Resource Corp.

Galore Creek Mine
BC, Canada

Project Engineer for preliminary analysis of potential tailings dam locations for the pre-feasibility level design. Work included assessment of watershed size, flood storage volumes, tailings facility capacity, and soil volumes required for dam construction, using volume elevation curves. Work carried out for Nova Gold Resources Inc.

**Flin Flon and Ruttan
Mines**
MB, Canada

As Project Engineer, conducted stability analyses for tailings facility raises and expansion. Work carried out for Hudson Bay Mine and Smelting Co. Ltd.

ARD Monitoring
Sudbury, ON, Canada

Conducted monitoring of five tailings dams and downstream watersheds for acid mine drainage and other water quality parameters to assess the extent and degree of impact. Work carried out for INCO Limited.

**SO₂ Impact
Assessment**
Sudbury, ON, Canada

Conducted watershed studies to develop a baseline for the evaluation of sulphur dioxide emissions on the vegetation, water chemistry, and aquatic species near several mines and processing mills. Work carried out for INCO Limited.



PROJECT EXPERIENCE – EARTHWORKS AND REMEDIAL CONSTRUCTION

Meadowbank Gold Project
Nunavut, Canada

Senior QA site engineer for dewatering dike construction and tailings facility dam construction during 2009. Lead team of up to 7 QA site inspectors performing QA inspections and testing. Work carried out for Agnico-Eagle Mines Ltd.

South Cardup Landfill
Byford, Western Australia

Construction manager for Cell 6 construction and Cell 5 sump reconstruction project, included supervision, inspection, design modifications, reporting, and liaison between contractor, owner, and design engineer. Landfill included a groundwater under-drainage system, compacted soil separation barrier, composite liner (compacted clay, GCL, and 2mm HDPE geomembrane), and leachate collection system. Work carried out for Western Australian Landfill Services.

Fons/Old Wayne Landfills
Michigan, USA

Resident Engineer for a \$12 million, 100-acre landfill cap construction and closure project, including supervision, inspection, and documentation of contractor's activities. Cap consisted of composite clay and LLDPE geomembrane liner. Work carried out for Fons/Old Wayne Landfills Potentially Responsible Parties.

Willow Run Creek Remediation Project
Michigan, USA

Assisted in the contractor supervision, on behalf of the owners, for a \$35 million, remediation project. The project included landfill construction, installation of one mile of sheet pile walls for the water diversion, pond dewatering, contaminated sediment stabilisation, removal, and disposal, wetlands restoration and replacement. Work activities included general oversight, documentation, and inspection of work performed by contractors in accordance with the project specifications. Designed and implemented the environmental air monitoring work plan for volatile organic compounds (VOCs), semi-volatile organic compounds, metals, and particulate matter. Designed and co-ordinated the environmental and geotechnical Construction Quality Assurance testing program. Work carried out for Willow Run Creek Potentially Responsible Parties.

Willow Run Creek Wetlands Construction
Michigan, USA

Designed and supervised the construction of an 8.5-acre wetland to mitigate wetlands lost during remedial construction. Submitted design to MDEQ, prepared bid documents for the construction, and obtained permits for construction. Presented design to local municipality and members of the public. Work carried out for Willow Run Creek Potentially Responsible Parties.

Metamora Landfill Remediation Project
Michigan, USA

Assisted in the supervision of a \$10 million (US) Superfund remediation project involving drum excavation, sampling, bulking, shredding, and disposal. Performed ambient air monitoring around the excavation area, property perimeter, stack emissions for VOCs, and dust particulate. Work carried out for Metamora Landfill Potentially Responsible Parties.

Drum Removal
Michigan, USA

Supervised the sampling, characterisation, and disposal of 500 drums in an abandoned industrial facility.

PVC Trim Factory
Ontario, Canada

Supervised the exit stabilisation activities and waste shipments from a former PVC trim and rubber manufacturing facility prior to plant closure. Work carried out for General Motors Corporation.



PROJECT EXPERIENCE – GEOTECHNICAL ENGINEERING

Mineração Onça Puma Pará, Brazil

As Project Engineer, conducted a geotechnical investigation program and data analysis to obtain geology and groundwater information, and assess foundation conditions in tropical residual soils and saprolite for the feasibility-level design of mine facilities (process plant, tailings facility and dams, water supply dam, access roads, and ore stockpiles). Field program included supervision of two drill rigs, logging, and sampling; piezometer installation, development, hydraulic testing, and groundwater monitoring; test pit excavation, logging, sampling, and collection of undisturbed samples for geotechnical testing; and conducting plate load test. Worked in coordination with local field staff and trained technicians. Work carried out for Canico Resource Corp.

North Vancouver Landslide British Columbia, Canada

Project Engineer for a geotechnical field investigation program to collect stratigraphic and hydrogeologic information for forensic analysis of the slide, to develop an early warning system for the hillside, and to design a stabilisation program. Analysed field and laboratory testing data. Field program included installation of CPT and seismic cone holes, auger (with SPT), direct push sampling, collection of Shelby tube samples, rotasonic drilling, piezometer installation, sampling, logging, hand auguring holes, test pit logging, and collection of undisturbed samples. Work carried out for District of North Vancouver and legal firms.

Ashcroft Mile 50.9 Landslide British Columbia, Canada

Project Engineer for a geotechnical field investigation program of a reactivated, historic landslide with the potential to impact the CN Railway near Ashcroft, BC. The program involved supervision, logging of drill core, installation of slope inclinometers, pneumatic and standpipe piezometers. Information gained from the field program and slope inclinometer measurement data was used to analyse and model slope movements. Work carried out for CN Railway.

Landslide Investigation and Re-route Northern Argentina

As Project Engineer, assisted in the field mapping and investigation program for selecting a pipeline re-route and preliminary design of a horizontal directional drill (HDD) path to bypass an active landslide in northern Argentina that had caused the pipeline to rupture. Work carried out for Gasoducto Nor Andino Argentina S.A.

Geotechnical, Environmental and Hydrogeological Investigations Various

Experience with auger and rotary drilling (air, water, and mud), sonic percussion drilling, cone penetration testing (CPT), geoprobes, triple tube coring, standard penetration testing (SPT), split spoon sampling, cone penetration testing, vane shear testing, Shelby tube sampling, and soil and rock core logging.



PROJECT EXPERIENCE – NATURAL HAZARD ASSESSMENT AND RISK MANAGEMENT

Andean Pipelines Argentina, Chile, and Bolivia

Identification and classification of natural hazards through field assessment and aerial photograph interpretation for over 3,000 km of natural gas and liquids pipelines in Argentina, Chile, and Bolivia. Natural hazards included hydrotechnical processes (river erosion), geotechnical processes such as landslides and rock falls, and tectonic processes such as fault rupture, earthquakes, volcanic eruptions, and tsunamis. Work carried out for Transredes S.A., Gasoducto Nor Andino Argentina S.A., and Gasoducto Atacama Cia Ltda.

OSSA-1 Pipeline Bolivia

Project Manager and Lead Geotechnical Engineer for a multi-disciplined quantitative risk assessment pilot study in Bolivia that encompassed all facets of pipeline integrity along the 420 km OSSA-1 Pipeline between Santa Cruz and Cochabamba. The pipeline crosses active terrain (landslide and flood prone terrain) within Bolivian Andes. Identified, classified, and gathered information used to quantitatively rank the risk due to natural hazards along the pipeline route. Developed algorithms to assess potential risk. Algorithms were calibrated utilising 35 years of operational incident data for the pipeline and other historic operational data from other pipelines in similar terrain. System is now being applied to identify and assess risk on other lines.

As part of the OSSA-1 project, a river crossing monitoring and data collection program was developed for Transredes field personnel. Prior to implementation of the program, a field training program was delivered to train personnel.

Prepared and implemented a detailed site investigation program for areas identified as having the highest degree of risk. Site investigation programs were used to design and provide recommendations for risk control structures or methods (hydrotechnical and geotechnical), conceptual short-term management, monitoring, and long-term operation protocols, as appropriate for each site. All work was carried out for Transredes S.A.

Nor Andino Northern Argentina and Chile

Identified, classified, and ranked natural hazards (hydrotechnical, geotechnical, and tectonic) along 1,400 km of natural gas pipeline. The project used a semi-quantitative method of risk management to rank hazard sites. Risk results were used to prioritise detailed assessment studies, remedial measures, and monitoring programs. Work carried out for Gasoducto Nor Andino Argentina S.A.

Gas Atacama South Australia

Assisted in the identification and classification of natural hazard sites (hydrotechnical, geotechnical, tectonic) for 1,200 km of pipeline. The project used a semi-quantitative method of risk management to rank hazard sites. Risk results were used to prioritise detailed assessment studies, remedial measures, and monitoring programs. Prepared detailed site investigation programs to assess the highest ranked natural hazard sites based on the risk assessment results. Work carried out for Gasoducto Atacama Cia Ltda.



PROJECT EXPERIENCE – ENVIRONMENTAL DESIGN AND INVESTIGATION

**Armstrong
Spallumacheen
Landfill**

Armstrong, BC, Canada

Designed and prepared contract documents, construction specifications, and drawings for several expansion cells of an existing and operational landfill. Work carried out for the North Okanagan Regional District.

**Waste Management in
Arctic Regions**
NU, Canada

Conducted a literature review to evaluate current solid waste management practices in arctic regions and to identify alternative techniques. Prepared a report to summarise findings from the review. Work carried out for the Department of Indian and Northern Affairs, Nunavut.

GM Powertrain Plant
OH, USA

Conducted an investigation of an operating GM manufacturing facility to determine impacts to groundwater, surface water, and sediments, and to investigate the extent of contamination. Analysed data, prepared reports, and presented results. Work carried out for General Motors Corporation.

Drum Removal
Detroit, MI, USA

Prepared bid documents for drum sampling, analysis, and disposal from an abandoned industrial facility.

Air Monitoring
MI, USA

Prepared air monitoring work plans to be implemented during the installation of groundwater/leachate collection system and 100-acre landfill capping and closure project (G&H Landfill US Superfund Project, Michigan), and for a landfill construction and sediment stabilisation, removal, and disposal project (Willow Run Creek Project, Michigan).

**Construction Quality
Assurance**
MI, USA

Prepared contract documents for Construction Quality Assurance testing for the Willow Run Creek Project and G&H Landfill US Superfund Project. Prepared permits for various phases of construction and environmental investigation activities.

Experience operating under environmental regulations, laws, and guidelines in various regions and countries.

PROJECT EXPERIENCE – HYDROGEOLOGIC INVESTIGATIONS AND ANALYSES

**Subsurface
Investigations**
Various

Supervised numerous subsurface investigations using a variety of techniques including auger, water rotary, sonic percussion drilling, geoprobe, cable tool, and test pit excavation. Logged installations and collected soil samples for geologic characterisation and chemical testing. Supervised the installation of monitoring wells and piezometers. Developed, tested, and sampled wells. Conducted permeability testing of formations through pump tests, slug tests, and falling head permeability tests. Work carried out for various clients.

Coquitlam Dam
British Columbia,
Canada

Conducted two-dimensional, transient seepage modelling of Coquitlam Dam using SEEP/W. Program also involved collecting thermal measurements and modelling heat flow through the dam to model seepage. Work carried out for BC Hydro.



**Willow Run Creek
Landfill**
Michigan, USA

Assisted in the analysis of geological and hydrogeologic data for a proposed TSCA (hazardous) landfill and reported data to US EPA and MDEQ. Work carried out for Willow Run Creek Potentially Responsible Parties

**Flow Through
Fractured Rock**
Manitoba, Canada

Conducted tracer test studies to evaluate the hydraulic conductivity in fractured igneous rock. Used SURFER™ to plot and monitor flow during tracer tests. Monitored and modelled seepage flows into the underground research laboratory. Work carried out for Atomic Energy of Canada.

PROJECT EXPERIENCE – ENVIRONMENTAL SITE ASSESSMENTS (ESAS)

Phase I/II ESA
Michigan, USA

Conducted Phase I and II ESA for a 60-acre vacant parcel of land and a 20-acre landfill, including the installation of monitoring wells, test pits, and sampling of groundwater, surface water, and sediment as part of a due diligence investigation for a potential development. Work carried out for a land developer.

PVC Trim Factory
Ontario, Canada

Conducted a Phase I ESA and Environmental Compliance Audit for a PVC trim and rubber manufacturing facility prior to closure. Work carried out for General Motors Corporation.

**Superior Propane/ICG
Facility**
Northern BC, Canada

Designed a Phase III ESA investigation program for the detailed characterisation of a contaminated fuel storage facility and to gather information for the preliminary remedial design and cost estimate. Work carried out for Superior Propane/ICG Propane.

Phase I and II ESAs
Various

Conducted numerous Phase I and II ESAs for potential property developments, dry cleaning operations, petroleum fuel stations, and former manufacturing facilities.

PROFESSIONAL AFFILIATIONS

Registered Professional Engineer, British Columbia, Yukon, Nunavut and Northwest Territories, Alberta

Registered Geologist and Engineering Geologist, Department of Licensing, State of Washington Geologist and Engineering Geologist

Member, Canadian Geotechnical Society

Member, Canadian Institute of Mining, Metallurgy and Petroleum

Member of Canadian Dam Association

PUBLICATIONS

Julien, M., Esford, F. and Janssens, G. 2014. "Design and monitoring considerations for heap pad facilities constructed in environments with steep topography and complex hydrogeological regime." Proceedings of Geo Regina, September 28 to October 1, 2014. Regina, Canada.



Esford, F. and Janssens, G. 2014. "Laboratory Test Results on a Bituminous Liner." Proceedings of Geosynthetics Mining Solutions, September 8 - 11, 2014. Vancouver, Canada.

Esford, F. and Julien, M. 2013. "Part 3: Performance monitoring of dikes - dewatering and operation Meadowbank Gold Mine, Nunavut" Proceedings of CDA 2013 Annual Conference, October 5 - 10, 2013. Montreal, Canada.

Esford, F. Bonin, G. and Julien, M. 2013. "Part 1: Construction of the dewatering dikes Meadowbank Gold Mine, Nunavut" Proceedings of CDA 2013 Annual Conference, October 5 - 10, 2013. Montreal, Canada.

Esford, F., Bedell, P., and Lamontagne, E. 2010. "Case study - tailings dam construction in an arctic climate." Proceedings of the First International Seminar on the Reduction of Risk in the Management of Tailings and Mine Waste, September 29 - October 1, 2010, Perth, Australia.

Esford, F., Porter, M., Savigny, K.W., Muhlbauer, K.W., and Dunlop, C. 2004. "A Risk Assessment Model for Pipelines Exposed to Geohazards." Proceedings of International Pipeline Conference, October 4 - 8, 2004, Calgary, Canada.

Porter, M., Logue, C., Savigny, K.W., Esford, F., and Bruce, I. 2004. "Estimating the Influence of Natural Hazards on Pipeline Risk and System Reliability." Proceedings of International Pipeline Conference, October 4 - 8, 2004, Calgary, Canada.

Porter, M., Esford, F., and Savigny, K.W. 2004. "Andean pipelines – a challenge for natural hazard and risk managers." Proceedings of the International Conference on Terrain and Geohazard Challenges Facing Onshore Oil and Gas Pipelines, June 2 - 4, 2004, London, U.K.

Savigny, K.W., Porter, M., Esford, F., Dunlop, C., and Reed, M.T. 2004. "Management of Geohazards in the Interest of Owners and Operators of Onshore Pipelines." Proceedings of the International Conference on Terrain and Geohazard Challenges Facing Onshore Oil and Gas Pipelines, June 2 - 4, 2004, London, U.K.



Education

*Ph.D. (p/t, suspended),
James Cook University,
Townsville, Queensland,
Australia*

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

Languages

English – Fluent

Golder Associates Ltd.

Principal, Senior Water Quality Specialist

John is an Associate, and senior water quality specialist in the Calgary office. He has over 20 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 almost 8 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. Pertinent work John undertook while at the Centre included an assessment of effects of mining and refinery operations to freshwater and inshore marine environments, an 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, and technical director for projects involving water quality baseline and assessment studies and environmental impact assessments. These projects have focused on mining and municipal industries. John's work has predominantly been associated with baseline and environmental assessments in north-western Canada; these include the environmental assessment and permitting process for the De Beers Gahcho Kué Diamond Mine Project, the De Beers Snap Lake Diamond Mine Aquatic Effects Monitoring Program, the environmental assessment for the Fortune NICO Project and the Dominion Diamond Jay Project, and an investigation of Tailings Lake at the former Colomac Mine site for DIAND. John has also provided senior technical support to projects associated with the annual environmental monitoring program for the City of Edmonton, and to environmental impact assessments for uranium mining projects in Saskatchewan and Ontario.

Throughout his career, John has authored or co-authored a number of journal articles and conference publications. He has prepared numerous technical reports and been involved in a number of workshops that have focused on water quality investigations, water and sediment sampling, and analytical techniques.

Employment History

Golder Associates Ltd. – Calgary, Alberta

Senior Water Quality Scientist (2007 to Present)

Responsible for the design, implementation, management, and interpretation of water quality investigations, including environmental baseline studies and components of environmental impact assessments (EIAs); project coordination and management; report preparation; and senior review of aquatic assessment reports.



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

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

Responsible for the 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 Zoology James Cook University – Townsville,
Queensland***

Research Assistant - Hydrobiologist/Chemist (1987 to 1988)

Developed a research program for a limnological assessment of a newly formed, highly turbid reservoir. Conducted monthly surveys of water quality and lower trophic community monitoring, carried out associated laboratory work, and reported results.

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

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

Aided in a program utilizing gel electrophoresis to map effects to amino acid distribution in C4 plants as a result of sodium deficiency. 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 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 – VARIOUS

Dominion Diamond Jay Project

Northwest Territories,
Canada

Water quality senior review and technical support to the water quality and water quality modelling component leads through the completion of the Developer's Assessment Report (2014) and Information Requests (2015), as well as strategic advice.

**Elizabeth Falls Project
- EA SaskPower**

Saskatoon,
Saskatchewan, Canada

A team member providing senior review and technical support to the water quality component lead of the EIS (2013).

**River Morphology and
Physical
Oceanography**

**Baseline Study, Farim
Phosphate Project GB
Minerals Ltd.**
Guinea-Bissau

A team member providing senior review and technical support to the water quality component (2013).

**Gahcho Kué Project De
Beers Environmental
Impact Statement (EIS)**

Gahcho Kué, Northwest
Territories, Canada

The Aquatics Coordinator for the initial EIS phase of the Project (2007 to 2009) responsible for the organization, management and preparation of the aquatic components of the EIS. Part of the responsibility included managing an external consultant was retained by De Beers for completion of several of the aquatic component sections for the EIS. This EIS project was put on hold by De Beers in 2009.

The project was reinitiated in 2010. My responsibility through to 2012 under the renewed project was as Technical Director leading the Golder technical team through a rewrite of the EIS and through the EIR process with MVEIRB, including the MVEIRB technical sessions and regulatory hearing for the project.

The director role has now extended into 2015 leading the Golder technical team through the project permitting process assisting De Beers in the Water Licence, Land Use Permit, and Fisheries Authorization approval process with the MVLWB and DFO and through the development of the Aquatic Effects Monitoring Program.

**Snap Lake AEMP -
Regulatory Support**

Snap Lake, Northwest
Territories, Canada

A team member providing senior review and technical support to the water quality component lead of the AEMP (since 2008).

**North Saskatchewan
River Monitoring
Program, City of
Edmonton**

Edmonton, Alberta,
Canada

A team member (since 2007) providing senior review and technical support to the project team responsible for various projects completed for the City including the environmental monitoring program (EMP), which reports the results of municipal loading to the North Saskatchewan River on an annual basis.

The role has developed from undertaking the reporting for the EMP, to the senior technical role for water quality-related issues for the EMP, and additional City projects such as the Intensive Intake Monitoring Program, and the Kennedale and Pylypow Wetland Monitoring Program.



Curriculum Vitae

JOHN W. FAITHFUL

Giant Mine MMR Annual Reporting Program, Giant Mine Yellowknife, Northwest Territories, Canada	A team member providing senior review and technical support to the water quality component lead (since 2010).
Wabamun Regional Biomonitoring Program, Stantec Alberta, Canada	A team member providing senior review and technical support to the water quality component lead (since 2009).
Baseline/EA Fortune NICO Project Northwest Territories, Canada	Water quality component lead (2009 to 2014) involved in the completion and reporting of water quality baseline data and water quality assessment for the EIS. Participated in the MVEIRB technical sessions and regulatory hearings, and the MVLWB permitting technical sessions and regulatory hearings for the project.
Contaminants Sampling Program BP Project Beaufort Sea, Nunavut, Canada	A team member providing senior review and technical support to the field and data analysis component leads of the contaminants program (2011 and 2012).
Gap Analysis/Baseline Program, Groundbirch Project, Shell Canada Ltd. British Columbia, Canada	A team member providing senior review and technical support to the water quality component for the gap analysis and baseline program (2010 and 2011).
Water Quality Baseline Study – Exploration Ramp Project, STRATECO Matoush, Ontario, Canada	A team member providing senior review and technical support to the water quality component lead for the project (2009 and 2010).
Tailings Lake Investigation – Colomac Minem, DIAND-CARD Yellowknife, Northwest Territories, Canada	A team member providing senior review and technical support to the water quality component lead for the project (2009 and 2010).
McArthur River Ore Haulage Project Description, AREVA Resources Saskatoon, Saskatchewan, Canada	A team member providing technical support to the environmental assessment process in the development of project descriptions and EIAs for uranium mining developments in northern Saskatchewan in 2009.



Curriculum Vitae

JOHN W. FAITHFUL

**Baseline Program
UTS/Teck Cominco
Equinox Project**

Oil Sands, Alberta,
Canada

Water quality component lead (2008 to 2011) involved in the organization, management and preparation of the baseline for the proposed Equinox Oil Sands development. Also responsible for providing support and coordination for the Pilot Plant testing program that will service the UTS/Teck Equinox and Frontier Oil Sands developments.

**Annual Aquatic
Studies Program
Newmont/Miramar
Hope Bay Project**

Hope Bay, Nunavut,
Canada

A team member providing senior review and technical support to the water quality component of the annual aquatic studies programs from 2006 to 2008.

**Millennium Mine
Project Proposal
Cameco Corporation**

Saskatoon,
Saskatchewan, Canada

A team member responsible for providing technical support for the environmental assessment process in the development of the project proposal for the Millennium Mine development in northern Saskatchewan (2009 and 2010).



SUPPLEMENTAL SKILLS

Research Experience

Areas of specific research interest include the limnology of tropical lakes and reservoirs, water quality processes, the assessment of trophic status of tropical freshwater systems, low-level nutrient analyses.

Specific projects include:

Assessment of water and sediment quality in tropical catchments on the eastern coast of north Queensland, as well as ephemeral water courses in north-western Queensland.

Assessment of water quality of runoff from plot and sub-catchment scale watersheds during wet season rain events and effects to receiving waters.

Assessment of water quality during event flow conditions of coastal rivers and inshore environment using a variety of sampling strategies, including catchment-based community volunteer sampling.

Limnological assessment of tropical reservoirs and lakes.

Development of automated low-level nutrient analyses to improve the sensitivity of current analytical methods for fresh, marine and estuarine waters (e.g. nitrate, nitrite, ammonia, filterable reactive phosphorus, silica, total nitrogen and phosphorus).

A review of constructed wetland systems to determine more efficient removal processes of phosphorus from wastewater.

Consulting Experience

Experience as a water quality scientist in tropical north-eastern Australia and western/north-western Canada with proven expertise in the sampling and analyses of marine and freshwaters for a variety of water and sediment quality indicators, interpretation and assessment.

General examples of projects include:

Seasonal limnological assessment of watersheds within, and adjacent to, metalliferous mining and refinery operations to meet environmental regulatory requirements.

Assessment of ship loading effects to bed sediment in a harbour environment to determine extent of spillage/discharge effects.

Assessment of sugar mill effluent ponds and design of mitigation features to reduce odour problems.

Assessment of aquatic ecosystem health elements of various environmental impact studies (e.g. coastal developments, water supply infrastructure), including water quality, sediment quality and lower trophic community quality components.

Review of environmental factors for state development projects, including highway upgrades.

Assessment of the effects of fertilizer treatments to runoff quality from sugar cane farms.



PROFESSIONAL AFFILIATIONS

Australian Society of Limnology
Australian Water Association
Canadian Society of Limnology
Society of International Limnology
International Water Association

PUBLICATIONS

Conference Proceedings

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 5th 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*. 13th 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*. 16th 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*. Tenth 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*. 2nd National Conference on Aquatic Environments: Sustaining our aquatic environments – Implementing Solutions. Queensland Department of Natural Resources and Mines. Brisbane, Australia.

Journal Articles

J.W., Faithful and Griffiths D.J. (in preparation) The influence of season on the variability of suspended solids concentrations within a highly turbid tropical reservoir.

J.E., Brodie, Schroeder T., Rohde T., Faithful J.W., Masters B., Dekker A., Brando V. and Maughan M. 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 (2010), 651-664.

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

Z.T., Bainbridge, Brodie J.E. , Faithful J.W., Sydes D.A. and Lewis S.E. 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 (2009), 1081-1090.

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

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

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

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



D.J., Griffiths and Faithful J.W. Effects of the sediment load of a tropical north-Australian river on water column characteristics in the receiving impoundment. *Arch. Hydrobiol, Suppl.* 113 Large Rivers 10(1-4) (1996), 147-157.

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

Other

Faithful, J.W. (2000) A Summary of the Water Quality Monitoring Program of the Willows Gardens Ornamental Ponds, Townsville. ACTFR Report No. 00/06 for the Delfin Property Group, Townsville.

Faithful, J.W. and B.M. Butler (2000) Evaluation of Stormwater Quality on the Mount Stuart Training Area – 1999/2000 Wet Season. ACTFR Report 00/10 for the Department of Defence, Townsville.

Lukacs, G.L. and J.W. Faithful (2000) Bruce Highway Upgrade – Ayr – Townsville Development Application for Fill Extraction: Ecological Issues. ACTFR Report 00/11 for John Holland Pty. Ltd., Townsville.

Faithful J.W. and Butler B. (2000) A Brief Assessment of the Significance of a Small Inlet in Black Weir, Ross River, within the Riverside Gardens Development, Townsville. ACTFR Report 00/14 for Delfin, Townsville.

Faithful, J.W. and B.M. Butler (2001) Halifax Bay Water and Sediment Quality Study – September 2000. ACTFR Report 01/01 for Central Queensland University.

Faithful, J.W. (2001) Invicta Mill Settlement Ponds - An Assessment of Odour Production Problems and Options for Remediation. ACTFR Report No. 01/02 for CSR Invicta Mill

Dixon, D., Winkel, P. and J.W. Faithful (2001) Flora and Fauna Survey of the Rockhampton City Council's Lakes Creek Road Landfill Site. Wet Season Survey. ACTFR Report No. 01/05 for Maunsell McIntyre Pty. Ltd., Rockhampton.

Loong, D., Faithful, J.W. and J. Brodie (2001) An Assessment of Potential Water Quality Impacts by Motorised Watercraft in Ross River Dam - A Literature Review. ACTFR Report No. 01/09 for NQ Water, Townsville.

Faithful, J.W. and B.M. Butler (2001) Halifax Bay Water and Sediment Quality Study – September 2001. ACTFR Report 01/10 for Central Queensland University.

Burrows, D.B. and J.W. Faithful (2002) Townsville Field Training Area (TFTA) Ecological Monitoring – 2001 Pre-Wet Season Aquatic Ecology and Surface Water Quality and 2002 Post-Wet Season Sediment Quality. ACTFR Report No. 02/05 for the Department of Defence, Townsville.



Faithful, J.W., Loong, D. and C. Perna (2002) Ross River Aquatic Weeds Study – A Preliminary Assessment of the Impacts of Aquatic Weeds Harvesting on the Physico-Chemical and Chemical Water Quality of Ross River. ACTFR Report No. 02/09 for Maunsell Australia (Townsville) Pty. Ltd.

Faithful, J.W. (2002) Water Quality in the Townsville/Burdekin Dry Tropics Region. ACTFR Report No. 02/12 to Conservation Volunteers Australia, National Heritage Trust Project No. 2002153.

Faithful, J.W. (2002) Water Quality in the Whitsunday Rivers Catchments. ACTFR Report No. 02/13 to the Whitsunday Rivers Integrated Catchment Association, Proserpine, Queensland. A Coast and Clean Seas Project (1999 – 2002).

Loong, D. and J.W. Faithful (2003) An Assessment of Lead in the Sediment of Lake Paluma Following a Dam Works Incident. ACTFR Report No. 03/01 for NQ Water Pty. Ltd.

Faithful, J.W., Loong, D. and D. Burrows (2003) Mount Gordon Mine Dry Season Limnological Survey – December 2002. ACTFR Report No. 03/07 for Western Metals Mount Gordon Operation.

Faithful, J.W. (2003) Halifax Bay Water and Sediment Quality Study – November 2002. ACTFR Report 03/09 for Central Queensland University

Faithful, J.W. (2003) A Limnological Assessment of Kingfisher Lagoon - A Small Embayment in Black Weir, Ross River, Townsville. ACTFR Report No. 03/10 for Delfin Townsville Pty. Ltd.

Burrows, D.B. and J.W. Faithful (2003) Townsville Field Training Area (TFTA) Ecological Monitoring – Monitoring of Aquatic Ecology, Water and Sediment Quality on the Townsville Field Training Area, November 2002 to June 2003. ACTFR Report No. 03/12 for the Department of Defence, Townsville.

Loong, D. and J.W. Faithful (2003) Impacts of Motorised Watercraft on Ross Dam – Intensive Activity Survey. ACTFR Report No. 03/14 for NQ Water Pty. Ltd.

Faithful, J.W. (2003) A Follow-Up Limnological Assessment of Kingfisher Lagoon - A Small Embayment in Black Weir, Ross River, Townsville. ACTFR Report No. 03/17 for Delfin Townsville Pty. Ltd.

Faithful, J.W. and W. Finlayson (2003) Water Quality Assessment for Sustainable Agriculture - Tully-Murray Rivers Catchment Area and Granite Creek on the Atherton Tablelands. ACTFR Report No 03/18 for the Natural Resource Management Board (Wet Tropics) Inc., Innisfail, Project No. 2012015.

Loong, D. and J.W. Faithful (2003) Microbiological Status of Paluma Township Weirs. ACTFR Report No. 03/21 for Thuringowa City Council.



Faithful, J.W. (2004) Halifax Bay Water and Sediment Quality Study – Pre-Wet Season 2003 and Post-Wet Season April 2004. A Component of a Multi-Disciplinary Southern Halifax Bay Ecological Assessment as part of the Environmental Assessment and Management Program for Queensland Nickel Pty. Ltd. ACTFR Report 04/03 for Central Queensland University.

Brodie, J., Faithful, J.W. and K. Cullen (2004) Community Water Quality Monitoring in the Burdekin River Catchment and Estuary, 2003 – 2004. ACTFR Report No. 03/16 for The Queensland Department of Primary Industries and Fisheries and the Burdekin Dry Tropics.

Post, D.A., Loong, D., Burrows, D., and J.W. Faithful (2004) Ecological Monitoring of the Townsville Field Training Area (TFTA) 2003/04. CSIRO Land and Water and ACTFR Report No. 590 for the Department of Defence.

Faithful, J.W., Loong, D., Davis, A. and D.B. Burrows (2004) Mount Gordon Mine Dry Season Limnological Survey, June/July 2004. ACTFR Report No. 04/12 for Aditya Birla Copper, Mount Gordon Operations.

Brodie, J., Bainbridge, and J.W. Faithful (2005) Community Monitoring of Suspended Solids and Nutrients in the Sub-Catchments of the Burdekin Region from the January Flood Event, 2005. ACTFR Report No. 05/01 for the Department of Natural Resources, Mines and Energy, Queensland.

Faithful, J., Brodie, J., Armstrong, C., Bubb, K., and P. Frayne (2005) Nutrient Concentrations in the 2003-04 Wet Season Run-Off Draining a Pine Plantation in the Wet Tropics. ACTFR Report No. 05/02 for Queensland Department of Primary Industries - Forestry.

Faithful, J.W. (2005) Halifax Bay Water and Sediment Quality Study – Pre-Wet (October/November 2004) and Post-Wet Season (April 2005). ACTFR Report No. 05/04 for the Centre for Environment Management, Central Queensland University.

Loong, D., Butler, B., Burrows, D., Faithful, J.W. and A. Davis (2005) Limnological Assessment and Benchmarking of Key Sentinel Wetlands in the Burdekin Catchment. ACTFR Report No. 05/09 for Burdekin Dry Tropics, Ayr, Queensland.

Faithful, J.W., Davis, A. and D. Loong (2005) Page Creek Post-Wet Season Limnological Survey, March 2005. ACTFR Report No. 05/10 for Zinifex Century Ltd.

Faithful, J.W., Davis, A. and D. Loong (2005) Mount Gordon Mine Dry Season Limnological Survey, June/July 2005. ACTFR Report No. 05/11 for Aditya Birla Copper, Mount Gordon Operations.

Post, D.A., Loong, D., Burrows, D. and J.W. Faithful (2005) Ecological Monitoring of the Townsville Field Training Area (TFTA) 2003/04: Monitoring of Water Quality, Aquatic Invertebrates and Riparian Vegetation on the Townsville Field



Training Area November 2004-July 2005. CSIRO Land and Water and ACTFR Client Report for the Department of Defence.

Rohde, K., Masters, B., Brodie, J., Faithful, J.W., Noble, R. and Carroll, C. (2006) Fresh and Marine Water Quality in the Mackay Whitsunday Region 2004/2005. Mackay Whitsunday Natural Resource Management Group, Mackay, Australia.

Brodie, J. Bainbridge, Z. Lewis, S.E. Post, D. Duncan, I. Faithful, J.W. and Furnas, M. (2006) Community Monitoring of Suspended Sediments and Nutrients in the Sub-Catchments of the Burdekin Region from the January Flood Event, 2005. ACTFR Report No. 06/01.

Faithful, J.W. (2006) Review of Groundwater Monitoring Data, Sun Metals Zinc Refinery – 2005. ACTFR Report No. 06/03 for Sun Metals Corporation, Townsville.

Faithful, J.W. (2006) Halifax Bay Water and Sediment Quality Study – Pre-Wet (December 2005) and Post-Wet Season (February/March and April 2006). ACTFR Report No. 06/04 for the Centre for Environment Management, Central Queensland University.

Faithful, J.W. and T. McShane (2006) Fate of Nutrients in BioDunder and Liquid One-Shot Hi-N – Preliminary Field Trial, November 2005 to January 2006. ACTFR Report No. 06/12. A combined ACTFR/BBIFMAC/MAFIA Project for CSR Ethanol.

Bainbridge, Z., Lewis, S., Brodie, J., Faithful, J.W. and M. Maughan (2006) Monitoring of Sediments and Nutrients in the Burdekin Dry Tropics Region: 2005/06 Wet Season. ACTFR Report No. 06/13 for the Burdekin Dry Tropics NRM. Australian Centre for Tropical Freshwater Research, James Cook University, Townsville.

Faithful, J.W., Brodie, J., Hooper, A., Leahy, P., Henry, G., Finlayson, W. and D. Green (2006) Plot-Scale Runoff of Nutrients and Sediment Under Varying Management Regimes on a Banana and Cane Farm in the Wet Tropics, Queensland, November 2002 to July 2006. An ACTFR Project for Task 1, Catchment to Reef Project. ACTFR Report No. 05/03.

Faithful, J.W., Davis, A. and D. Loong (2006) Page Creek Post-Wet Season Limnological Survey, May 2006. ACTFR Report No. 06/16 for Zinifex Century Ltd.

Faithful, J.W., Davis, A. and D. Loong (2006) Mount Gordon Mine Dry Season Limnological Survey, July 2006. ACTFR Report No. 06/17 for Aditya Birla Copper, Mount Gordon Operations.

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Golder Associates Ltd. – Calgary

Career Summary

Linda Havers possesses over 20 years of experience that combines community development and social program planning, social impact analysis, gender-based social analysis and public and stakeholder consultation. She has taken the lead role in developing social baselines and conducting social impact assessments of projects in the nuclear energy sector and in mining, oil sands development and linear developments in contexts as diverse as Tanzania, Vietnam, rural Washington, Canada's north and in the provinces of Alberta, Ontario and Saskatchewan. Ms Havers has worked within many regulatory frameworks including those of Canada's as well as NEPA in the U.S.A. and the IFC World Bank.

Education

Ph.D. Program: Resources and the Environment, completed graduate level course work and research on mining in northern Vietnam, University of Calgary, 2004-2006

M.A. Anthropology, University of Calgary, 1990

B.A. Anthropology, University of Calgary, 1984

Languages

English – Fluent

Ms Havers has represented social aspects of a proposed diamond mine in the NWT at technical meetings and regulatory hearings and has recently expanded her scope of interest in polar regions to lead the social baseline data collection and reporting for an offshore exploration project in Greenland. She has recently completed various social components of a proposed uranium mine and a proposed gold mine in Kivalliq Region, Nunavut. Work here involves broad based community consultation and in depth examination of defining characteristics of community well being such as family functionality, social and cultural values and belief systems. Effects on Inuit culture is a key issue for examination. Ms Havers is currently the technical advisor on a proposed mining project in Guinea, West Africa. This project involves Human Rights Risk Assessment and planning for in-migration and other potential social effects of the project including resettlement.

Prior to her work in the mining and oil and gas sectors, Ms Havers worked in the area of program evaluation for the Government of Canada, developed community-based programs to address the needs of low income families in Calgary, and also taught various anthropology courses including Research Methods and Applied Anthropology. Ms Havers is an advocate for Participatory Community Assessment and is skilled at various kinds of social planning research such as community needs assessment, and Appreciative Inquiry.

Employment History

Golder Associates – Calgary, Alberta

Senior Social Scientist (2005 to Present)

Responsible for undertaking social baseline studies and social impact assessments, community development planning, and consultation programs in both domestic and international contexts. Conversant with regulatory systems in Canada and the U.S.A., as well as the International Finance Corporation (IFC) World Bank. Working in sectors such as mining, oil and gas, and energy. Provides mentorship to other social science group members.

***Tiberon Minerals – Thai Nguyen Province, Vietnam****Social Specialist (contract) (2002 to 2005)*

Collected and analyzed baseline data on women's roles, incomes, and work for socioeconomic impact assessment of a mining interest in Thai Nguyen Province, Vietnam. Contributed paper: Women and Sustainable Livelihoods in Rural Vietnam, to World bank resettlement coordinators and presented at 2004 American Council of Learned Societies Conference; developed monitoring plan with gender equality indicators; reviewed business development plans targeted to women in the project affected area; developed gender analysis questionnaire; and conducted focus group discussions.

Mount Royal College – Calgary, Alberta*Experiential Learning Specialist (1996 to 2000)*

Developed curriculum and opportunities for experiential learning, such as on-the-job training, internships, and mentor programs. Designed and conducted college-wide needs assessment focusing on students needs for various career services, educational support services, and customized job training. Responsible for accessing and interpreting labour market information and writing briefing papers on labour market and human resources topics for distribution to various stakeholders, including students, teaching faculty, and professional associations.

Government of Canada Human Resources Development (HRDC) – Calgary, Alberta*Program Consultant (1991 to 1996)*

Developed and operationalized community consultation framework with stakeholders, such as government departments, social development agencies, women's groups, education and training organizations, and local businesses. Co-authored 1996 "Strategic Plan for Calgary HRDC" after scoping, environmental scanning, stakeholder consultation, and desk review of government priorities. Developed pre-employment and employment interventions with embedded systems of monitoring and evaluation. Oversaw comprehensive evaluations of HRDC-funded job training programs and job search clubs, including those targeted specifically to people with disabilities, women returning to work, and First Nations individuals (budget for evaluations was \$1.5 million annually).

Greater Forest Lawn Initiative Council – Calgary, Alberta*Executive Director (1989 to 1991)*

Managed a community development organization aimed to further the integration in five ethnically diverse neighbourhoods. (The Council was funded by all three levels of government.) Developed grass-roots initiatives aimed at addressing issues related to poverty, settlement concerns of new immigrants, and issues of concern to youth and female-headed households.

Cambyr Counselling Agencies – Calgary, Alberta*Counsellor (1992 to 1994)*

Designed and managed a counselling and mentoring program for 20 Southeast Asian youths experiencing dislocation problems. Organized and delivered



Curriculum Vitae

LINDA HAVERS

workshops on life management topics and organized job shadowing and mentoring. Contributed to journals and newsletters on the challenges faced by immigrant youth in Canada.



PROJECT EXPERIENCE – SOCIO-ECONOMIC IMPACT ASSESSMENT

**Dominion Diamonds
Ekati**
Northwest Territories,
Canada

Managed the development of a socio-economic report detailing the existing regulatory climate in the Northwest Territories, including impact benefit agreement establishment and the development of socio-economic agreements between proponents and regulators. Reviewer and advisor of a social baseline, impact assessment and participant in technical hearings.

**Socio-cultural Study,
Maersk Oil Kalaallit
Nunaat, Baffin Bay**
Baffin Bay, Greenland

Project Director and Senior Technical Reviewer for a socio-cultural study establishing baseline conditions in Greenland for Maersk oil Kalaallit Nunaat on behalf of Cairn Energy PLC, ConocoPhillips, Shell Greenland and Maersk Oil Kalaallit Nunaat (the companies), and will be used to inform Social Impact Assessments that the companies might conduct for future potential exploration activities in Greenland (Baffin Bay) between 2014 and 2017.

**Socio-cultural Studies,
Imperial Oil**
Inuvialuit Settlement
Region, Canada

Component Lead: Socio-Cultural Studies. Responsible for providing on-going permitting support to Imperial Oil's exploration project in the Beaufort Sea, and the direction of the socio-cultural team. Work involves consultation with communities in the Inuvialuit Settlement Region on traditional activities and contributions to a Canada Plan to ensure maximization of benefits to local communities.

**Socio-economic
Impact Assessment,
De Beers, Gahcho Kue
Project**
Northwest Territories,
Canada

Technical reviewer and expert witness for the socio-economic component of an Environmental Impact Assessment at a proposed diamond mine 280 km northeast of Yellowknife, Northwest Territories. Key issues are around project effects on culture, including social disparity in and between communities, effects on community cohesion, and the long-term social and economic effects of the mine in this natural resource based economy. Provided strategic socio-economic support to this client including historical information on impact benefit agreements and socio-economic monitoring agreements. Provided briefing papers for relevant Ministers in NWT.

**Social Review of
Socio-economic
Impact Assessment of
Hydroelectric
Expansion**
Northwest Territories,
Canada

Performed a third party technical review of socio-economic impact assessment of hydroelectric expansion (690 km transmission line) on the Talston River, Northwest Territories. Communities potentially affected are South Slave Metis and Akaitcho and aboriginal groups in the South Slave Region. Review included Terms of Reference conformance checks and critical review of Livelihoods Framework as conceptual tool for analyzing effects.

Agnico Eagle Mines
Nunavut, Canada

Responsible for social baseline programme and reporting and writing a socio-economic impact assessment and social management plan for a proposed gold mine near Rankin Inlet, Nunavut. The ESIA was submitted to the Nunavut Impact Review Board. Key discussion is on the pace of development and cumulative effects of mining projects on crime rates, housing and crowding and training of an Inuit workforce. Other issues of particular importance are enhancing employment opportunities and managing the potential effects on Inuit culture and economies.



**Socio-economic
Impact Assessment,
Uranium Mine**
Nunavut, Canada

Responsible for preparation of social components of environmental impact assessment, to be submitted to the Government of Nunavut, for a uranium mine and access road. Work included the development of social baseline study of seven communities, impact evaluation and social mitigation and monitoring for project affected people. Responsible for supporting the EIA application and preparation for regulatory hearing. Issues of particular importance are enhancing employment opportunities and managing the potential effects on Inuit culture and economies.

**Socio-economic
Impact Assessment,
Euromax Gold,**
Macedonia

Lead social baseline data collection, public consultation and impact assessment for a gold mining project in SE Region, Macedonia. Key issues are project effects on irrigated farming, agro- business, business survey and maximization of local benefits and training.

**Guyana Goldfields
Aurora Project**
Guyana

Due diligence audit for financial company seeking information on whether the ESIA conforms with revised 2012 IFC Performance Standards. Work involves a site visit and interviews with HSEC department heads and reviewing documents such as grievance procedures, employment and training plan, social management plans and approach to artisanal gold miners.

**Social Review of
Socio-Economic
Impact Assessment,
Gold Mine**
Greenland

Performed a third party technical review of socio-economic impact assessment for proposed mine development based on the Bureau of Minerals and Petroleum's Guidelines for Social Impact Assessment for Mining Projects in Greenland (2009). Review included Terms of Reference conformance checks and critical review of SIA content and methods, management strategies and public consultation processes.

**Socio-Economic
Impact Assessment
and Baseline, Coal
Mine**
Olympia, Washington,
U.S.A.

Researched and wrote an extensive social baseline report with regard to communities and counties affected by the potential closure of a large surface coal mine in the United States of America. The baseline was developed to National Environmental Policy Act (NEPA) specifications and included extensive interviewing of stakeholders and analysis of the mines impact on local economies. Responsible for overseeing an economic impact assessment of current operations and advising on consultation approaches.

**Torex Morelos Gold
Mine**
Mexico

Senior advisor social impact assessment and resettlement. Role on this project involves advising resettlement planners using IFC guidance notes and the IFC Resettlement Handbook; preparation of a Resettlement Action Plan, including a baseline report on the socio-economic situation of farmers that will require resettlement due to the Project's land acquisition; provide advice and oversight of consultation with affected families.

**Socio-economic
Strategic Advice,
Nickel Project**
Dominican Republic

Responsible for providing recommendations to nickel mine on socio-economic issues, opportunities and risks associated with decisions to move forward with resettlement and completion on social baseline studies and impact assessment. Work includes supervision and quality control of the work of Golder staff and sub consultants.



**Commonwealth of
Dominica**
Dominica

Oversaw the development of a high level social impact assessment related to options to improve surface water supply by providing an improved river intake structure on this Caribbean island that experiences frequent storms and flooding. The social component involves participating in the determination of locations based on resettlement and compensation needs and the potential for benefit by local communities. The project is funded by the Caribbean Development Bank.

**Socio-Economic
Technical Advisor, Iron
Ore Project**
Republic of Guinea

Responsible for providing recommendations and technical advice of socio-economic issues, opportunities and risks associated with the development of an iron ore mine in Southeastern Guinea. Work includes advising on social baseline studies and impact assessment, resettlement planning, public consultation, supervision and quality control of the work of Golder staff and sub consultants.

**Social Baseline
Reporting, Copper
Mine**
Democratic Republic of
Congo

Reviewed social baseline data collected by sub consultants and prepared a social baseline summary report. The baseline data and social indicators were then used as a basis for evaluating socio-economic impacts of the proposed mine on several nearby villages. This assignment also involved preparing a traffic assessment and reviewing resettlement action plans and the final impact assessment.

**Socio-economic
Impact Assessment
and Consultation
Planning and
Implementation, Nickel
Mine**
Tanzania

Responsible for preparation of social components of an environmental impact assessment of a proposed nickel mine in Tanzania consistent with international (IFC) standards, including supervision and quality control of sub consultants locally contracted. Work included planning and carrying out consultations, development of baseline studies, impact evaluation and social management planning. A resettlement plan was updated by the social team. Review of community needs assessments and recommending community development strategies were a key facet of this project. Work was undertaken from 2007 to 2012.

**Socio-Economic
Impact Assessment
and Stakeholder
Consultation, Nickel
Mine**
Madagascar

Summarized social baseline data collected in Madagascar by local sub consultants in areas surrounding a mining development. Reviewed public and stakeholder comments and issues and wrote report on results of consultations including identifying and detailing mitigation of effects. Project specifics included summarizing issues and consultation activities, issues matrices, and analysis. Final report on the Public Involvement Program for this project was reviewed by the International Finance Corporation (IFC) of the World Bank Group.

**Socio-Economic
Impact Assessment,
Tungsten Mine**
Hanoi, Vietnam

Developed Economic Gender Equalities Indicator Survey for mine development in Vietnam as per World Bank operational directives. Carried out consultation with men and women to assess how they will be differentially affected by a new mine and resettlement and made recommendations regarding community development and mitigation measures. As part of Ph.D. requirements, developing a research program that specifically addresses impacts of mining on communities and women's livelihoods in particular and on how gender roles and responsibilities are altered.



**Social Baseline-
Development of
Research Tools, Gold
Mine
China**

Developed research approaches and instruments for a mining project in Taipingzhuang, China. Provided ongoing support and supervision to socio-economic researchers that were working on the development of social baseline that would be suitable for assessing project impacts against. Review of consultation approaches and developed strategies for developing responses to community concerns.

**Social Review of
Health Baseline Report
& Impact Assessment
of Hydroelectric
Project
Newfoundland and
Labrador, Canada**

Performed senior review of proposed hydroelectric project and its potential effects on the health and wellness of Innu communities in Labrador. Review included technical quality checks, review of methodology, logic and interpretation.

**Social Baseline SAGD
Project
Christina Lake, Alberta,
Canada**

Developed a social baseline for subsequent evaluation of socio-economic effects for expansion to a Canadian Natural Resources Limited (CNRL) Kirby steam-assisted gravity drainage (SAGD) project in the Christina Lake, Alberta area.

**Socio-Economic
Assessment In-situ Oil
Sands Project
Christina Lake, Alberta,
Canada**

Managed a socio-economic assessment of a 75,000 bitumen barrels per day (bbpd) expansion of an in-situ operation at MEG Energy's Christina Lake, Alberta operation.

**Social Baseline Report
Alberta, Canada**

Researched and wrote a scoping document and baseline document for Shell International on several remote First Nations communities in northern Alberta. This desktop study included a review of recent ethnography and ethno-history of the area, a gap analysis and media analysis in addition to the gathering and analysis of social baseline information.

**Socio-Economic
Impact Assessment,
Nuclear Plant
Alberta, Canada**

Responsible for planning and preparation of the social components of an environmental impact assessment of Alberta's first nuclear facility. In addition to broad based consultation with various publics, including several First Nations communities, work involves public perception surveying, social baseline characterization and planning for growth strategies. The proposed facility is to be sited in northern Alberta, near several small communities with populations not exceeding 3,000. Managing the effects of a large construction workforce and operations staff are of primary importance in this assignment.

**Socio-Economic
Impact Assessment,
Oil Sands Projects
Alberta, Canada**

Responsible for managing the social component of environmental impact assessments for submission to regulatory authorities in Alberta. Work included supervision of subcontracted economists and Golder staff. Provided advice to proponent on opportunities for local benefit enhancement, workforce management strategies and other aspects planning a project with a foreign construction workforce.



**Social Baseline Study,
In-situ Oil Sands
Project**

Alberta, Canada

Developed social baseline for a large in-situ oil sands project in the western Athabasca region of Alberta. Project included a livelihoods approach to analyzing potential effects of project on a number of First Nation communities. Developed plan for community-based social research, training, and coaching of First Nations communities to perform much of the social baseline work and social impact assessment. Preparation of monitoring program and community development initiatives to benefit women, youth and senior members of First Nations communities.

BC Hydro
British Columbia,
Canada

Leading First Nation community assessments, as required by BCEA, for a proposed hydro project in northern BC. Community assessments are developed in collaboration with several First Nations whose right to hunt, trap and access their traditional territory may be affected by the project. Other impacts on First Nation reserve communities involve the presence of a large construction workforce and the potential for impacts on social infrastructure and community wellbeing.

**Socio-Economic
Assessment**
Saskatchewan, Canada

Conducted a socio-economic assessment for a new biofuels plant in Saskatchewan. The process involves participating in community consultations, developing a social baseline of affected communities, and measuring the project's impacts and benefits against it.

**Socio-Economic
Impact Assessment,
Hydroelectric Dam**
Saskatchewan, Canada

Identified issues resulting from consultations and wrote baseline and socio-economic impact assessment reports for the North Saskatchewan River Water Supply Feasibility Study. This study involved identifying locations of inundated structures and estimating costs of relocation of homes and other buildings. Other effects analyzed include those resulting from the presence of a large construction workforce and overall economic effects of the proposed dam.

**Socio-Economic
Impact Assessment,
Gold Mine**
Saskatchewan, Canada

Researched and wrote social baseline report and impact assessment for First Nations communities in northern Saskatchewan that are experiencing the effects of a mine expansion near La Ronge. Key issues involved employment in remote First Nations communities, transportation issues and economic development strategies.

**Socio-Economic
Impact Assessment**
Ontario and Manitoba,
Canada

Responsible for social components of environmental impact assessments of ten wind farm developments in Ontario and Manitoba. Project involved profiling First Nations communities and supporting consultation efforts. Issues involved the high tourism potential in these areas, effects on property values, visual disturbance and potential for noise.

**Social Impact
Assessment**
Deep River, Ontario,
Canada

Conducted research for socio-economic impact assessment of pipeline looping project in NE Ontario. Performed desk study, and scoping; interviewed affected residents and stakeholders, projected impacts and assessed as to significance using NEB 2004 filing requirements as a guide.

**Social Impact
Assessment**
Niagara, Ontario,
Canada

Conducted socio-economic impact assessment regarding two pipeline compressor stations in Ontario, Canada. Worked closely with consultation specialist and client to develop, in addition to community profiles and an impact statement, an issues report and strategies for dealing with community concerns.



**Socio-Economic
Impact Assessment,
Nuclear New Build**
Kincardine, Ontario,
Canada

Responsible for management of social components of an environmental impact assessment of a proposed nuclear new build project on an existing site in Ontario. Developed tools for gathering social data, supervised Golder staff and provided senior technical review of social baseline report and socio-economic impact assessment consistent with standards set by the Canadian Nuclear Safety Commission. Special studies on the project's potential effects on tourism and public attitude research were undertaken as well as an examination of "stigma" and living near a nuclear facility.

**Socio-Economic
Impact Assessment,
Gas Pipelines**
Ontario, Saskatchewan,
Canada

Conducted research for socio-economic impact assessment of pipeline projects in northeast Ontario and near Estevan, Saskatchewan. Performed desk study and scoping initially; interviewed affected residents and stakeholders; projected impacts; and assessed as to significance using National Energy Board (BEP) 2004 filing requirements as a guide.

**Socio-Economic
Impact Assessment,
Natural Gas Plant**
Sarnia, Ontario, Canada

Developed a screening level socio-economic baseline and effects assessment for a natural gas plant unit addition near Sarnia, Ontario. Assignment included stakeholder analysis and characterization of issues, estimation of economic benefits and visual effects.

PROJECT EXPERIENCE – STAKEHOLDER CONSULTATION

**Public Consultation
Reporting**
Panama

Wrote a report consolidating all consultation results during the EIA process regarding a large copper mine in Panama. Developed an ongoing stakeholder engagement program for future phases of project development.

**Consultation Planning
and Implementation,
Nickel Mine**
Tanzania

Responsible for design of consultation program, development of materials and carrying out consultations with fifteen villages that are potentially affected by a proposed nickel mine. Work involved training and supervising local sub consultants and interpreters. Clarifying issues, proposing mitigations were a key part of this project as well as preparing a report for submission to Tanzanian authorities and the IFC World Bank.

**Stakeholder
Consultation
Reporting, Nickel Mine**
Madagascar

Provided ongoing recording and management of issues regarding the consultation program for a large nickel mine in Madagascar. Project specifics included summarizing issues and consultation activities, issues matrices, and analysis. Final report on the Public Involvement Program for this project was reviewed by the International Finance Corporation (IFC) of the World Bank Group.

**Consultation Planning
and Implementation,
Nuclear Plant**
Peace County, Alberta,
Canada

Ongoing planning of consultations for a proposed nuclear facility in northern Alberta. This work has included participation in scoping and siting studies, developing consultation approaches and overall management of consultation program.



Curriculum Vitae

LINDA HAVERS

**Public Consultation
Program Coordination,
Wind Energy**
Calgary, Alberta,
Canada

Developed a comprehensive public consultation program regarding a wind energy project in southern Alberta. Deliverables included materials development, organization of open houses, strategy, and media relations. All activities and issues were documented for report and application to provincial and national regulatory bodies

**Stakeholder
Consultation, Pipeline**
Calgary, Alberta,
Canada

Member of a team bringing planning expertise to a major Canadian pipeline company in order to better manage stakeholder relations and carry out broad stakeholder consultations in Alberta and British Columbia. Provided input into the facilitation process with landowners, municipalities, aboriginal groups, and environmental non-governmental organizations (NGOs). Planned consultation events, such as workshops and open house events.

**Community
Consultation, Power
Plant**
Keephills, Alberta,
Canada

Providing audit services of consultation program related to a power plant expansion in northwest Alberta. Tasks include reviewing documentation for compliance with the Energy and Utility Board and preparing the final submission to regulators.

Consultation Support
Suffield, Alberta ,
Canada

Provided planning support and documentation of public consultations program for the Canadian Government's Department of National Defence program at Suffield, Alberta. Work involved identifying Canadian Environmental Assessment Agency (CEAA) requirements, scoping issues with regard to the reclamation program, and developing ways to engage the public.

Consultation Support
Trochu, Alberta, Canada

Provided consultation support to an out-of-province wind power company for its 45 turbine project near Trochu, Alberta. Work included consultation planning and building internal capacity to carry out and lead consultations.

PROFESSIONAL AFFILIATIONS

International Association of Impact Assessment (IAIA)

**Education**

M.Sc. Geology, McMaster University, Hamilton, Ontario, 2002

B.Sc. (Hons) Geology, McMaster University, Hamilton, Ontario, 2000

Languages

English – Fluent

Spanish – Fluent

Golder Associates Ltd. – Burnaby

Mr. Herrell has a M.Sc. in Geology from McMaster University and has over 10 years of experience in academia and geochemical investigations. He currently works as a Senior Geochemist with the Mine Water Management Group of Golder Associates Ltd. in Burnaby, B.C and is responsible for conducting geochemical site investigations, environmental monitoring programs and 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. Mr. Herrell's computing experience includes geochemical speciation models, contaminant transport models and spreadsheet modeling.

Mr. Herrell is responsible for presenting and defending the results of geochemical and water quality modeling studies to regulators, first nations and other stakeholders. He has performed as an expert witness in panel review hearings for environmental assessments and water license applications.

Mr. Herrell has been a member of multi-disciplinary teams and has been exposed to large projects on local, national and international scales. During his career, he has developed the project management, client management and team organizational skills that are crucial for the success of these projects. Michael is a registered professional geoscientist with the Association of Professional Engineers and Geoscientist of British Columbia.

Employment History***Golder Associates Ltd. – Burnaby, British Columbia***

Geochemist – Mine Water Management Group (2008 to Present)

Golder Associates Ltd. – Mississauga, Ontario

Geochemist – Mine Waste Environmental Group (2004 to 2007)

Responsible for mine waste characterization, acid generation/metal leaching prediction and water quality tasks that included field sample collection, laboratory coordination, data analysis and report preparation.

Worked on geochemical assessment projects in support of studies for various levels of mining: i.e., scoping studies, feasibility studies, baseline studies, environmental impact assessments (during the construction period, operations, closure/post-closure phases), permitting, operational compliance monitoring and closure plans.

Conducted studies, which included probabilistic and deterministic modelling of geochemical interactions of surface water and groundwater hydrology and water treatment related to mining environments.

Conducted field investigations including waste rock geochemical characterization, geotechnical soil/rock core logging, piezometer installation, conductivity testing and sampling in soil, rock, groundwater and surface water.

Prepared proposals, budgets and schedules for large multidisciplinary and smaller-scale projects.

***Gartner Lee Ltd. – Burnaby, British Columbia****Geochemist (2007 to 2008)*

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.

School of Geography & Geology, McMaster University – Hamilton, Ontario*Sessional Lecturer (2003 to 2004)*

Crystallography and Optical Mineralogy – Fall 2003
(Optical properties, structure, chemistry and paragenesis of rock forming minerals).

The Earth and the Environment – Spring 2003 & 2004
(Introductory geology and environmental science course, which included a mandatory field trip).

School of Geography & Geology, McMaster University – Hamilton, Ontario*Instructional Assistant (2002 to 2004)*

Supported the ongoing instructional activities of the School of Geography and Geology.

Assisted with the preparation of course materials and created rock and mineral identification labs.

Demonstrated and instructed laboratory and field techniques.



PROJECT EXPERIENCE – MINING

Dominion Diamond NWT, Canada	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 responsible for presenting and defending the water quality predictions to the MVEIRB and other stakeholders as part of the ongoing permitting process.
Gahcho Kue NWT, Canada	Responsible for the projection of surface site and downstream water quality for a proposed diamond mine to evaluate project impacts to surface water quality as part of the EIA. Michael performed as an expert witness in the environmental assessment and water license application panel review hearings.
Quinsam Coal Campbell River, BC	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.
Minas Conga Cajamarca, Peru	Responsible for prediction of tailings facility water quality to support detailed design of a treatment plant. Michael was 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. Michael's other involvement at Minas Conga includes collection of geochemical rock samples to characterize the expected environmental conditions of non-contact diversion channels in the feasibility stage of the project.
Xstrata Copper Arequipa, Peru	Responsible for the prediction of surface water quality impacts to downstream receptors from a proposed copper mine in Southern Peru. Project work involved development of detailed pit lake and downstream receiving water quality models, interpretation and reporting of modelled results.
PERCAN Lima, Peru	Responsible for managing the environmental activities for the Peru-Canada Mineral Sectors Reform Project. Project work included authoring technical guidance documents, training of ministry staff on existing environmental guidelines and assisting the Peruvian Ministry of Energy and Mines to advance their abandoned mine site inventory. Responsible for managing a large team of technical professionals from Canada and Peru.
Eldorado Gold Efemcukuru, Turkey	Use of spreadsheet and geochemical models to predict site water quality for an underground gold mine in Turkey. Project work included development of a conceptual model based on existing documentation and creating a site-wide geochemical model that incorporated all of the proposed mine components. Simulated results supported detailed design of a water treatment plant.
Xstrata Copper Arequipa, Peru	Responsible for identification and collection of geochemical rock samples to support geochemical baseline studies as part of an Environmental Impact Assessment for a proposed open pit copper mine.



Barrick Gold Trujillo, Peru	Responsible for identification and collection of geochemical rock samples to support geochemical baseline studies as part of an Environmental Impact Assessment for a proposed open pit gold mine.
Minera Panama S.A. Penonome, Panama	Responsible for identification and collection of geochemical rock samples to support geochemical baseline studies for a proposed open pit copper mine. Assisted with baseline water quality data collection, interpretation and reporting in support of an Environmental Impact Assessment. Developed detailed site-wide water quality and receiving water quality models to predict the impacts of the project to the downstream surface water quality.
Redfern Resources British Columbia, Canada	Lead geochemist responsible for documenting existing geochemical data and providing simulated water qualities in support of Environmental Management Act and Mine's Act permits. Was required to meet with regulatory agencies to present supporting documentation related to construction permit applications.
Barrick Gold Nunavut, Canada	Lead geochemist responsible for identifying ARD issues at a closed and reclaimed mine site in Nunavut, Canada. Project work included a site visit to assess the existing conditions, collect representative samples and coordinate geochemical testing. A final document was required to present the current conditions, geochemical results and to present recommendations for further site remediation.
Western Copper Corporation Yukon, Canada	Development of a characterization program for assessing the acid generation and metal leaching potential of mine waste materials including static and kinetic testing for an open pit gold mine in Yukon, Canada. Project work included identifying rock core sample intercepts and coordinating testing of tailings materials to support baseline EIA studies.
Atlantic Gold Touquoy, Nova Scotia	Development of a characterization program for assessing acid generation and metal leaching of mine waste materials including static and kinetic testing for an open pit gold mine in Nova Scotia, Canada. Project work included collection of rock core for testing, prediction of waste geochemical behavior, organizing, administering and interpreting geochemical results in support of a bankable feasibility study.
Barrick Gold Buzwagi, Tanzania	Involved in geochemical characterization programs of mine wastes at an open pit gold mine in Tanzania including, processing and interpretation of large data set of geochemical results. Project work included developing a water quality model using GoldSim for water quality impact assessment and assisting in authoring technical sections facilitating the client's regulatory requirements in international operations for baseline and EIA studies.
Barrick Gold Alto Chicama, Peru	Assisted with the management of ongoing kinetic geochemistry data to determine the acid rock drainage potential of waste materials. Project work included analysis and reporting of humidity cell data.
Tiberon Minerals Ltd. Nui Phao, Vietnam	Involved in processing and interpretation of static and kinetic geochemical laboratory results for characterization of mine wastes for an open pit bismuth/tungsten mine in Vietnam. Project work included developing a site wide water quality model and assisting with authoring of geochemistry and water quality reports as a part of the client's Feasibility Study.



St. Andrew Goldfields Ltd.

Timmins, Ontario

Assisting with the development of a field testing program which included drilling, test pitting and piezometer installation. Collected soil samples and measured hydraulic conductivities in all installations. Project work included interpretation of groundwater and surface water quality data and authoring of supporting documentation for the client's application for a Permit to Take Water.

DeBeers

Snap Lake, NWT

Use of spreadsheet and geochemical models to predict site water quality for an underground diamond mine in NWT. Work included managing and maintaining large geochemical databases used in the development of a trend analysis model to ensure recent measured samples agree with EIA predictions.

Teck Cominco Ltd.

Red Lake, Ontario

Implemented a field program consisting of overburden drilling, piezometer installation, test pitting, and surface and groundwater sample collection to support the client's regulatory requirements as part of the mine closure plan. Other project work included interpretation and reporting of the field testing program results.

Antamina Mine

Antamina, Peru

Assisted with the development of a GoldSim water quality model to predict metal loading from a large copper-zinc mine in northern Peru and examining drill-core data to assist with implementation of future drilling programs.

Encana

Lorado Mine,
Saskatchewan

Developed a GoldSim water quality model to assess various remediation options of a site containing a lake under acidic conditions. Project work included processing and interpretation of static geochemistry data and assisting with authoring of technical sections.

Kumtor Operating Company

Kumtor, Kyrgyzstan

Assisted in annual updates of a tailings dam study for a gold mine in Kyrgyzstan. Project work included assessment of surface and groundwater quality data and assisting in authoring technical sections facilitating the client's regulatory requirements in international operations for mine site effluents.

Falconbridge Ltd.

Koniombo,
New Caledonia

Use of spreadsheet and geochemical models to predict the preliminary site water quality for a nickel mine in New Caledonia.

TRAINING

MEND Annual ARD Workshop

December 2008

7th International Conference on Acid Rock Drainage

March 2006

Metal Leaching and Acidic Drainage

Ontario Ministry of Northern Development and Mines, February 2005

Other Professional Development Courses

Project Management, 2006

Environmental Site Assessment, 2007

H&S Training (First Aid, Hazard Assessment & Risk Evaluation, Field Inspections)



PROFESSIONAL AFFILIATIONS

Member, Association of Professional Engineers and Geoscientists of the Province of British Columbia (APEGBC)

PUBLICATIONS

Beddoes, P., Herrell, M.K., Vandenberg, J. Role of Professional Judgement and Scaling in Interpretation of Water Quality Model Results. Reliable Minewater Technology. IMWA 2013. Wolkersdorfer, Brown and Figueroa (Eds.)

Herrell, M.K., Vandenberg, J., Faithful, J. Designing meromictic pit lakes as a mine closure mitigation strategy in northern Canada. Paper to be presented at the 2009, Securing the Future and 10th ICARD, April 20-23, 2015, Santiago, Chile.

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.

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.

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.

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



Education

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

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

Golder Associates Ltd. – Calgary

Kristine is a project manager/director and senior fisheries biologist with more than 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 federal *Fisheries Act* and has been involved in the development of offsetting (previously fish habitat compensation) plans.

Kristine has provided technical or project direction on large environmental assessment projects. She is currently providing technical direction for the Dominion Diamond Ekati Corporation Jay Project and was the aquatics technical director during the completion of the Developer's Assessment Report, which involved integration with the engineering and environmental teams. She previously was the project director for an environmental assessment project for Teck Coal in the Elk Valley of British Columbia.

For the De Beers Canada Inc. Gahcho Kué Project, Kristine was the fish and fish habitat component lead during the development of the environmental impact statement and the associated review process. She was the aquatics technical coordinator for follow-up work, including Information Request responses, regulatory/technical meetings, regulatory support and advice, offsetting planning, and water licencing. She was involved in the development of the conceptual Aquatic Effects Monitoring Program.

In the Oil Sands Region in Northern Alberta, Kristine was the Project Manager for an environmental impact assessment of an Oil Sands Project in Northern Alberta. She has also been the fish and fish habitat component senior review/director.

Kristine was also involved in impact assessment, permit approvals and hearing preparation/support for the fish and fish habitat component of the Mackenzie Gas Project.

Employment History

Golder Associates Ltd. – Calgary, Alberta

Associate. Senior Fisheries Biologist/Project Manager/Director (2000 to Present)

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



Aquatics Division Manager (2008 to 2009)

Fisheries Group Manager (2006 to 2008)

Responsibilities included scheduling, workload allocation, participation in the office management team, financial analysis and reporting, recruiting and personnel management, as well as contribution to strategic decisions.

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 for large-scale industrial and mining projects. Responsible for proposal preparation, client liaison and budget tracking for selected projects. Supervised field crews in remote locations and delegated responsibility for planning and post-field data analyses. 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.



SELECTED PROJECT EXPERIENCE

Dominion Diamond Jay Project
Northwest Territories

Technical direction and senior fish and fish habitat component director for the environmental assessment for proposed Jay Project. Responsible for preparation of the Developer's Assessment Report for aquatics components, including fish and fish habitat. For Information Requests, responsible for overall review and integration with engineering. Also involved in providing regulatory support and advice and offsetting and fish-out planning.

Dominion Diamond Lynx Project
Northwest Territories

Technical support and direction for the development of the Project Description. Involved in hearing support for the Water Licence. Involved in providing regulatory support and advice related to offsetting and fish-out planning.

De Beers Canada Inc. Gahcho Kué Project
Northwest Territories

Fish and fish habitat component lead for the environmental impact statement and aquatics component technical coordinator for follow-up work, including Information Request responses, regulatory/technical meetings, regulatory support and advice, offsetting planning, and development of the conceptual Aquatic Effects Monitoring Program. Provided support for the Review Board and Land and Water Board technical sessions and hearings.

Teck Coal Baldy Ridge Extension Project
Sparwood, BC

Project Director for the baseline sampling and initiation of the environmental assessment for the Baldy Ridge Extension Project. Provided direction on assessment methodology, documentation, scheduling, Health and Safety, cost tracking, and quality control.

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 Project
Fort McMurray, Alberta

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 of productive capacity of fish habitat, as well as follow-up work related to the project.

Suncor Energy, Voyageur South Project
Fort McMurray, Alberta

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 the Poplar Creek and Beaver River watersheds north of Fort McMurray.



Mackenzie Gas Project
Northwest Territories,
Canada

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. Involved in permit approval process and hearing preparation/support.

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

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 to Sunshine.

**Parks Canada,
TransCanada Highway
Twinning, Phase IIIB**
Banff, Alberta

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. The screening was required to meet requirements of the Canadian Environmental Assessment Act.

**Chevron Canada
Resources, Winter
Seismic Monitoring**
Mackenzie Delta,
Northwest Territories

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.

**WesternGeco, Winter
Seismic Monitoring**
Mackenzie Delta,
Northwest Territories

Project manager for environmental monitoring of winter seismic programs conducted in the Mackenzie Delta at the Parsons Lake, Nuna and Titlalik seismic programs. Responsibilities included field coordination, sampling, client and regulatory liaison, data analyses and report preparation. Field studies monitored water quality during drilling and blast induced overpressures during blasting.

**Salmo Consulting,
Monitoring Data
Review**
Calgary, Alberta

Project manager for project for data analyses of water quality and overpressure monitoring data collected in the Mackenzie Delta in winter 2002. Data from multiple programs and program areas were compiled, analyzed, and summarized in a report, incorporated into a background paper on the Use of Explosives in Waterbodies for Canadian Association of Petroleum Producers (CAPP).

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

Project to conduct 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. Involved identification of linkages, database searches, selection of relevant literature and summarizing into a report.

**Fisheries and Ocean
Canada, Dredging
Review**
Inuvik, Northwest
Territories

Managed project to conduct literature review on the potential physical and biological effects of dredging in the Beaufort Sea. The results of the literature review 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.

PROFESSIONAL AFFILIATIONS

Member, Alberta Society of Professional Biologists (ASPB)



Education

M.A. Socio-Cultural Geography, University of Calgary, Calgary, 2010

B.A. (hons) Environmental Geography, University of Calgary, Calgary, 2008

Certifications

Standard First Aid Level C, February, 2014

Languages

English – Fluent

Golder Associates Ltd. – Calgary

Socio-Economist and Social Impact Assessment Specialist

As a Social Impact Assessment Practitioner, Jesse focuses on the social, economic, cultural, legislative, and land use aspects of social and environmental impact assessments (SEIA). Jesse leads the social components of SEIAs, with a focus on methodology design, baseline studies, impact assessments, social management plans, and strategic regulatory briefings, and the supervision of junior team members. He also acts as a coordinator for the socio-cultural team, and as a project manager on Golder Canada's involvement with international environmental impact assessments.

The majority of Jesse's work considers the impacts of the mining sector, and is geographically focused on the Circum-Polar regions of the world and southern Canada (predominantly in the context of oil and gas and pipeline construction activities in Northern Alberta). He has also worked on projects in Eastern Europe, Latin America, and West Africa.

Jesse received his M.A. in Geography (Socio-Cultural) from the University of Calgary, where he studied the spatial, psychological, and socio-economic acculturation process of Canadians and Americans permanently expatriating to Yucatan, Mexico. He also holds a B.A. (hons) in Geography. His Honours thesis focused on the effects of climate change on wetlands in Quebec.

Employment History

Golder Associates Ltd. – Calgary, AB

Socio-Economist (2011 to Present)

Focuses on Socio-Economic impact assessment work and providing strategic advice to clients on Socio-Cultural and Economic issues. Collects, analyses and reports on social, economic, regulatory and resource use data components of environmental impact assessments. Coordinates project schedules, budget tracking, and logistics. Coordinates regulatory hearing proceedings for the Cultural Sciences group in conjunction with project management teams.

University of Calgary, Department of Geography – Calgary, AB

Researcher and Graduate Teaching Assistant (2008 to 2010)

Instruct intermediate and senior laboratory and tutorial courses in the fields of pedology and environmental, urban, social, and cultural geography. Contributed papers to academic conferences. Contributed to research in the fields of socio-cultural geography, gerontology, demography and cross-cultural studies.

University of Calgary, Department of Geography – Calgary, AB

Research Assistant (2006 to 2008)

Contributed to the design, implementation, and management of a research project aimed at identifying the effects of drainage on peatland methane cycling. Conducted fieldwork, laboratory sampling, statistical analysis, and data presentation. Supervised and trained laboratory and field assistants.



NORTHERN PROJECT EXPERIENCE

**Dominion Diamond
Corp - Ekati Diamond
Mine Expansion**
Northwest Territories,
Canada

Discipline Lead and Author (DAR): Socio-Economic Baseline and Impact Assessments, including: population demography, economics, employment and education, physical infrastructure and services and land use management assessments, and a social and economic management plan for the proposed mine.

Regulatory Advisor: Provide strategic advice regarding socio-economic trends, issues and recent regulatory requirements in the NWT to the client.

Regulatory Engagement Lead: Lead for regulatory activities following the submission of a Developer's Assessment Report for a mine expansion, including engagement workshops.

**De Beers - Gahcho Kue
Diamond Mine**
Northwest Territories,
Canada

Regulatory Advisor (EIA): Respond to MVEIRB Information Requests and Technical Comments relating to socio-economics, traditional land use, and resource use. Contribute to the social management plan for the proposed mine. Provide strategic support during the regulatory process.

Regulatory Coordinator (Socio-Cultural): Coordination of Information Request (IR) process and hearing preparation for multiple disciplines.

**Agnico Eagle -
Meliadine Gold Mine**
Nunavut - Kivalliq,
Canada

Author (ESIA): Socio-Economic Baseline and Impact Assessment; Non-Traditional Land and Resource Use Assessment Coordinator: Socio-Cultural Impact Assessment (including social, economics, traditional knowledge and land use and land management).

Regulatory Coordinator (Socio-Cultural): Coordination of Information Request (IR) process and hearing preparation for multiple disciplines.

**AREVA - Kiggavik
Uranium Mine**
Nunavut, Canada

Regulatory Advisor (EIS): Respond to community, regulator and government request for information and technical comments.

Contributing Author: Finalize socio-economic, traditional land use and resource use baseline and impact assessments, as well as a social management plan for the project.

**Imperial Oil - Beaufort
Sea Offshore Project**
Northwest Territories,
Canada

Contributing Author (EIA): Socio-Economic Baseline and Impact Assessment.



OTHER PROJECT EXPERIENCE

PROJECT MANAGEMENT

Euromax - Ilovitza Mine Bosilovo, Republic of Macedonia	Project Manager (Canadian Operations): Manage Canadian operations (finance, logistics, health and safety, administration) on an international, interdisciplinary baseline study.
SMFG - Nimba Iron Project Guinea, Guinea	Logistics Coordinator (ESIA): Pre-field logistics and H&S coordination for a large, multi-disciplinary/multi-national team conducting an SEIA over the course of several years. Also provided financial management support to senior Project Directors, and oversaw the Project wrap-up process for Canadian operations.
CNRL - Kirby North Alberta, Canada	Regulatory Coordinator (EIA): Internal coordination of client responses to Supplemental Information Requests (SIRs) from regulatory bodies.
Shell - Albion Alberta, Canada	Project Coordinator (EIA): Logistical, H&S and financial coordination for a large-scale archaeological investigation in the Albion Oil Sands.

MINING

Euromax - Ilovitza Gold/Copper Mine Republic of Macedonia	Methodology Advisor (ESIA): Social statistics, household surveys, consultation and research design. Author: Socio-Economic Baseline.
Société des Mines de Fer de Guinée (SMFG) - Nimba Iron Project Guinea, Guinea	Author (ESIA): Protected Areas Impact Assessment; Natural Resource Use Impact Assessment. Contributing Author: Social Assessment methodology; Socio-Economic Baseline and Impact Assessment; Land Use and Tenure and Traffic Impact Assessments.
Cliffs Natural Resources - Facility Ontario, Canada	Contributing Author (ESIA): Socio-Economic Impact Assessment.
Torex Gold - Morelos Gold Mine Guerrero, Mexico	Contributing Author (ESIA): Resettlement Action Plan.
TrasAlta - Highvale Coal Mine Alberta, Canada	Discipline Lead (Integrated Regulatory Application): Socio-Economics and Land and Resource Use Baselines and Impact Assessments
Vale Canada - Vale Kronau Potash Mine Saskatchewan - Southern, Canada	Contributing Author (ESIA): Socio-Economic Baseline.



PIPELINES

TransCanada Pipelines - Eastern Mainline Project (NEB 52) Ontario, Canada	Methodology Advisor/Reviewer (EA): Socio-Economics and Land Use and Management: NEB Human Occupancy and Resource Use, Quality of Life, Human Health, Visual Aesthetics, Infrastructure and Services, and Employment and Economy Assessments.
TransCanada Pipelines - Four NEB 52, and 10 NEB 58 Applications Alberta, Canada	Discipline Lead (EA): Socio-Economics and Land Use and Management: NEB Human Occupancy and Resource Use, Quality of Life, Human Health, Visual Aesthetics, Infrastructure and Services, and Employment and Economy Assessments.
TransCanada Pipelines - Groundbirch Project British Columbia, Canada	Discipline Lead (EA): Socio-Economics and Land Use and Management: idem.

OIL & GAS

Cenovus Energy Inc. - Kirby East Project Alberta, Canada	Discipline Lead (EIA): Land and Resource Use Baseline and Impact Assessment
Shell - Jackpine Mine Expansion Project Alberta, Canada	Contributing Author (EIA): Cultural Effects and Traditional Land Use Assessments.
Cenovus Energy Inc. - Pelican Lake Project Alberta, Canada	Author (EIA): Socio-Economic and Land and Resource Use Baseline and Impact Assessment.
ConocoPhillips Canada - Surmont In Situ SAGD Project Alberta, Canada	Contributing Author (EIA): Socio-Economic and Land and Resource Use Baseline and Impact Assessment.

CULTURAL SCIENCES

Métis Local 1935 - Historical Atlas Alberta, Canada	Author: Historical Atlas: data collection, transcript coding and preparing chapters in a historical land use atlas for the Métis Local 1935. Chapters written draw on the experiences of over 100 Métis Elders to discuss Métis Traditional Resource Use, Lifeways, History, Family and Culture, and Travel and Access.
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ECOLOGY

Geo-Chemical Assessment - Peat Harvesting Operation Quebec, Canada	Research Coordinator: design and implement a collaborative environmental assessment project aimed at determining the effects of water table drawdown on peatland carbon cycling.
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TRAINING

Project Management Fundamentals

Golder Associates Ltd., June 2014

Contracts and Liability

Golder Associates Ltd., June 2014

Health and Safety Module 5 -Supervisors and Managers

Golder Associates Ltd., March 2013

Project Management (PM) 24

Golder Associates Ltd., November 2011

BST for Project Managers

Golder Associates Ltd., November 2011

Workplace Hazardous Materials Information System (WHMIS)

Golder Associates Ltd., March 2011

Health and Safety Module 2

Golder Associates Ltd., March 2011

Construction Safety Training System (CSTS)

Alberta Construction Safety Association, March 2011

OSSA Regional Orientation Program

Golder Associates Ltd., March 2011

Health and Safety Module 1

Golder Associates Ltd., February 2011

PUBLICATIONS

Books

Metis Local 1935, Mitchell Goodjohn, Jesse O'Brien, Ed Kempenaar, Rebecca Stuparyk and Deborah Maier. 2012. *Mark of the Metis: traditional knowledge and stories of the Metis people of northeastern Alberta*. Fort McMurray, Fort McMurray Metis Local 1935.

**Conference
Proceedings**

Strack, Maria, Jesse O'Brien and J.M. Waddington. 2008. *Assessing the role of ecological succession for peatland methane dynamics: potential climate change feedback*. 13th International Peat Congress. Jyväskylä, Finland.



Education

Ph.D. Biology, University of Saskatchewan, Saskatoon, 1998

B.Sc. Zoology, Major, University of Manitoba, Winnipeg, 1988

B.A. History, University of Manitoba, Winnipeg, 1985

Certifications

Wilderness Advanced First Aid & Adult CPR, 2014

Transport of Dangerous Goods, 2012

WHMIS, 2012

Golder Associates Ltd. – Winnipeg

Employment History

Golder Associates – Winnipeg, MB

Senior Ecologist (2012 to Present)

Parks Canada, Western & Northern Service Centre – Winnipeg, MB

Monitoring Ecologist (2005 to 2012)

Ontario Ministry of Natural Resources, Northeast Science &

Information Section – South Porcupine, ON

Wildlife Populations Specialist (1998 to 2005)

University of Saskatchewan, Department of Biology – Saskatoon, SK

Assistant Professor (2002 to 2003)

University of Saskatchewan, Department of Biology – Saskatoon, SK

Doctoral Candidate (1992 to 1998)

PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

Canadian Zinc Prairie Creek Mine Road

Northwest Territories, Canada

Designed field study program for the assessment of the probability of wildlife occurrence on a 130 km mine access road.

Dominion Diamond Jay Project

Northwest Territories, Canada

Lead for environmental assessment of the effects of the Jay open pit diamond mining project on barren-ground caribou in a 300,000 square km study area. The assessment included project specific effects and cumulative effects of previous, existing, and reasonably foreseeable future developments. Conducted population modelling of the Bathurst caribou herd.

Manitoba East Side Road Authority

Manitoba, Canada

Advisor on environmental monitoring study design and analysis and senior reviewer of annual monitoring reports.

Dominion Diamond Jay and Lynx Project Baseline Reporting

Northwest Territories, Canada

Lead for baseline assessment of status of wildlife in a study area for two planned open-pit diamond mines. Led assessment of current condition of carnivores, ungulates, and avian species in local and regional study areas.



**Wataynikaneyap New
Transmission Line to
Pickle Lake Project**
Ontario, Canada

Lead for assessment of the effects of a transmission line on boreal terrestrial ecosystems in northwestern Ontario. Led environmental assessment team to plan studies, analyze data and report on the effects of a new hydroelectric transmission line to remote communities. Assessments included those required for permit acquisition under the Ontario Endangered Species Act.

Cliffs Chromite Mine
Ontario, Canada

Lead on Cumulative Effects Assessment of mine site and road on woodland caribou. Led team to develop exploration data layer, establish zones of influence for various features and conduct cumulative effects assessments on caribou habitat in the effects study area, and encounter analysis of woodland caribou with the mine site and road alignment.

**Manitoba Hydro Bipole
III Transmission Line**
Manitoba, Canada

Data analyst, species specialist. Sub-contracted with Joro Consultants to: conduct resource selection function and population dynamics analyses for woodland caribou; model Manitoba moose populations; present results in the Bipole III transmission project caribou technical report and enhanced moose assessment report to Manitoba Hydro, and to testify at the Manitoba Clean Environment Commission hearings on the Bipole III transmission line.

Energy Consultants
Manitoba, Canada

Project lead - Identified and reported on issues of concern for woodland caribou populations along potential routes for the Manitoba Hydro Bipole III transmission line east of Lake Winnipeg.

PROJECT EXPERIENCE – WILDLIFE RESEARCH

**Elk Island National
Park**
Alberta, Canada

Joint principal investigator - the effects of giant liver fluke on moose populations. Design of control-impact study employing the two separate blocks of EINP as independent sites; determined sample size requirements through power analysis of projected mortality rates.

**Gros Morne National
Park**
Newfoundland and
Labrador, Canada

Principal investigator - designed a multi-year research study collaboratively with the University of Saskatchewan. The study is examining the effect of licensed hunting on moose densities, resource selection, morphology, and vital rates (age-specific recruitment and mortality rates, age at first reproduction).

**Riding Mountain
National Park**
Manitoba, Canada

Supervisor – oversaw a post-doctoral fellow who compiled more than thirty years of aerial survey data and employed Bayesian analysis to build a corrected, long-term, estimate of the elk population in and around RMNP in south-western Manitoba.

**Prince Albert National
Park**
Saskatchewan, Canada

Project lead - Development of comprehensive songbird monitoring protocols for PANP. Included were refined monitoring objectives, and standards for field collection, data management, and reporting. Sample distribution and sample sizes were based on power analysis of historic data.

**Government of
Northwest Territories**
Northwest Territories,
Canada

Principal investigator - Used computer modelling of wildlife surveys to provide guidance to territorial government for its barren-ground caribou monitoring program. Produced report: Determining optimal radio-collar sample sizes for monitoring barren-ground caribou populations. Contract No. SC 411076



**Northeastern Ontario
woodland caribou
research project**
Ontario, Canada

Project manager - for the northeastern Ontario woodland caribou research project, conducted south of James Bay. The project was funded jointly by the provincial government and the forestry and mining industries. The project resulted in two graduate theses and four publications in refereed journals.

TAEM Consultants
Alberta, Canada

Data analyst – created resource selection functions for wetland habitat selection by woodland caribou in Alberta.

**Woodland caribou
ecology in central
Saskatchewan**
Saskatchewan, Canada

Graduate student – ran field program, conducted analysis, wrote scientific papers on: boreal forest vegetation community classification; woodland caribou population dynamics; animal morphology; wildlife disease; and woodland caribou behavioural ecology, including creation of resource selection functions.

PROJECT EXPERIENCE – WILDLIFE MANAGEMENT

**Porcupine Caribou
Management
Agreement - senior
officials**
Yukon / Northwest
Territories, Canada

Reviewer - at request of the senior official of parties to the Porcupine Caribou Management Agreement, reviewed the proposed harvest reporting program that informs management decision making. Assisted in running a workshop for community and government employees on data collection, storage, and analysis.

**Ontario Ministry of
Natural Resources**
Ontario, Canada

Project lead - revised the OMNR moose aerial inventory program to optimise survey plot allocation throughout each survey. Wrote stand-alone software package that analyses data and simulates future survey plot results to optimize efficiency based on daily survey updates. Coordinated and ran two series of workshops to educate district biologists in data collection and analysis and use of the computer program.

PROJECT EXPERIENCE – WORKSHOP AND TRAINING PRESENTATIONS

**Effective
Environmental
Monitoring**
Manitoba, Canada

Coordinated and presented a one-day workshop to environmental regulators and resource sector clients. The subject was the importance of environmental monitoring study design and power analysis to maximize return on investment in monitoring programs.

**Porcupine Caribou
Herd harvest workshop**
Inuvik, NT, Canada

Porcupine caribou herd harvest reporting requirements. Presentations of study design and data collection requirements at a two day workshop. June 2011.

**Wildlife Conservation
Society woodland
caribou aerial survey
workshop**
Toronto, ON, Canada

Adaptive cluster sampling. Presented as part of a session comparing various methods of surveying woodland caribou. September 2008.

**Parks Canada Agency
power analysis
workshop**
Saskatoon, SK, Canada

Introduction to power analysis. Prepared and presented a three-day course on the application of power analysis in ecological monitoring. January 2008.



**Ontario Ministry of
Natural Resources
moose aerial inventory
software training**
Ontario, Canada

One-day workshop presented in three locations. Trained provincial district biologists in: MAI desktop - an optimal sampling and data analysis program for the Ontario Ministry of Natural Resources Moose Aerial Inventory Program. October 2004.

**Ontario Ministry of
Natural Resources
moose aerial inventory
workshop**
Ontario, Canada

One-day workshop presented in three locations. Trained provincial district biologists in statistical analysis training for the Ontario Ministry of Natural Resources moose aerial inventory - working from first principles. October / November 2001.

PROFESSIONAL AFFILIATIONS

The Wildlife Society, Member, 1998 to present.

Manitoba Chapter of the Wildlife Society, member, 2010 to present.

Journal referee, 1996 – present, various journals including: Acta Theriologica, Basic and Applied Ecology, Behavioral Ecology and Sociobiology, Biological Conservation, Canadian Journal of Zoology, Ecography, Ecoscience, Forestry Chronicle, Journal of Applied Ecology, Journal of Wildlife Management, Rangifer, Wildlife Research.

Graduate student committee member: S.E. Simpson. M. Sc., University of Saskatchewan, 2015. Life history and population dynamics of Sable Island horses.

Member, Expert Working Group for the elimination of Bovine Tuberculosis in the Riding Mountain Ecosystem (2009 – 2012).

Co-chairman – Parks Canada Chronic Wasting Disease Working Group (2009 – 2012).

Member, Parks Canada National Ecological Integrity Monitoring Task Team (2005 – 2012).

Member, Parks Canada Animal Care Committee (2008 – 2012).

Supervisor, post-doctoral fellow: L.J. Kjør. 2010-2011. Elk population dynamics 1978-2010 in Riding Mountain National Park.

Member, Science Review Team, Proposed NE Ontario Regional Caribou Conservation Plan, Canadian Parks and Wilderness Society (2008).

Independent Science Advisory Team member, Eastern Manitoba Woodland Caribou Advisory Committee (2005 – 2008).

Coordinator, Interior Plains Bioregion Ecological Integrity Monitoring Group, Parks Canada (2005 – 2008).

Graduate student committee member: G.S. Brown. Ph.D., University of Guelph, 2005. Habitat selection by woodland caribou in the managed boreal forest of northeastern Ontario.

Science Advisor to Ontario Ministry of Natural Resources Wildlife Assessment Program (2005).



Graduate student external examiner: M.B. Coady. M.Sc., Trent University, 2005. A distance-based analysis of seasonal habitat use and den site selection by American black bears (*Ursus americanus*) on the Bruce Peninsula, Ontario.

Co-Chairman, Ontario Provincial Woodland Caribou Recovery Team (2004 – 2005).

Editor, Ontario Woodland Caribou Recovery Strategy (2004 – 2005).

Ontario Provincial Woodland Caribou Recovery Team (2001 – 2005).

Northeast Region (Ontario) Caribou Task Team (2000 – 2005).

Project Manager, Northeastern Ontario Woodland Caribou Research Project (1998 – 2005).

Graduate student committee member: S.K. Proceviat. M.Sc., Laurentian University, 2003. Effects of careful logging on availability of caribou (*Rangifer tarandus caribou*) forage in northeastern Ontario.

Ontario Provincial Moose Technical Committee (2001 – 2002).

Special Graduate Faculty, University of Guelph, Department of Zoology - Guelph, ON (2000 – 2005)

Adjunct Professor, Laurentian University, Department of Biology - Sudbury, ON (1999 – 2006)

The Ecological Society of America, Member, 1998-1999.

PUBLICATIONS

Refereed Journal Articles

Brown, G.S., W.J. Rettie and F.F. Mallory. Predicting the impacts of forest management on woodland caribou habitat suitability in black spruce boreal forest. *Forest Ecology and Management*, 245 (2007), 137-147.

Brown, G.S., W.J. Rettie and F.F. Mallory. Application of a variance decomposition method to compare satellite and aerial inventory data: a tool for evaluating wildlife-habitat relationships. *Journal of Applied Ecology*, 43 (2006), 173-184.

Rettie, W.J.. Morphology of female woodland caribou, *Rangifer tarandus caribou*, in Saskatchewan. *Canadian Field-Naturalist*, 118 (2004), 119-121.

Jordan, L.T., W.J. Rettie and S.V. Tessaro. Evidence of herpesvirus infection in woodland caribou in Saskatchewan. *Journal of Wildlife Diseases*, 39 (2003), 216-220.

Brown, G.S., F.F. Mallory and W.J. Rettie. Range size and seasonal movement for female woodland caribou in the boreal forest of northeastern Ontario. *Rangifer Special Issue*, 14 (2003), 227-233.

Proceviat, S.K., F.F. Mallory and W.J. Rettie. Estimation of arboreal lichen biomass available to woodland caribou in Hudson Bay lowland black spruce sites. *Rangifer Special Issue*, 14 (2003), 95-99.



Rettie, W.J. and F. Messier. Range use and movement rates of woodland caribou in Saskatchewan. *Canadian Journal of Zoology*, 79 (2001), 1933-1940.

Rettie, W.J. and F. Messier. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. *Ecography*, 23 (2000), 466-478.

Brown, W.K., W.J. Rettie, B. Wynes and K. Morton. Wetland habitat selection by woodland caribou as characterized using the Alberta wetland inventory. *Rangifer Special Issue*, 12 (2000), 153-157.

Rettie, W.J. and P.D. McLoughlin. Overcoming radio-telemetry bias in habitat selection studies. *Canadian Journal of Zoology*, 77 (1999), 1175-1184.

Rettie, W.J. and F. Messier. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. *Canadian Journal of Zoology*, 76 (1998), 251-259.

Ferguson, S.H., W.J. Rettie and F. Messier. Fractal measures of caribou movement behaviour. *Rangifer Special Issue*, 10 (1998), 135-147.

Rettie, W.J., T.W. Rock and F. Messier. Status of woodland caribou in Saskatchewan. *Rangifer Special Issue*, 10 (1998), 105-109.

Rettie, W.J., J.W. Sheard and F. Messier. Identification and description of forested vegetation communities available to woodland caribou: relating wildlife habitat to forest cover data. *Forest Ecology and Management*, 93 (1997), 245-260.

Conference Proceedings

Schindler, D., D. Walker, W.J. Rettie and F. Scurrah. 2012. *Effects of disturbance and fragmentation on Lambda for boreal woodland caribou in northern Manitoba*. Fourteenth North American Caribou Workshop, September. Ft. St. John, BC, Canada.

Hegel, T.M., W.J. Rettie, K. Russell, T. Pretzlaw and D. Tate. 2010. *A mark-and-multiple-resight population estimate of the South Nahanni caribou herd*. Thirteenth North American Caribou Workshop, October. Winnipeg, MB, Canada.

Proceviat, S.K., F.F. Mallory and W.J. Rettie. 2001. *Seral changes in forage availability for woodland caribou in northeastern Ontario black spruce sites impacted by careful logging*. Ninth North American Caribou Workshop, April. Kuujuaq, QC, Canada.

Caulkett, N.A., W.J. Rettie and J.C. Haigh. 1996. *Immobilization of free ranging woodland caribou (Rangifer tarandus caribou) with medetomidine-ketamine and reversal with atipamezole..* Proceedings American Association of Zoo Veterinarians 1996: 389-393.

Other

Cool, N.C., W.J. Rettie, and T.K. Shury. 2012. Chronic wasting disease surveillance and management plan for Elk Island National Park. Unpublished report. Parks Canada. 19 pages.



Rettie, W.J. 2010. Gros Morne National Park: Models for hyperabundant moose population reduction through managed hunting in St. Paul's and Sally's Cove proposed Moose Management Areas. Unpublished report. Parks Canada Western and Northern Service Centre, Winnipeg. 15 pages.

Rettie, W.J. 2010. Porcupine Caribou Herd: A review of the design of the harvest reporting program. Unpublished report for the senior officials of parties to the Porcupine Caribou Management Agreement. Parks Canada Western and Northern Service Centre, Winnipeg. 20 pages.

Rettie, W.J. 2009. Riding Mountain National Park: Elk population models relevant for TB testing and population reduction program in the TB control zone. Unpublished report. Parks Canada Western and Northern Service Centre, Winnipeg. 11 pages.

Rettie, W.J., and N. Berglund. 2009. Avian Point Count Monitoring Protocols for Prince Albert National Park. Parks Canada Western and Northern Service Centre, Winnipeg. 108 pages.

Rettie, W.J. 2009. Riding Mountain National Park: Elk population models relevant for TB testing program, Version 2. Parks Canada Western and Northern Service Centre, Winnipeg. 13 pages.

Wade, K.D., M. Meadows, W.J. Rettie, and A.R. Rodgers. 2006. Caribou (*Rangifer tarandus*) literature citation database. Ontario Ministry of Natural Resources, Centre for Northern Forest Ecosystem Research, Northern Mammal Ecology Program. Thunder Bay, Ontario, Canada.

Rettie, W.J. 2005. MAI Desktop 2.1: A desktop support tool for the Ontario Ministry of Natural Resources' moose aerial inventory program. [A Visual Basic computer program]. Ontario Ministry of Natural Resources, Northeast Science & Information Section CD – 002.

Rettie, W.J. 2005. Optimal Sample 2.0: A program for designing and apportioning hunter surveys. [A Visual Basic computer program] Ontario Ministry of Natural Resources, Northeast Science & Information Section CD – 003.

Landriault, L.J., M.E. Obbard, and W.J. Rettie. 2000. Nuisance black bears and what to do with them. Ontario Ministry of Natural Resources, Northeast Science & Technology. Technical Note TN-017. 20 pages.



TRAINING

Chemical Immobilization of Wildlife

Canadian Association of Zoo and Wildlife Veterinarians, 2012

Modelling Patterns and Dynamics of Species Occurrence

Proteus Wildlife Research Consultants, 2008

Advanced Distance Sampling

Centre for Research into Ecological and Environmental Monitoring, St. Andrews University, 2004

Introduction to Distance Sampling

Centre for Research into Ecological and Environmental Monitoring, St. Andrews University, 2004



Education

*Ph.D. Civil Engineering -
Fluid Mechanics, University
of Canterbury, 1998*

*M.Sc. Civil Engineering -
Water Resources,
University of Alberta,
Alberta, 1992*

*B.Sc. Civil Engineering -
Co-op Program, With
Distinction, University of
Alberta, Alberta, 1990*

*Applied Fluvial
Geomorphology, Dave
Rosgen/Wildland
Hydrology, 2001*

Languages

English – Fluent

Affiliations

*Association of Professional
Engineers and
Geoscientists of Alberta*

*Association of Professional
Engineers and
Geoscientists of British
Columbia*

*Association of Professional
Engineers and
Geoscientists of Northwest
Territories*

*International Association for
Hydraulic Research*

*Canadian Institute of
Mining, Metallurgy and
Petroleum (Environment
Section)*

*Canadian Water Resources
Association*

Golder Associates Ltd. – Edmonton

Senior Water Resources Engineer

Dr. Nathan Schmidt has worked on mining projects across Canada, with an emphasis on the North. His scopes of practice include baseline hydrology, water management planning, design and environmental impact assessment. Nathan has played a key role in several northern EIAs and providing design services for these and other projects.

His recent work includes involvement with the Dominion Diamond Jay and Lynx projects, De Beers Gahcho Kué diamond project, the Giant Mine remediation project, the Agnico-Eagle Meliadine gold project and the Fortune Minerals NICO project. Nathan has extensive experience in fish habitat compensation and erosion and sediment control.

Nathan is registered as a professional engineer in the Northwest Territories and Nunavut, Alberta and British Columbia. He is the former chair of the APEGA Environment Committee and has served five terms on NSERC Grant Selection Committees.

Employment History

Golder Associates Ltd. – Edmonton, AB

Associate then Principal, Senior Water Resources Engineer (2002 to Present)

Consultant and Project Manager on projects related to river engineering, hydrology, water management, and environmental impact assessment in the mining, water resources, power, forestry, and transportation market sectors.

Golder Associates Ltd. – Calgary, AB

Senior Water Resources Engineer (1997 to 2002)

Consultant and Project Manager on a variety of projects. Highlights included managing the climate and hydrology component of the Regional Aquatics Monitoring Program for five years, leading the surface water hydrology components of the CNRL Horizon Oil Sands Project EIA and Suncor Firebag In Situ Oil Sands Project EIA, and leading the Functional Design, Hydrology, and Hydraulics components of the Iron Ore Company Wabush Lake Tailings Management Project.

University of Canterbury – Christchurch, New Zealand

Research/Teaching Assistant, Fluid Mechanics (1993 to 1997)

Alberta Transportation & Utilities – Edmonton, AB

Bridge Planning Engineer (1992 to 1993)

University of Alberta – Edmonton, AB

Research/Teaching Assistant, Water Resources Engineering (1990 to 1992)

Stanley Associates Engineering Ltd. – Edmonton, AB

Hydrotechnical Engineer (1990 to 1990)



PROJECT EXPERIENCE – ENVIRONMENTAL IMPACT STUDIES

**Dominion Diamond
Ekati – Jay and Lynx
Projects**
Lac de Gras, NT

Directed and senior reviewed baseline hydrology studies for these new pit developments, including an intensive first baseline on the Lac du Sauvage watershed. Provided regulatory input for the Lynx Pit water licence and responsible for baseline study and environmental assessment report for the Jay Project. This project included a hydrometric field program and hydrological modelling to provide a basis for design and impact assessment.

**Giant Mine
Remediation - PWGS
Canada**
Yellowknife, NT, Canada

While developing preliminary design reports for the surface water and Baker Creek remediation components of this project, provided support to the impact assessment before the Mackenzie Valley Review Board, including technical session participation and writing responses to two rounds of Information Requests.

**TOTAL E&P Canada
Strathcona Upgrader**
Fort Saskatchewan, AB,
Canada

Component lead for the hydrology section of an Environmental Impact Assessment for a bitumen upgrader project. The assessment focused on disturbance to local drainage patterns, as well as the effects of water withdrawal and water intake construction on the North Saskatchewan River. The EIA was submitted to the Alberta Energy and Utilities Board and Alberta Environment.

**De Beers Canada
Gahcho Kué Diamond
Project**
NT, Canada

Responsible for the hydrology components of the Environmental Impact Statement for a proposed diamond mine located east of Yellowknife in the Lockhart River basin. Tasks included baseline data collection and preparation and submission of a baseline hydrology report and Environmental Impact Statement for submission to the Mackenzie Valley Land and Water Board, as well as federal regulatory agencies, and working with the engineering team to develop dewatering and water management approaches. Participated in the environmental review process including Mackenzie Valley Review Board technical sessions and hearing. The proposed project will drain a small subarctic lake to access diamondiferous kimberlite pipes, and a major focus of the EIS was on downstream effects of water diversion during lake draining and refilling.

**Miramar Mining Doris
North Gold Mine
Project**
NU, Canada

Responsible for the hydrology components of the Environmental Impact Statement for a proposed gold mine on the Hope Bay Belt. This included an assessment of effects on a local lake due to withdrawals for water supply, development of a hydrological design basis for a fisheries compensation (No Net Loss) plan, and provision of input data for a tailings facility water balance. Done in conjunction with supplemental climate and hydrology data collection.

**Jivko Engineering –
Mackenzie River
Bridge**
Fort Providence, NT

Contributed to environmental impact assessment, including study of effects of ferry crossing decommissioning on sediment deposition into the Mackenzie River and effects of bridge pier and approach causeway construction on physical habitat characteristics.

**Canadian Natural
Resources Ltd. –
Horizon Mine**
Fort MacKay, AB,
Canada

Managed the surface water hydrology component of the impact analysis for the Horizon Mine project, located northwest of Ft. Mackay, Alberta. Tasks included preparation of a report detailing baseline climate, hydrology and geomorphology, identifying changes in site hydrologic conditions and sediment yields and impact on the Athabasca River due to the project and other planned developments.



Diavik Diamonds – Lac de Gras
NT, Canada

Project engineer responsible for developing a water balance model, calibrated to baseline site hydrological conditions, to quantify changes to Lac de Gras caused by the Diavik Diamond Mine. Conducted an impact analysis to quantify the incremental hydrologic impacts of the Diavik Diamond Mine project and the cumulative impacts of the Diavik and BHP projects. Tasks included identifying changes in site hydrologic conditions and water balance and describing changes in sediment yields and suggesting procedures for mitigating any impact on the environment. Analyzed climatic, snow survey and local stream gauging data to determine snowmelt and seasonal runoff coefficients from small watersheds on the east island and adjacent mainland in the Lac de Gras basin.

Suncor Energy Inc. - Firebag In Situ Project
Fort MacKay, AB, Canada

Performed a field reconnaissance to determine the origin of base flow in small tributaries to the Steepbank, Muskeg and Firebag Rivers. The area was surveyed for the existence of streams fed by springs originating in the sand and gravel aquifer beneath Muskeg Mountain. Responsible for hydrologic components of the environmental impact study.

PROJECT EXPERIENCE – MINE WATER

Giant Mine - Deton Cho Nuna
Yellowknife, NT, Canada

Provided detailed design services to the care and maintenance contractor of a gold mine, to address mine water management and erosion and sediment control concerns prior to closure.

Dominion Diamonds Lynx Project
Lac de Gras, NT

Senior reviewer for baseline hydrology and associated components of water licensing for the Lynx expansion at the Ekati Project. Participated in technical sessions with stakeholders and regulators.

Giant Mine Remediation - PWGS Canada
Yellowknife, NT, Canada

Task lead for surface water drainage and Baker Creek components of this mine closure and remediation project. Prepared preliminary design reports for the two components, including preliminary engineering designs and Class B cost estimates suitable for presentation to the Treasury Board of Canada for funding applications. The work included consultation with stakeholders including Fisheries and Oceans Canada, Environment Canada, Northwest Territories Environment and the project owner, Aboriginal Affairs and Northern Development Canada. Also developed a high-level erosion and sediment control plan for the project in care and maintenance.

Fortune Minerals NICO Project
North of Wha Ti, NT

Senior reviewer for the erosion and sediment control plans for this Gold-Cobalt-Bismuth-Copper mine. Contributed to the surface water related components of the water licence application.

TransAlta Pit 9 Geomorphology and Closure Planning
Duffield, AB, Canada

Senior reviewer for geomorphological characterization and mine closure drainage planning for the Highvale Mine Pit 9 in the North Saskatchewan River valley.

PWGSC Tundra Mine Remediation
NT, Canada

Component lead for hydrological modeling at the Tundra Mine site, for a remediation project funded by Public Works and Government Services Canada. Developed a water balance model to evaluate the effects of remediation alternatives and design parameters on refilling duration and water yields in an evaporation-dominated, subarctic environment.



Agnico Eagle Meadowbank Gold Mine Project Kivalliq, NU, Canada	Senior reviewer and engineer of record for water management infrastructure. Project components included a mine surface water management plan and a submerged diffuser-style wastewater outfall. Design documents were used to support a Type A Water License application to the Nunavut Water Board.
De Beers Snap Lake Project NT, Canada	Hydrology and water management tasks contributing to an alternative evaluation of measures to manage and mitigate mine water inflows. Prepared a mine water management plan to satisfy regulatory requirements for the mine water license.
Fording Coal Ltd. – Greenhills Mine Elkford, BC, Canada	Preliminary site assessment of requirements for dam break inundation study component of Emergency Preparedness Plan for the main and west tailings dams.
Syncrude Canada Ltd. – Aurora North Mine Fort McMurray, AB, Canada	Project manager for evaluation of clean water diversion alternatives at the Aurora North mine, including outlets to Stanley Creek, the Muskeg River, Mills Creek, Fort Creek and the Athabasca River. The evaluation considered economic, environmental and technical/operational criteria to determine the best alternative. Served as project manager for the next phase of the project, which involved detailed design of ditch, pump and pipeline facilities for clean water diversion.
Canadian Natural Resources Ltd. – Horizon Mine Fort MacKay, AB, Canada	Manager for development of operational water management plan, closure reclamation drainage plan and conceptual design of the Athabasca River water intake. The operational water management plan included development of design criteria consistent with best management practices for oil sands mining operations, design of site-specific surface drainage, dewatering and diversion systems, development of a basal aquifer dewatering plan, development of a mine water balance for closed-circuited areas and derivation of raw water supply requirements for mining operations. The closure reclamation drainage plan involved the development of a progressive drainage plan, incorporating hydrologic and geomorphic considerations to ensure sustainability of the drainage system and landscape.
Syncrude Canada Ltd. – Aurora North Mine Fort McMurray, AB, Canada	Project manager for development of an operational water management plan for 10 years of mining activities, including a review of design criteria with specific application to Aurora North mine components, an assessment of surface water hydrology and drainage facilities at the mine, development of a muskeg and overburden dewatering plan and development of guidelines for sizing mine pit sumps and pumps.
TrueNorth Energy Fort McMurray, AB	Developed water management infrastructure designs for the TrueNorth Energy Fort Hills project plant site.
Albian Sands Energy Fort McMurray, AB	Update of closure reclamation drainage plan for mine components addressed in the 10-year conservation and reclamation plan. Component lead for a project to evaluate the alternatives and feasibility of release of saline basal aquifer water to surface water receiving environments.
Quintette Coal – Deputy and Shikano Common Pits Tumbler Ridge, BC	Review of hydrologic studies for this area, including derivation of design discharges for closure planning. Design of closure drainage facilities for two catchments, including feasibility-level design of a stepped spillway in bedrock for the Shikano Common pit.



**Iron Ore Company of
Canada – Wabush
Lake**

Labrador City, NL,
Canada

Task manager for hydrology and functional design components of this tailings management project. Responsible for baseline data collection and hydrological simulation model of the Wabush/Shabogamo Lake watershed, which was used to characterize baseline conditions and model the impacts of a tailings management system on the lake. Responsible for documenting and modeling ice conditions on the lake and assessing changes to the lake ice regime due to the tailings management system. Other tasks included lake bathymetry, water quality profiling, sediment sampling, infiltration testing on terrestrial tailings deposits, and training client personnel for hydrological data collection.

**Quintette Coal –
Babcock Window Pit**

Tumbler Ridge, BC,
Canada

Prepared water management plans for the Babcock Window pit and haul road at Quintette Operating Corporation's mine near Tumbler Ridge. Performed an analysis of available climatic and hydrologic data to determine site runoff and designed a sedimentation pond in accord with Provincial guidelines. Prepared quantity and cost estimates for construction.

**Syncrude – Beaver
River Diversion**

Fort McMurray, AB,
Canada

Prepared feasibility-level designs for several river diversion alternatives considered during closure planning for the Mildred Lake facility north of Ft. McMurray. Prepared quantity and cost estimates based on these designs and performed a net present value analysis to compare alternatives.

PROJECT EXPERIENCE – FISH HABITAT AND STREAM RESTORATION

**Agnico Eagle
Meadowbank Gold
Mine Project**

Rankin Inlet, NU

Senior reviewer and engineer of record for fish habitat compensation works design, developed to compensate for mine and access road development. Compensation measures included submerged reef structures in a lake environment and spawning riffles in an arctic river.

**Whitemud Creek
Erosion Study**
Edmonton, AB, Canada

Project manager an assessment of existing erosion and evaluation of future erosion potential under urbanized conditions. The project involved intensive data collection for approximately 40 km of stream length on Whitemud and Blackmud Creeks within the City limits. It included assessments of stream hydrology, geomorphology and valley wall instability, with the objective of identifying and prioritizing areas for application of mitigation measures.

**Big Island Lake
Stabilization**
Strathcona County, AB,
Canada

Project manager responsible for establishing the pre-disturbance water level regime of a small prairie lake and performing feasibility-level design of a control structure to restore the lake level. Included field surveys, hydrological and hydraulic modeling, environmental assessment and public consultation.

**Miramar Doris North
Gold Mine Project**
NU, CANADA

Engineer of record for design of fish habitat compensation works at the Doris North project, developed to compensate for mine, access road and port development. Compensation measures included spawning and rearing reef structures in lake and marine environments, rearing habitat in small streams, and fish passage mitigation works.

**ASRD – Watershed
Integrity Study**
AB, CANADA

Senior reviewer for a project commissioned by Alberta Sustainable Resource Development (ASRD) to use GIS methods to develop fish-based Indices of Biological Integrity (IBI) for Battle River sub-watersheds. The study used source data, including urban density, road network density and agricultural use to prepare maps that predicted levels of disturbance and IBI.



**EPCOR Water Services
– Fish Habitat
Compensation**
Edmonton, AB

Senior technical advisor to fish habitat compensation design for two rock riprap spurs on the North Saskatchewan River. These were developed to compensate for the effects of a new water intake structure for the E.L. Smith Water Treatment Plant.

**CN Rail – Fish Habitat
Compensation**
Wabamun Lake, AB,
CANADA

Senior technical advisor to fish habitat compensation design on False Creek, at the west inlet to Wabamun Lake. The project involved bank stabilization and habitat enhancement to provide compensation for damage caused by oil released during a train derailment.

**North Saskatchewan
Watershed Alliance**
Edmonton, AB,
CANADA

Hydrology and geomorphology component lead for the NSWA Instream Flow Needs (IFN) scoping study. This project was the first step in a process for watershed management under the framework of the Alberta Water for Life strategy, with the NSWA serving as the WPAC for the NSR.

**EPCOR Power –
Kepphills 3 Fish
Exclusion**
Kepphills, AB, CANADA

Prepared a study addressing fish exclusion at two river water intakes, two cooling pond intakes and a reservoir blowdown structure. These were used to evaluate alternatives for expansion of a coal-fired power generation facility and were used as a basis for discussions with regulatory agencies.

**Provincial Watercourse
Crossing Committee**
Kepphills, AB, CANADA

Senior technical advisor for a study entitled “Culvert stream crossings in Alberta – a review and evaluation of current practices” that examined legislation and regulations; standards and specifications; best management practices; education and outreach; stewardship; biological information; and landscape data. The intent of the project was to summarize and identify deficiencies in available information, and provide recommendations that might be effective in improving existing standards and procedures.

**Murray-Cheslatta
Stream Restoration
Scoping Study**
Prince George, BC

Hydrology and geomorphology component lead for a literature review addressing restoration alternatives for a river system that was previously degraded by a large scale stream diversion. This work was done for the Nechako Enhancement Society.

**City of Edmonton –
Clover Bar Creek
Restoration**
Edmonton, AB,
CANADA

Project manager an assessment of existing erosion and evaluation of future erosion potential under urbanized conditions. Undertook an intensive site reconnaissance on 5 km of stream length, assessed erosion potential and developed recommendations for restoration of existing erosion and treatments to prevent erosion under the future, urbanized flow regime. The project included a comprehensive alternative evaluation and quantity and cost estimates for selected alternatives. Later participated in process to resolve dispute over funding responsibilities between two municipalities.

**Regional Municipality
of Wood Buffalo**
Fort McMurray, AB,
CANADA

Project manager and lead engineer on a project to revitalize the Snye, a waterbody located upstream of the confluence of the Athabasca and Clearwater rivers. The Athabasca end of the Snye was blocked by causeway construction in the late 1960's, resulting in siltation and stagnation. This project included field surveys, a hydrology study and development of a feasibility-level design for hydraulic structures to manage flow through the Snye to enhance water quality and maintain a self-scouring inlet for navigation at the Clearwater entrance.

**DFO – Nulahugyuk
Creek**
Bernard Harbour, NU

Undertook a field reconnaissance and provided hydrology and geomorphology input to a study of an Arctic stream, to determine reasons why the historic Arctic char spawning run has not occurred in recent years and to develop remedial measures.



**Foothills Model Forest
– Hardisty Creek
Restoration**

Hinton, AB, CANADA

Project manager for fisheries and hydrological assessment and development of remediation measures for stream restoration and fish passage. Responsible for addressing concerns of stakeholders including industry, regulatory agencies, municipalities and environmental groups. The project included several phases, including assessment and design (2003-4), construction of stream restoration prescriptions (2004) and construction of a 1.8 m high riffle to backflood a culvert for fish passage (2005).

PROJECT EXPERIENCE – MANUALS AND GUIDELINES

**Alberta Gravel Pit
Development BMP
Guideline**

Edmonton, AB, Canada

Served as a senior reviewer for a project to develop the Best Management Practices User Manual for Aggregate Operators on Public Land, developed for Alberta Sustainable Resource Development in collaboration with the Alberta Sand and Gravel Association.

**Agriculture Canada
IWRM Guideline**

Brandon, AB, Canada

Served as project manager and contributing author for development of several modules and factsheets for an Integrated Water Management Guideline being developed internally by Agriculture and Agri-Food Canada. Phase 1 of the project included developing final drafts of 7 manual modules related to integrated water management in an agricultural context, and Phase 2 of the project included developing 35 factsheets describing various indicators related to agricultural water supply reliability, drainage, water use and conservation.

**TAC National Guide to
Erosion & Sediment
Control**

Ottawa, ON, Canada

Primary author and project manager for development of the TAC National Guide to Erosion and Sediment Control on Roadway Projects. This document was developed with the TAC Project Steering Committee, with review by the TAC Environmental Issues Subcommittee, the TAC Environment Council and the TAC Chief Engineer's Council, and it was subject to review and comments by Fisheries and Oceans Canada (DFO) at the regional and national levels. The intent of the document was to address erosion and sediment control regulatory issues, physical theory and risk assessment, as well as provide methods for developing erosion and sediment control plans over the life cycle of a project.

**TAC Erosion &
Sediment Control
Training**

Ottawa, ON, Canada

Provided technical input into development of a one-day training course based on the TAC National Guide to Erosion & Sediment Control on Roadway Projects, and subsequently led deliveries in Vancouver, Calgary, Red Deer, Ottawa, Saskatoon, Edmonton (2), Winnipeg, Fredericton (3) and Prince George.

**Alberta Transportation
Fish Habitat Manual**

Edmonton, AB, Canada

Co-author of the AT&U Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta. Wrote chapter on Erosion and Sediment Control Plan, including sample plans for bridge and culvert construction, and subsequently revised the chapter on Fish Passage. Prepared factsheets describing recommended mitigation procedures.

**TAC Synthesis of
Practice for the
Protection of Fish
Habitat**

Ottawa, ON, Canada

Contributed to, and compiled, TAC's Synthesis of Practice for the Protection of Fish Habitat. This document discusses the integration of habitat issues into transportation and stream crossing planning, reviews regulatory approval requirements and presents best management practices for habitat protection, channel design, fish passage and erosion and sediment control.



**MTO Gravity Pipe
Manual**
Toronto, ON, Canada

Senior technical reviewer for the Ontario Ministry of Transport (MTO) Gravity Pipe Design Manual. This document considered round pipes of less than 3 m diameter, including life cycle costing and risk analysis for concrete, steel, PVC and polyethylene materials.

DFO Culvert Guideline
Ottawa, ON, Canada

Contributor to the Fisheries and Oceans Canada (DFO) Guidance Document for Culvert Installation Modification and Maintenance.

PROJECT EXPERIENCE – HYDROLOGY/HYDROGRAPHICS

**Government of
Northwest Territories**
Sahtu Region, NT

Project director and senior reviewer for a surface water and groundwater baseline study of the Central Mackenzie Valley in the Sahtu region. The project involved an intensive review of scientific and traditional knowledge, including a field camp to validate findings with local First Nations.

Bluefish Hydro
Prosperous Lake, NT,
Canada

Developed erosion and sediment control plans for construction of a new dam and removal of the existing dam at the Bluefish Hydro project on the Yellowknife River, north of Yellowknife. The plan was submitted to regulatory authorities as part of the approval process and updated throughout construction. Provided expert advice for post-construction hydrological monitoring.

**Comaplex Meliadine
West Project 2007-2010**
NU, Canada

Performed a site reconnaissance was undertaken to determine station locations and locations relative to proposed mine infrastructure. Managed an annual hydrometric program and completion of the climate and hydrology components of an aquatic baseline synthesis report, including historical data and hydrological modeling to characterize long-term baseline conditions.

**North Saskatchewan
River Hydrographics
2003-12**
Kepphills, AB, Canada

Project manager for hydrographic and terrestrial surveys to monitor erosion and sedimentation over a reach length of approximately 1.5 km. The project also included use of an Acoustic Doppler Current Profiler (ADCP) to measure the velocity structure of flows on ten cross-sections along the reach.

**Bruce Power Peace
River NGS Baseline**
Peace River, AB

Component lead for baseline studies to support the impact assessment and potential development of a nuclear generating station on the Peace River, north of Peace River, Alberta.

**Genesee Expansion
Baseline**
Genesee, Alberta,
Canada

Component lead for baseline studies to support the impact assessment of a coal mine and power generating station expansion. Tasks included characterizing hydrological regime and geomorphology of local watercourses and the North Saskatchewan River.

**Miramar Doris North
Hydrological
Monitoring 2003-8**
NU, Canada

Responsible for the installation and operation of stream discharge and water level monitoring stations at the Project. Three stations were operated in 2003, six in 2004 and 2005, 17 in 2006 and 2007 and 18 in 2008. They were installed in stream, lake and marine environments. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime. Additional tasks included spring snowcourse surveys to measure snow depths and snow water equivalents on the range of aspects and terrain present at the project.

**De Beers Gahcho Kué
Project Monitoring
2007, 2010, 2011**
NT, Canada

Managed the installation and operation of six continuous hydrometric stations. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime.



Triex Mountain Lake Project
NU, Canada

Component lead for manual hydrometric monitoring and site reconnaissance at a uranium mining exploration project.

Dundee George & Goose Hydrological Monitoring 2005
NU, Canada

Managed the installation and operation of one continuous and two manual stream discharge and lake level monitoring stations at the Dundee Precious Metals George and Goose (Back River) Project. Tasks included manual stream gauging, development of stage-discharge rating curves and processing of data used to characterize the local hydrological regime.

CNRL – Primrose and Wolf Lake Expansion Project
AB, Canada

Responsible for initial scoping of the climate and hydrology baseline study, including definition of the local and regional study areas and identification of existing sources of data. Responsible for recommendations and cost estimates for the local climate and hydrology monitoring program.

Oil Sands Climatic & Hydrological Monitoring 1998 to 2002
AB, Canada

Managed the climate and hydrology component of the Regional Aquatics Monitoring Program (RAMP). This study of various streams and lakes in the oil sands area included approximately 35 hydrometric stations and three climate stations from Janvier in the south to the Firebag River in the north. It included the Athabasca River, Muskeg River and tributaries, Birch Mountains drainages, Poplar Creek, Kearl, McClelland and Isadore's Lakes. Responsible for the collection of data from climatic monitoring stations in the area and for undertaking snow surveys in various study areas. Analysis included processing stream discharge and water level data, preparing stage-discharge rating curves and synthesizing hydrographs. All available local and regional data were compiled in a database for easy reference. Provided data support to RAMP funders and to authorized third parties, including regulatory agencies, consultants and contractors.

Oil Sands Regional Hydrological Modeling
Fort McMurray, AB, Canada

Project manager for development of a regional hydrological (HSPF) model of the oil sands region. This model has subsequently been used as the basis for several environmental impact assessment baseline reports. The model was also used as the basis for development of design runoff curves for mine operational water management.

De Beers Canada Mining Inc. - Snap Lake Project
NT, Canada

Managed the baseline hydrology study, including acquisition and processing of local snowpack, stream discharge and water level data. Responsible for the installation and operation of three stream discharge monitoring stations and one lake level monitoring station at Snap Lake.

OPTI Canada Ltd. – Long Lake Project
AB, Canada

Task manager for spring 2000 snow survey. Participated in initial scoping of the climate and hydrology baseline study, including identification of existing sources of data. Responsible for recommendations and cost estimates for the local climate and hydrology monitoring program.

Synenco Field Reconnaissance
AB, Canada

Led a field reconnaissance to identify potential locations for hydrometric monitoring activities to support baseline hydrological data collection. The study area was located in the Marguerite River watershed, approximately 100 km north of Fort McMurray.

Suncor Firebag River Field Reconnaissance
AB, Canada

Performed a field reconnaissance to determine the origin of base flow in small tributaries to the Steepbank, Muskeg and Firebag Rivers. The area was surveyed for the existence of streams fed by springs originating in the sand and gravel aquifer beneath Muskeg Mountain.



Syncrude Canada Ltd.
- Mildred Lake
Fort McMurray, AB,
Canada

Performed a regional hydrological analysis of Environment Canada–Atmospheric Environment Service precipitation and evaporation data to derive inflows to approximately 70 lakes in the region. This information was used in an environmental impact study of airborne emissions on lake water quality.

**Mackenzie River near
Fort Providence**
NT, Canada

Observed and collected field data during the period of ice breakup to be used in a study to identify factors influencing the date of river breakup. Relevant data included river stage, ice characteristics and Water temperatures.

PROJECT EXPERIENCE – PIPELINES

Pipeline Crossing Overview

Nathan has led pipeline watercourse crossing designs for oil, gas, bitumen, diluent and water pipelines, primarily in Alberta, for Shell, Enbridge, TCPL, Anadarko, Talisman and other companies. These assignments typically involve characterizing the hydrological regime at the crossing, modeling watercourse hydraulics, including scour potential, and considering the fluvial geomorphology at the crossing to assess lateral channel migration potential. The results of this analysis are used to specify pipeline burial depths, sagbend setbacks and associated mitigation measures to prevent exposure over the operating life of the pipeline. This work also typically contributes to regulatory applications and compliance, under Alberta Water Act Codes of Practice, Environmental Protection Plans and Conservation and Reclamation Plans, and support for applications under the Canada Fisheries Act, Navigable Waters Protection Act and National Energy Board Act.

PROJECT EXPERIENCE – BRIDGES, CULVERTS AND BANK PROTECTION

River Crossing and Bank Protection Overview

Nathan has led the hydrotechnical component of stream crossing assessment and design for numerous public and private organizations, including hydrotechnical designs for over a dozen highway bridges in Alberta and British Columbia, hydrotechnical assessments for dozens of sites in Alberta, river protection works in Alberta and British Columbia, and mine access road crossings in Alberta, the Northwest Territories and Nunavut. These assignments typically involve characterizing the hydrological regime at the crossing, modeling watercourse hydraulics, including scour potential, and considering the fluvial geomorphology at the crossing to assess channel stability. The results of this analysis are used to specify waterway openings, structure elevations and headslope armour requirements. Many assignments included regulatory tasks including provincial and federal agencies.

PROJECT EXPERIENCE – EROSION AND SEDIMENT CONTROL

Erosion and Sediment Control Overview

Nathan has over ten years experience at erosion and sediment control planning, regulatory compliance, guidance document preparation and training delivery. This includes assignments in northern environments, including Giant Mine care and maintenance activities, the Mackenzie Valley Winter Road and the Bluefish Hydro dam replacement project. He was the primary author of the TAC National Guide to Erosion and Sediment Control on Roadway Projects and is the current lead instructor for the associated training course.



PROJECT EXPERIENCE – MUNICIPAL & INDUSTRIAL WATER MGMT

Lowe's Site Assessment Alberta, Canada	Senior reviewer for a site assessment at proposed Lowe's big box store locations in South Edmonton Common, Stony Plain Road West, Clareview and Red Deer, including flooding and site water management issues and regulatory compliance.
TOTAL E&P Canada Strathcona Upgrader Ft. Saskatchewan, AB	Served as senior technical advisor for a water intake scouting study on the North Saskatchewan River, including field studies and alternatives evaluation.
City of Edmonton Environmental Monitoring Program Edmonton, AB, Canada	Project manager for the City of Edmonton's Environmental Monitoring Program (EMP) and North Saskatchewan River (NSR) monitoring program, 2006-2012. This program included dry weather and storm event monitoring of storm sewer and combined sewer outflows, stormwater management ponds, the NSR and tributaries. A quasi-realtime monitoring program was also conducted by sampling from industrial and municipal water intakes, while considering NSR travel times.
TrasnAlta Sundance NGCC Plant Alberta, Canada	Senior reviewer for a stormwater management assessment of a proposed natural gas combined cycle (NTCC) power plant on the Sundance Cooling Pond, south of Wabamun Lake. Also responsible for evaluation of water supply issues from the North Saskatchewan River.
Morris Wetland Hydrology Alberta, Canada	Senior advisor for a study to evaluate mitigation measures required for remediation of an existing stormwater management pond, with a planned contaminated sediment remediation and conversion to a constructed wetland.
Alta Steel Stormwater Management Pond Alberta, Canada	Senior reviewer for a study to evaluate the performance and regulatory compliance for an industrial stormwater pond at a steel recycling facility in the City of Edmonton, discharging to Gold Bar Creek.
Confidential Client – Water Supply Scoping Study Fort Saskatchewan, AB, Canada	Authored a scoping study to examine water supply and wastewater disposal issues related to development of a bitumen upgrader in Alberta's Industrial Heartland. The study examined the hydrological characteristics of the North Saskatchewan River and other potential sources of water supply and wastewater disposal. It provided a review of regulatory issues related to site development and water supply, including the draft Alberta Environment Water Management Framework, and discussed the role of regulatory and stakeholder bodies.
Confidential Client - Industrial Heartland Water Management Alberta, Canada	Reviewed stormwater management pond design for an industrial site in Alberta's Industrial Heartland for a confidential client, provided recommendations for pond sizing and overall site water management, and completed regulatory application for stormwater management.
Government of Northwest Territories DOT Sahtu Region, NT, Canada	Provided hydrological data collection and analysis for eighteen watercourses along the Mackenzie Valley Winter Road to assess their viability for winter water supply. These watercourses are regulated by the Mackenzie Valley Water Board and Fisheries and Oceans Canada to prevent harm to aquatic life. The study considered site-specific data collected for the project and for previous studies, including the Mackenzie Gas Project (2002-2004) and Arctic Gas Project (1972-73), as well as long-term regional data collected by Environment Canada.



**Athabasca River Water
Intake Construction
Monitoring**
Fort MacKay, AB

Project director for provision of environmental monitoring services at the Canadian Natural Resources Ltd. Athabasca River water intake. Golder monitored sediment and other water quality parameters to ensure regulatory compliance.

Rio Tinto Alcan Facility
Alberta, Canada

Performed an assessment of an existing coke handling facility in Strathcona County to evaluate compliance with stormwater management regulations.

**Mackenzie Property
Stormwater Mgmt**
Alberta, Canada

Senior advisor/reviewer for design and permitting of remedial stormwater measures at a country residential property, after the client had been issued a remediation order by a provincial regulatory agency.

**Alberta Infrastructure
ASAP2 School Siting
Studies**
Alberta, Canada

Undertook reviews of available flood hazard assessment information for 14 proposed schools in southern Alberta to establish whether they were situated above the 1:500 year flood level. This was done to determine their suitability for use as community disaster response facilities. Where necessary to fill data gaps, supplementary hydrological and hydraulic studies were performed.

**Capital Power Genesee
Generating Station**
Genesee, AB, Canada

Project manager responsible for hydrological and water quality studies to support permit applications for a new water licence at the Genesee Generating Station, to enhance water quality in the cooling pond. Tasks included participation in a community consultation workshop.

**Alberta Infrastructure
P3 Hospital Siting
Studies**
Northern Alberta,
Canada

Served as the project manager for siting studies of proposed P3 hospital projects in Edson, Grande Prairie and High River, and as the component lead for flood hazard assessment. The purpose of each flood hazard assessment was to establish whether the locations were situated above the 1:1000 year flood level, because these are critical disaster response facilities. Supplementary hydrological and hydraulic studies were performed at the Edson and High Prairie sites to fill gaps in the available data.

**Alberta Infrastructure -
LETC Siting Studies**
Fort McLeod, AB,
Canada

Component lead for flood hazard assessment at a proposed Law Enforcement Training Centre at Fort McLeod, adjacent to the Oldman River. The work entailed desktop studies to evaluate whether proposed location was situated above the 1:500 year flood level, to confirm its suitability for use as a community emergency response location. Existing information was compiled and evaluated, and supplementary hydrological and hydraulic studies were performed.

**Alberta Infrastructure -
ASAP3 School Siting
Studies**
Southern Alberta,
Canada

Component lead for flood hazard assessments at 13 proposed schools in southern Alberta. The work entailed desktop studies to evaluate whether proposed school locations were sited above the 1:500 year flood level, to confirm their suitability for use as community emergency response locations. Existing information was compiled and evaluated, and where necessary, supplementary hydrological and hydraulic assessments were performed.

**Peace River Oil –
Bluesky Upgrader**
McLennan, AB, Canada

Prepared a water supply scoping study for a proposed bitumen upgrader. Evaluated surface water supply alternatives based on hydrological and ice characteristics and provided quantity and cost estimates.

**CN Rail – McLennan &
Grande Prairie Yards**
Alberta, Canada

Senior technical advisor for water quality assessment and remedial drainage design for a rail yard, including topographic and drainage surveys, water quality sampling conceptual and detailed design of mitigation measures.



**Hwy 679 and 749
Drainage Study**
High Prairie, AB,
Canada

Project manager for assessment and remedial drainage design of two intersecting sections of rural highway. Project components included a field reconnaissance, site surveys, interviews with local residents and hydrological modeling to evaluate deficiencies in the existing system and to develop design recommendations to mitigate flooding.

**Igloo Building
Products**
Stony Plain, AB, Canada

Project manager for drainage design of an 80 ha parcel of land in the Acheson Industrial Park. The project included hydrological modeling and grading design to meet Province of Alberta and Parkland County regulations.

Golden West Homes
Stony Plain, AB, Canada

Project manager for stormwater management permitting (Alberta Water Act) drainage design of an 11 ha parcel of land in Parkland County. The project included hydrological modeling to meet provincial and county regulations.

**County of Vermilion
River**
Kitscoty, AB, Canada

Golder was a subconsultant to Urban Systems Limited on this water supply study for the County of Vermilion River, and was responsible for the surface water hydrology, hydrogeology and geographic information systems components of the project. Served as the Golder project manager and senior reviewer. Long-term hydrometric data were used to determine water supply availability under mean and 10-year dry conditions, including an allowance for Instream Flow Needs. The GIS component included analysis of groundwater and surface water supply as well as the results of a public consultation.

**Prairie Farm
Rehabilitation
Administration**
Barrhead, AB, Canada

Golder was a subconsultant to Urban Systems Limited on this water supply study for Barrhead County, and was responsible for the surface water hydrology, hydrogeology and geographic information systems components of the project. Served as the Golder project manager and was responsible for the hydrology analysis. Long-term hydrometric data were used to determine water supply availability under mean and 10-year dry conditions, including an allowance for Instream Flow Needs. The GIS component included analysis of groundwater and surface water supply as well as the results of a public consultation.

PROJECT EXPERIENCE – SERVICE

2012-2014	NSERC Grant Selection Committee, Research Tools & Instruments
2011-	Stollery Children's Hospital / Edmonton Rowing Club "Row for Kids" fundraiser - Co-chair (2011) then Chair (2012-)
2009-2011	NSERC Grant Selection Committee, Civil Engineering Environment
2003-2010	APEGA Environment Committee (Chair, 2004-2010)
2002-2009	Consulting Engineers of Alberta Environment Committee
2004-2009	Canadian Water Resources Association, Alberta Director
2005	CSCE 17 th Hydrotechnical Conference – Technical Program Chair and Proceedings Editor
2005	CWRA National Conference – Organizing Committee

**Education**

*Post-Doctoral Fellowship
Environmental Biology &
Ecology, Alberta Co-
operative Conservation
Research Unit, Edmonton,
AB, 2006*

*PhD Environmental Biology
& Ecology, University of
Alberta, Edmonton, AB ,
2005*

*MSc Biology, University of
New Brunswick,
Fredericton, NB, 2000*

*HBSc Zoology, University
of Guelph, Guelph, ON,
1996*

Languages

English – Fluent

Golder Associates Ltd. – Edmonton***Aquatic Biologist***

Cam is a senior aquatic biologist based out of Golder's Edmonton office. He holds a PhD in Environmental Biology and Ecology from the University of Alberta, and a Post-Doctoral Fellowship from the Alberta Cooperative Conservation Research Unit. For the past eight years Cam has been providing ecological advice as the lead project biologist for mining and energy sectors. Cam consults on environmental impact assessments, monitoring programs, community engagement, and applied research, as part of regulatory requirements for both proposed and operating developments in northern and western Canada.

Cam is committed to innovative solutions under the demands of environmental permitting schedules and the rigours of regulatory review. His approach considers the best available technology, tools, and the most recent scientific advances for understanding the diversity of interactions that characterize ecosystems. Key skills include strong communication in the science and technical aspects of consulting to various audiences and readers. His accomplishments include an executive position with the Mid-Canada Chapter (MCC) of the American Fisheries Society, a community outreach award from the Consulting Engineers of Alberta, and numerous peer-reviewed publications, the most recent on conservation planning for Arctic Grayling in Alberta.

Employment History***Golder Associates Ltd. – Edmonton***

Project Biologist (2006 to Present)

As a consultant with Golder, Cam has been providing advice on various ecological projects and monitoring programs in Western Canada, the Canadian Arctic, and Central America. Cam's projects have included cumulative effects assessments and baseline data collections for aquatic resources as part of regulatory requirements for new mining developments. Conservation planning is also a part of his work for governmental and non-governmental contracts. These projects often include sophisticated analyses for modelling fish and wildlife habitat and populations.

***ACCRU (Alberta Cooperative Conservation Research Unit) –
Edmonton, AB***

Research Associate (2006 to 2006)

As a post-doctoral fellow, Cam was the lead researcher of a team of biologists from the Alberta Conservation Association, Alberta Sustainable Resource Development, and the University of Alberta. Cam's primary objective was to conduct a pilot study near Three Hills, Alberta to assess whether an effective fish-based monitoring tool could be developed to characterize the ecological condition of small streams in the grassland ecoregion. This work has been published in the Alberta Conservation Association report series, and has been presented many times to various stakeholders and agencies throughout Alberta.

***University of Alberta – Edmonton, AB****Graduate Student (2000 to 2005)*

Cam studied various topics related to conservation biology, boreal amphibians, ecology of beaver ponds, and population monitoring. His research included a large-scale field program assessing population sizes of amphibians on beaver ponds. Cam also conducted a mesocosm experiment of the physiochemical factors affecting larval performance in ponds. The field work was conducted in the Weyerhaeuser Forest Management Area near Drayton Valley. Field data was supplemented with GIS-based information, for example, Cam used a novel combination of a digital elevation model, vegetation inventory data, and spatial analyst tools in ArcGIS to characterize the distribution of beaver ponds on boreal streams. This research was funded by successful grants received from the ACA Challenge Grants in Biodiversity, Canadian Circumpolar Institute, Mountain Equipment Co-op, and the Alberta Government Development Initiative. This work resulted in numerous publications, research awards and media coverage.

University of New Brunswick – Fredericton, NB*Graduate Student (1998 to 2000)*

Cam studied the effects of wetland restoration on waterfowl populations and wildlife communities in PEI. Briefly, in the field, Cam conducted surveys for waterfowl pairs and broods, playback surveys for secretive marsh birds, and call surveys for breeding anurans. In a GIS platform, Cam measured landscape metrics for wetlands using GIS buffer and nearest neighbour functions, and georeferenced, spatially-corrected aerial photographs in ArcVIEW. This research was funded by Ducks Unlimited Canada and the Government of Prince Edward Island.

Canadian Wildlife Service – Bay of Fundy, NB*Research Assistant (Volunteer) (1998 to 1999)*

This position was to provide assistance for monitoring populations of seabirds and their movements via a research vessel in the Bay of Fundy during winter 1998-1999. The work led to multiple publications on the ecology of seabirds.

Thunder Cape Bird Observatory – Lake Superior, ON*Research Assistant (Volunteer) (1996 to 1997)*

This was a volunteer position. Primary duties were to assist with observing and banding migratory birds during their fall migration. I banded approximately 500 birds of 100 species while monitoring migrating waterfowl and raptors during fall 1996 and fall 1997.

Trent University – Peterborough, ON*Research Assistant (1996 to 1996)*

This was my first position as a research assistant. I assisted with locating nests, radio-tracking ovenbirds, and trapping insects in fragmented forests of Central Ontario. The work sparked a passion for the study of fish and wildlife that I continue to have to this day.



PROJECT EXPERIENCE – ENVIRONMENTAL ASSESSMENT

**Back River Habitat
Offsetting**
Nunavut, Canada

Cam is the project manager for the development of a habitat offsetting plan for a new mining development in Nunavut. The work is being performed under the recently revised Fisheries Act for an authorization for development under Section 35. A key part of the plan is the application of Golder's "Bernard Harbour Study" as the offsetting option to counterbalance losses incurred at the mine site. Fisheries and Ocean's Canada is a staunch supporter of this project, in part, because the project aligns with their new policy. Baseline studies of the Arctic Char run at Bernard Harbour were performed in 2013. The development of the detailed offsetting plan will occur in 2014. A novel element of the work is the partnership with the community Hunters and Trappers Organization in Kugluktuk.

Izok Corridor Project
Nunavut, Canada

Cam led a baseline assessment of fish and fish habitat in preparation of an environmental impact statement for a new mining development in Nunavut, Canada. The project included a hydroacoustic study of fisheries and lake substrate for a small Arctic lake. The assessment provided an accounting of habitat losses to be incurred by proposed mining activities, as part of the No-Net Loss Plan (under the Fisheries Act). Golder Project #12-1373-0020.

Meliadine Project
Nunavut, Canada

Cam was the component lead for fish and fish habitat in the Environmental Impact Statement (EIS) for a new gold mine near Rankin Inlet, Nunavut. The work assessed incremental and cumulative impacts in accordance with the terms of the Nunavut Impact Review Board. The EIS is currently under review and can be downloaded at www.nirb.ca. Golder Project # 10-1373-0076.

NICO Project
NWT, Canada

Cam was the lead author for the fish and wildlife (higher trophic level) components of a Developer's Assessment Report (DAR) for a new gold mine for Fortune Minerals Inc. in the Northwest Territories (NWT). Cam wrote a scientifically defensible assessment of cumulative impacts to aquatic resources and the terrestrial environment. Part of the assessment included the development and application of a winter resource selection function (RSF) for barren-ground caribou. The assessment exceeded the Terms of Reference prepared by the Mackenzie Valley Environment Impact Review Board. The EIS can be downloaded at www.reviewboard.ca. Cam was a key witness for the client as part of a successful hearing for the assessment. Golder Project # 09-1373-1004.



Gahcho Kue Project
NWT, Canada

Cam was the lead author and component lead for the wildlife sections of an environmental impact statement (EIS) for a new diamond mine for DeBeers Canada in the Northwest Territories (NWT). Cam's main role was to deliver a defensible assessment of cumulative impacts to barren-ground caribou and carnivores that exceeded the Terms of Reference put forward by the Mackenzie Valley Environmental Impact Review Board. The EIS was subject to independent review of the highest level required for a development by the Review Board in NWT. The EIS was a culmination of multiple years of environmental baseline data collection and impact assessment analysis of which Cam was a key team member. Cam's work was shared with, and communicated to the local aboriginal communities in NWT. The EIS team, of which Cam was a part of, was selected for a President's Award within Golder Associates Canada Ltd. The EIS can be downloaded at www.reviewboard.ca. Cam was a key witness for the client as part of a successful hearing for the environmental assessment. Golder Project # 11-1365-0012

Legacy Project
Saskatchewan, Canada

Cam was a technical lead for an environmental impact statement (EIS) for a new potash mine for Potash One in southern Saskatchewan. Cam's primary roles were to oversee reporting phases and to ensure that the biodiversity section met the Terms of Reference of the Saskatchewan Ministry of the Environment. Cam also led the habitat modelling components, such as habitat suitability indices and resource selection functions, for a suite of species of conservation concern. The project was selected for a President's Award within Golder Associates Canada Ltd. The EIS can be viewed at www.environment.gov.sk.ca/environmentalassessment. Golder Project # 08-1362-0493.

Petaquilla Project
Colon, Panama

Cam was the 'Aquatic Resources' technical lead collecting baseline information for a new copper mine development for Teck Resources Limited in a remote tropical forest ecosystem. The work was prepared according to International Finance Corporation performance standards and was consistent with Panamanian environmental law. Data was collected on a diversity of fish and macroinvertebrate species in stream sections representing various distances to the coast. Golder Project # 07-1334-0018.

Back River Project
Nunavut, Canada

Cam was the project manager and 'Aquatic Resources' lead for a baseline study for a new gold mine for Dundee Precious Metals in the Central Canadian Arctic. The work met federal and territorial regulatory requirements for a future application to license the mine. Components of the work included collections of environmental and fisheries data in small Arctic lake in the study region. The overall goal was to generate a rigorous ecological database for a future environmental impact statement. Golder Project # 06-1373-045



PROJECT EXPERIENCE – BIOLOGICAL SCIENCES

Bernard Harbour Arctic Char Nunavut, Canada

Cam was the project manager and lead researcher for an environmental stewardship - education outreach program with the goal of maintaining the persistence of a self-sustaining population of Arctic char in Nulahugyak Creek (Bernard Harbour). The project, administered by the local Hunting and Trapping Organization, was funded by multiple jurisdictions and agencies. The project engaged local youth from the community of Kugluktuk who actively participated in restoring stream connections in a small stream flowing into Bernard Harbour. The study was presented with an award from the Consulting Engineers of Alberta, and is being prepared for submission to a peer-reviewed journal. Golder Project # 10-1373-0075.

PROJECT EXPERIENCE – BIOLOGICAL SCIENCES

Caribou Habitat Mapping for Cliffs Chromite Project Ontario, Canada

Cam was the component lead for a study titled "Resource Selection Functions (RSFs) for Forest-Dwelling Woodland Caribou in the Far North of Ontario". The primary objective was to use satellite collar data for developing season-specific RSF models that reliably predict preferred habitats (and distributions) for forest-dwelling woodland caribou in northern Ontario. A secondary objective was to better understand habitat requirements for the persistence of self-sustaining populations for the forest-dwelling ecotype. The final report was submitted to the Ontario Woodland Caribou Resource Selection Function Working Group in September 2012. Golder Project # 10-1118-0015.

Hydroacoustic Assessment of Habitat Compensation Alberta, Canada

Cam was the component lead for a hydroacoustic assessment of fisheries in Horizon Lake, Alberta. Biosonics echosounders were deployed along transects. Data were evaluated in Echoview using a Fish Tracking module, combined with Love's target strength equation. The work was part of a habitat compensation plan for an oil sands mine in northern Alberta. Golder Project #13-1337-0006.

Hydroacoustic Fisheries Assessment of a Small Arctic Lake NWT, Canada

Cam was the component lead for a hydroacoustic assessment of fisheries in Kennady Lake, NWT. BioSonics echosounders (side and down-looking) were deployed along transects, representing a pre-determined level of coverage to meet reliability expectations. Data were evaluated using integration methods, target strength equations were applied, and results were linked to gill netting catch data. The work was part of a baseline study for an environmental impact statement. The study can be downloaded at www.reviewboard.ca. Golder Project # 09-1365-1004.



PROJECT EXPERIENCE – BIOLOGICAL SCIENCES

**Effects of Water
Quality on Amphibians
in Beaver Creek**
Alberta, Canada

Cam was the lead researcher in a study of amphibians in Beaver Creek, Alberta, downstream of Mildred Lake. The study had three components: field surveys of amphibian populations, an in-situ field experiment examining larval growth and development, and a controlled study in a laboratory setting at the University of Alberta. The work will contribute to an understanding of downstream effects from an oil sand development in northern Alberta. Golder Project # 12-1337-0004.

**Effects of Development
on Barren-ground
Caribou**
Nunavut, Canada

The study assessed the effects of the mining sector and other developments on the behaviour and movements of caribou using a spatial dataset of collar locations combined with observations reported by local elders and hunters in Kugluktuk. Cam was the lead author of the scientific component. The study team consisted of the Kugluktuk Hunting and Trapping Organization (KHTO), and Golder Associates Ltd, and was funded by both the KHTO and the Nunavut Wildlife Management Board. A significant component of this project included community engagement and environmental stewardship. The report is being prepared for submission to the journal Rangifer. Golder Project # 10-1328-0042.

**Conservation Planning
in Central Ontario**
Ontario, Canada

Cam was the lead author and project manager for a conservation assessment of surrogate species representing biodiversity and ecosystem values in the Eastern Ontario Model Forest (as part of the National Agri-Environmental Standards Initiative). Cam used GIS-based habitat suitability models to quantify the amount and configuration of habitats for various management scenarios. These scenarios were compared in population viability analyses. Linkages to, and identification of minimum habitat requirements that sustain populations above critical thresholds were determined. Golder Project # 06-1373-052.

**Battle River Index of
Biological Integrity**
Alberta, Canada

Cam was the lead investigator for the development and testing of a fish-based Index of Biological Integrity (IBI) for the Battle River, AB. The goal was to develop a bio-monitoring tool and then quantify the health of the Battle River. Data for this project was collected by the Alberta Conservation Association, and was part of provincial efforts for developing monitoring standards. This work was published in the Water Quality Research Journal of Canada. Golder Project # 07-1373-0066.

**Monitoring Wolverine
Activity at a Diamond
Mine**
NWT, Canada

Cam was the lead investigator on a study of a comparison of effects monitoring methods for wolverine at the Diavik Diamond Mine Inc. (DDMI). The primary goal was to assist DDMI with the evaluation of their wildlife management plan. Specifically, Cam examined the efficiency of measurements obtained from DNA-based mark-recapture methods, versus snow tracking methods for monitoring temporal and spatial changes in wolverine activity (2003-2006). This research is being prepared for submission to a peer-reviewed journal. Golder Project # 10-1328-0028.



PROJECT EXPERIENCE – TEACHING

University of Alberta
Alberta, Canada

Cam was a teaching assistant for the Department of Biological Sciences, University of Alberta (2000-2005). Cam taught undergraduate labs for Biology 108 (Introduction to Biology), Zoology 332 (Community Ecology), and Zoology 224 (Vertebrate Diversity). Cam was awarded letters of commendation for his teaching while at the university.

**University of New
Brunswick**
New Brunswick, Canada

Cam was a teaching assistant for the Department of Biology, University of New Brunswick. Cam taught undergraduate labs for Biology 1001 (Introduction to Biology) and Biology 2113 (Ecology).

PROFESSIONAL AFFILIATIONS

Mid-Canada Chapter, American Fisheries Society (President 2010-11)

American Fisheries Society (Member since 2007)

Society for the Study of Amphibians and Reptiles (Member since 2001)

Canadian Journal of Fisheries and Aquatic Sciences (Reviewer)

Journal of Herpetology (Reviewer)

Biological Conservation (Reviewer)

PUBLICATIONS

Other

Macpherson, L. M., M. G. Sullivan, A. L. Foote, and C. E. Stevens (2012) Evaluating sampling techniques for low-density populations of Arctic grayling (*Thymallus arcticus*). *Northwestern Naturalist* 93: 120-132.

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Stevens, C.E., and C.A. Paszkowski, and A.L. Foote (2007) Beaver (*Castor canadensis*) as a surrogate species for conserving anuran amphibians on boreal streams. *Biological Conservation* 134:1-13.

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Stevens, C., G. Scrimgeour, W. Tonn, C. Paszkowski, M. Sullivan, and S. Millar (2006). Quantifying the health of grassland streams in Alberta using Index of Biotic Integrity methods. Produced as technical report in the Alberta Conservation Association Report Series.



Gillies, C.S., Krawchuk, M.A., Aldridge, C.L., Hebblewhite, M., Frair, J.L., Saher, D.J., Stevens, C.E., Jerde, C.L., and S.E. Nielsen (2006) Application of random effects to the study of resource selection by animals. *Journal of Animal Ecology* 75:887-898.

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Stevens, C. E., and C. A Paszkowski (2005) a comparison of two pitfall trap designs in sampling boreal anurans. *Herpetological Review* 36:147-149.

Stevens, C.E. (2005) Role of Beaver in Amphibian Ecology and Conservation in the Boreal Foothills of Alberta. Thesis presented in partial fulfillment of requirements for Ph.D., University of Alberta, Fall 2005.

Stevens, C. E. (2005) Review of CARCNET 2005. *Canadian Association of Herpetologists* 13 (2):5.

Stevens, C. E., and C. A Paszkowski (2004) Using chorus-size ranks from call surveys to estimate reproductive activity of wood frogs. *Journal of Herpetology* 38:404-410 (Kennedy Student Award).

Eaton, B. R., S. Eaves, C. E. Stevens, A. Puchniak, and C. A. Paszkowski (2004) Deformity levels in wild populations of wood frog in 3 ecoregions of western Canada. *Journal of Herpetology* 38:283-287.

Stevens, C. E. (2004) Effects of a petroleum pipeline failure on an aquatic environment in the Alberta Foothills. Pages 4-5 in *Environmental News*, volume 4, issue 1, Beverley Levis (editor). Environmental Research and Studies Centre, University of Alberta, Edmonton, AB.

Stevens, C. E. (2004) Restored wetlands on Prince Edward Island, Canada. Pages 374-376 in *Fundamentals of Biogeography*, 2nd edition, Richard John Huggett (editor). Routledge Fundamentals of Physical Geography, NY.

Stevens, C. E., T. S. Gabor, and A. W. Diamond (2003) Use of restored small wetlands by breeding waterfowl in Prince Edward Island, Canada. *Restoration Ecology* 11: 3-12.

Stevens, C. E., and S. Gabor (2003) Waterfowl on Prince Edward Island. *Ducks Unlimited Conservator* 24(1):38.

Stevens, C. E., and C. A. Paszkowski (2003) Amphibian Research in Drayton Valley Forest Management Area, Weyerhaeuser, Canada, Ltd. Technical Report for Weyerhaeuser, Canada, Ltd., Edmonton, AB.

Stevens, C. E., S. Eaves, and C. A. Paszkowski (2003) The boreal chorus frog: groundfrog or treefrog? Page 5 in *Croaks and Trills*, volume 8, issue 1, Kris Kendell (editor). Alberta Conservation Association and Alberta Sustainable



Resource Development, Edmonton, AB.

Stevens, C. E., A. W. Diamond, and T. S. Gabor (2002) Anuran call surveys on small wetlands in Prince Edward Island, Canada restored by dredging of sediments. *Wetlands* 22: 90-99.

Huettmann, F., K. MacIntosh, C. E. Stevens, T. Dean, and A.W. Diamond (2000) A mid-winter observation of a large population of Bonaparte's Gulls in the Head Harbour Passage, Passamaquoddy Bay. *Canadian Field-Naturalist* 114: 327-330.

Brooks, R.J., M. A. Krawchuck, C. E. Stevens, and N. Koper (1997) Testing the precision and accuracy of age estimation using lines in scutes of *Chelydra serpentina* & *Chrysemys picta*. *Journal of Herpetology* 31: 521-529.

Huettmann, F., B. Dalzell, T. Dean, A. W. Diamond, D. MacFarlane, K. MacIntosh, L. Murison, and C. Stevens (1999) Aspects of change for wintering Razorbills (*Alca torda*) in the Lower Bay of Fundy. In *Understanding Change in the Bay of Fundy Ecosystem*, J. Ollerhead, P. W. Hicklin, P. G. Wells, and K. Ramsay (Editors). Pages 30-33.

Stevens, C. E. (1998) The PEI wetland restoration project. *New Brunswick Naturalist* 25(3):83.

Stevens, C.E. (1996) Testing the accuracy of age estimation using lines of scutes of *Chelydra serpentina*. Honors Thesis presented in partial fulfillment of B.Sc., University of Guelph, Spring 1996.



Education

*B.Sc. (Honours) Zoology,
University of British
Columbia, Vancouver,
British Columbia, 1988*

*M.Sc. Biology, University of
Saskatchewan, Saskatoon,
Saskatchewan, 1991*

*Ph.D. Biology, University of
Saskatchewan, Saskatoon,
Saskatchewan, 1997*

Golder Associates Ltd. – Saskatoon

Senior Ecologist

John Virgl is a Principal and Senior Ecologist with Golder Associates Ltd. in Saskatoon.

Dr. Virgl has over 20 years of domestic and international experience in the design, statistical analysis, interpretation, and practical and theoretical application of ecological studies in research and industrial projects. He has written over 50 reports and published 18 articles in refereed scientific journals on a wide range of taxonomic groups including benthic invertebrates, fish, song birds, peregrine falcons, small mammals, black bears, and tundra and woodland caribou. His expertise includes academic research and teaching, environmental impact assessment and monitoring, population modelling and risk assessment, and cumulative effects assessment.

His main area of practice is the mining industry, but he has also worked with clients in the power, oil and gas, and forestry. John has provided his expertise to potash, uranium, diamond, gold, and base metal clients in Canada, United States, and Madagascar. Within Canada, he has worked on projects in British Columbia, Alberta, Saskatchewan, Ontario, Northwest Territories, and Nunavut. He has performed as an expert witness at several technical sessions and public hearings, and presented a number of papers at professional conferences, including the International Atomic Energy Agency. His involvement with these projects and his ongoing communication with government biologists, regulators, and communities have provided him with an understanding of the issues that are important to all stakeholder groups, including industry.

Employment History

Golder Associates Ltd. – Saskatchewan

Principal, Senior Ecologist (1997 to Present)

Senior ecologist involved in the technical direction of study designs, analyses, presentation, and reporting for environmental impact assessments, and environmental effects monitoring programs.

University of Saskatchewan – Saskatchewan

Graduate Student and Sessional Lecturer (1996 to 1997)

Completion of Ph.D. thesis project and lecturer for first year biology at the University of Saskatchewan.

Graduate Student and Statistical Consultant (1996)

Continuation of Ph.D. project and statistical consultant for caribou mark-recapture analysis for the Government of Newfoundland.



Curriculum Vitae

JOHN A. VIRGL

Graduate Student (1992 to 1996)

Fieldwork and analysis of data for Ph.D. project on population dynamics of muskrats.

Graduate Student (1989 to 1991)

Fieldwork and analysis of data for M.Sc. project on energetics in muskrats.

University of British Columbia – British Columbia

Student and Research Assistant (1984 to 1988)

Field work and analysis of data for honours thesis on mating behaviour in male bison. Field work and data analysis on population ecology of three-spined sticklebacks.



PROJECT EXPERIENCE – MINING

**Dominion Diamond
Ekati Corporation**
Northwest Territories,
Canada

Technical director and editor for terrestrial environment (geology, soils, vegetation, and wildlife) of an environmental impact statement for a proposed extension of an existing diamond mine.

**Cliffs Natural
Resources**
Ontario, Canada

Senior technical lead for wildlife for environmental impact assessment for a chromite mine in northern Ontario. Project components included a mine site, 350 km all-season access road and production facility.

Teck Coal
British Columbia,
Canada

Technical director and editor for terrestrial environment of environmental impact assessments for expansions to coal mines in the Elk Valley.

Vale Potash
Saskatchewan, Canada

Technical director and editor for environmental impact assessment for a proposed potash mine.

Western Potash Corp.
Saskatchewan, Canada

Technical director and editor for environmental impact assessment for a proposed potash mine.

Agrium Triton Project
Saskatchewan, Canada

Technical lead and editor for terrestrial environment (terrain, soils, vegetation, and wildlife) of an environmental impact statement for a proposed potash mine.

**Potash One Legacy
Project**
Saskatchewan, Canada

Environmental assessment manager and editor for of an environmental impact statement for a proposed potash mine.

**De Beers Gahcho Kue
Project**
Northwest Territories,
Canada

Technical director and editor for terrestrial environment (geology, soils, vegetation, and wildlife) of an environmental impact statement for a proposed diamond mine.

Dynatec Corporation
Madagascar

Senior technical lead for baseline reporting and impact assessment of the Ambatovy and Analamay mining project on biodiversity. Project components included a mine, 200 km slurry pipeline, and tailings/processing plant facilities.

UEX Corporation
Saskatchewan, Canada

Project director and senior technical advisor for baseline data collection, reporting, and environmental impact assessment of a proposed uranium mine.

Miramar Hope Bay Ltd.
Nunavut, Canada

Senior technical lead for revising wildlife environmental impact statement and wildlife mitigation and monitoring program for Doris North Gold Mine Project.

**De Beers Snap Lake
Diamond Project**
Northwest Territories,
Canada

Senior wildlife biologist for ongoing monitoring program and environmental permitting.

**Diavik Diamond Mines
Inc.**
Northwest Territories,
Canada

Project manager and principal scientist for providing assistance with the wildlife monitoring program, analysis, and reporting.



Curriculum Vitae

JOHN A. VIRGL

Fortune Minerals Ltd. NICO Project Northwest Territories, Canada	Technical director and editor for an environmental impact assessment for a proposed gold-cobalt-bismuth mine.
Great Western Minerals Group Saskatchewan, Canada	Project manager and senior technical lead for environmental studies for exploration and initial permitting phase of proposed rare earth metal mine.
De Beers Fort a la Corne Project Saskatchewan, Canada	Project manager and senior technical lead for environmental studies for exploration and initial permitting phase of proposed diamond mine.
EnCana Corporation (Lorado) Saskatchewan, Canada	Senior technical lead for terrestrial component of environmental risk assessment for reclamation of abandoned uranium tailings site.
Department of Indian Affairs and Northern Development Northwest Territories, Canada	Senior technical review of site remediation and associated terrestrial monitoring plans for a gold mine. Issues primarily related to contamination of water, soils and vegetation, and potential physical hazards influencing the health, behaviour, and movement of animals within the area.
COGEMA Resources Inc. Saskatchewan, Canada	Project manager and technical lead for the compilation and analysis of data into several Technical Information Documents that will be used for environmental assessment, licensing, and environmental effects studies. Project involved a multidisciplinary team for air, hydrology, water quality, aquatic organisms, soils and vegetation, wildlife, heritage resources, hydrogeology, radiation safety, and cumulative effects.
Black Bird Mine Risk Assessment Idaho, USA	Responsible for study design, statistical analysis, and reporting of post-disturbance effects of mine effluent on habitat and animal species associations and community assemblages.
De Beers Snap Lake Diamond Project Northwest Territories, Canada	Responsible for study design and analysis of potential local and cumulative impacts of mining activities on caribou, wolves, grizzly bears, wolverines, and avifauna. Technical task leader for wildlife, cumulative effects assessment for the project, and development of monitoring program for the project.
Confidential Client Northwest Territories, Canada	Review of regulatory framework in the Northwest Territories with emphasis on identifying changes due to implementation of the Mackenzie Valley Environmental Impact Review Board and the role of aboriginal groups in the environmental assessment process.
BHP Billiton EKATI Diamond Mine Monitoring Program Northwest Territories, Canada	Principal scientist and project manager. Responsible for statistical analysis and study design of monitoring program for caribou, grizzly bears, wolves, wolverines, breeding migratory birds and raptors, and habitat loss (1997-1998 and 2000-2003). Also played an integral part in risk analysis for determining key species/groups for monitoring.
Phelps Dodge Environmental Impact Assessment Madagascar	Statistical analysis of tropical forest species communities. Specifically, analysis of species abundance, composition, diversity, and generation of species-area curves to predict impacts from mine developments.



**Puerto Plata
Environmental Effects
Monitoring**
Dominican Republic

Statistical analysis and reporting of mine effluent effects on benthic macroinvertebrates, algae, and macrophytes.

**Diavik Diamond Mine
Environmental Impact
Assessment**
Northwest Territories,
Canada

Review of statistical models for predicting impact of increased phosphorus on chlorophyll concentration and trophic structure in Lac de Gras.

PROJECT EXPERIENCE – POWER

NT Power
Northwest Territories,
Canada

Senior technical review for wildlife for environmental impact assessment for the Taltson Hydroelectric Expansion Project.

Wataynikaneyap Power
Ontario, Canada

Technical direction for environmental assessment for wildlife for proposed transmission line.

PROJECT EXPERIENCE – FORESTRY

**Department of
Resources, Wildlife
and Economic
Development**
Northwest Territories,
Canada

Responsible for development of growth and yield models and stratification of yield classes for the Cameron Hills timber supply analysis.

**Prince Albert Model
Forest Association**
Saskatchewan, Canada

Project manager for the development of criteria and indicators for monitoring forest ecosystem change.

Spray Lake Sawmills
Alberta, Canada

Involved in the analysis and interpretation of site index and height-growth curves for generating yield volumes and forecasting harvest rates.

**Weyerhaeuser
Environmental Effects
Monitoring**
Saskatchewan, Canada

Determination of appropriate sample size for monitoring effects of pulp mill effluent on key fish species. Analysis and recommendations regarding effects of pulp mill effluent on white suckers. Statistical analysis and reporting of mine effluent effects on benthic macroinvertebrates and sentinel fish species.

**Weldwood Grizzly Bear
Habitat Suitability
Index and Cumulative
Effects Assessment
Models**
Alberta, Canada

Responsible for reviewing and compiling literature on grizzly bear habitat suitability index and cumulative effects assessment models. Information was used to assess the efficacy of different models for project level planning and mitigation of the effects of linear disturbances on grizzly bear populations.



**Weyerhaeuser
Environmental Impact
Assessment**
Saskatchewan, Canada

Responsible for data management and statistical analysis of field data collected for habitat assessments for vegetation, amphibians, small mammals, birds, furbearers, and ungulates. Also involved in the writing of the environmental impact assessment and generation of habitat suitability index models.

PROJECT EXPERIENCE – OIL & GAS

**PetroCanada
Environmental
Assessment**
Alberta, Canada

Conducted population viability analysis for caribou, moose, and black bear using a spatial population model that integrates landscape data with demographic estimates.

**Rio Alto Environmental
Assessment**
Alberta, Canada

Conducted population viability analysis for caribou, moose, and black bear using a spatial population model that integrates landscape data with demographic estimates.

**Suncor Ltd.
Environmental Impact
Assessment**
Alberta, Canada

Statistical analysis and reporting of habitat assessments for songbirds and ungulates. Also involved in validation of habitat suitability index models.

**Pan Canadian Ltd.
Environmental Impact
Assessment**
Alberta, Canada

Statistical analysis and reporting of habitat assessments for songbirds and ungulates.

**Shell Canada Ltd.
Environmental Impact
Assessment**
Alberta, Canada

Responsible for data management and statistical analysis of field data collected for habitat assessments for: birds, furbearers, and ungulates. Also included in writing of environmental impact assessment and generation of habitat suitability index models.

PROFESSIONAL AFFILIATIONS

V.P. Finance, Graduate Student Association, University of Saskatchewan, 1991-1992

Member, American Society of Naturalists, 1994-1996

PUBLICATIONS

**Refereed Journal
Articles**

Coulton, D.W., J.A. Virgl and C. English. Falcon nest occupancy and hatch success near two diamond mines in the southern Arctic, Northwest Territories. *Avian Conservation and Ecology*, 8 (2013), 14.

Smith, A.C., J.A. Virgl, D. Panayi and A.R. Armstrong. Effects of a diamond mine on tundra-breeding birds. *Arctic*, 58 (2005), 295-304.

Virgl, J.A., S.P. Mahoney and K. Mawhinney. Phenotypic variation in skull size and shape between Newfoundland and mainland populations of North American black bears, *Ursus americanus*. *Canadian Field-Naturalist*, 117 (2003), 236-244.



Mahoney, S.P. and J.A. Virgl. Habitat selection and demography of a non-migratory woodland caribou population in Newfoundland. *Canadian Journal of Zoology*, 81 (2003), 321-334.

Mahoney, S.P., J.A. Virgl and K. Mawhinney. Potential mechanisms of phenotypic divergence in body size between Newfoundland and mainland black bear populations. *Canadian Journal of Zoology*, 79 (2001), 1650-1660.

Virgl, J.A. and F. Messier. Assessment of source-sink theory for predicting demographic rates among habitats that exhibit temporal changes in quality. *Canadian Journal of Zoology*, 78 (2000), 1483-1493.

Larivière, S., L.R. Walton and J.A. Virgl. Field anaesthesia of American mink, *Mustela vison*, using halothane. *Canadian Field-Naturalist*, 114 (2000), 142-144.

Mahoney, S.P., J.A. Virgl, D.W. Fong and A.M. Maccharles. Evaluation of a mark-resighting technique for woodland caribou in Newfoundland. *Journal of Wildlife Management*, 62 (1998), 1227-1235.

Virgl, J.A. and F. Messier. Habitat suitability in muskrats: a test of the food limitation hypothesis. *Journal of Zoology, London*, 243 (1997), 237-253.

Virgl, J.A. and F. Messier. Population structure, distribution, and demography of muskrats during the ice-free period under contrasting water fluctuations. *Écoscience*, 3 (1996), 54-62.

Ferguson, S.H., J.A. Virgl and S.L. Lariviere. Evolution of delayed implantation and associated grade shifts in life history traits of North American Carnivores. *Écoscience*, 3 (1996), 7-17.

Virgl, J.A. and F. Messier. Postnatal growth and development in semi-captive muskrats, *Ondatra zibethicus*. *Growth, Development, and Aging*, 59 (1995), 159-169.

Virgl, J.A. and F. Messier. Evaluation of body size and condition indices in muskrats. *Journal of Wildlife Management*, 57 (1993), 854-860.

Virgl, J.A. and F. Messier. The ontogeny of body composition and morphology in free-ranging muskrats. *Canadian Journal of Zoology*, 70 (1992), 1381-1388.

Virgl, J.A. and F. Messier. Seasonal variation in body composition and morphology of adult muskrats in central Saskatchewan, Canada. *Journal of Zoology, London*, 228 (1992), 461-477.

Messier, F. and J.A. Virgl. Differential use of bank burrows and lodges by muskrats in a northern marsh environment. *Canadian Journal of Zoology*, 70 (1992), 1180-1184.

Messier, F., J.A. Virgl and L. Marinelli. Density-dependent habitat selection in muskrats: a test of the ideal free distribution model. *Oecologia*, 84 (1990), 380-



385.

Melton, D.A., N.C. Larter, C.C. Gates and J.A. Virgl. The influence of rut and environmental factors on the behaviour of wood bison. *Acta Theriologica*, 34 (1989), 175-189.

Journal Articles

Virgl, J. and S. Larivière. Hutte ou terrier? Le dilemme du rat-musqué. *La trappe*, 1(1) (1994), 6.

Larivière, S. and J. Virgl. Le piège du rat-musqué au printemps: la science justifie telle la tradition?. *L'association des trappeurs*, 4(3) (1993), 8-9.

Conference Proceedings

Virgl, J.A. 2004. *An approach to cumulative effects assessment for the uranium mining industry in the Athabasca Basin Ecoregion*. 2004 Conference for the International Atomic Energy Association.

Virgl, J.A. 2004. *Linking changes in habitat availability and quality with population viability analysis: a probabilistic approach to cumulative effects assessment*. In Prediction to Practice: Environmental Assessment Follow-up. 2004 Alberta Society of Professional Biologists.

Ealey, M. and J. Virgl. 2001. *Natural regeneration on a pipeline right-of-way in the boreal forest of west-central Saskatchewan*. 7th International Symposium on Environmental Concerns in Rights-of-Way Management.

Other

2014. External Examiner for two Master Thesis Defences (University of Saskatchewan)

2003. Review of Manuscript for Journal of Wildlife Management.

2002. External Examiner for Master Thesis Defence (University of Saskatchewan).

ERIC DENHOLM, P.Eng.

**EDenholm Consulting
Yellowknife, NT, Canada
(867) 688-2709 / (867) 920-7018
edenholm@theedge.ca**

PROFILE

Eric Denholm is a registered Professional (Geological Engineering, NT/NU) who has 30 years experience with Canadian mining projects, primarily in Canada's North, covering the spectrum from grassroots exploration through to mine permitting, operations and reclamation. Eric brings a practical approach and an ability to move projects forwards, working primarily on:

- Strategic Planning;
- Environmental Design;
- Environmental Management;
- Community Engagement; and
- Regulatory Affairs.

Eric's career includes direct experience in mine engineering, mine operations, mine reclamation, and environmental affairs at complex operating mines ranging in scale from 400 to 13,000 tonnes per day process plant input. Many of these mines were high in the public profile in their regions. Additionally, Eric has contributed to many mining projects in the Canadian North as a northern-based consultant with the firm of Gartner Lee Limited. All of this work has also included appearances at formal Public Hearings, meetings in aboriginal communities, and other public venues at which Eric is very comfortable and effective.

Eric is an efficient, safety-oriented professional who can be relied on to provide focused technical analysis, fit-for-purpose operating designs, effective regulatory submissions, and targeted strategic planning.

Prior to starting his own consulting business, Eric contributed to the Ekati Diamond Mine (for BHP Billiton and subsequently Dominion Diamond) as Superintendent – Traditional Knowledge and Permitting. Through this high-profile position, Eric successfully managed several large permitting projects, successfully introduced new community engagement and Traditional Knowledge programs, and successfully advanced planning for closure and reclamation including reclamation security.

After many years in the North, Eric and his partner Sandy Osborne are relocating in 2015 from Yellowknife, the capital of the Northwest Territories, to the City of Nelson in the Kootenay region of British Columbia, where they will continue to work on varied and interesting projects throughout Northern and Western Canada.

Eric Denholm, P.Eng. EDenholm Consulting

AREAS OF INTEREST AND SPECIALIZATION

- Professional management of environmental and regulatory affairs seeking respectful and collaborative relationships
- Meaningful interaction and support to aboriginal and local communities
- Design and implementation of focussed mine environmental management and monitoring programs
- Assessment of environmental data providing clear and realistic recommendations
- Development of junior technical staff
- Effective management of technical consultants
- Preparation of objectives-based Reclamation Plans, including acid rock drainage

UNIVERSITY EDUCATION

Bachelor of Applied Science in Geological Engineering, 1986
University of Waterloo, Waterloo, ON, Canada

PROFESSIONAL HISTORY

Owner, EDenholm Consulting

2015 +

Eric started his own consulting firm in 2015 to provide professional environmental services for mining projects. One current project is the provision of contracted professional services to Dominion Diamond's Ekati Mine for permitting of a major 10-year extension project and environmental management.

Superintendent – Traditional Knowledge and Permitting, Ekati Diamond Mine BHP Billiton / Dominion Diamond Corporation, Yellowknife, Northwest Territories

2007 to 2015

The EKATI mine is a 12,500 tonnes per day (process plant feed) diamond mine located in the central Arctic tundra of the Northwest Territories. The mine operates within a complex regime of overlapping aboriginal land claims, a newly implemented and evolving regulatory system and demanding environmental expectations. This role is largely accountable for maintaining the Licence to Operate and links closely with Environment, Aboriginal Affairs and Long Range Planning. This role assisted with and crossed over a change of ownership of the Ekati Mine from BHP Billiton to Dominion Diamond Corporation. Eric continues to provide contract professional services to Dominion Diamond.

Eric's key contributions included establishing constructive relationships with regulatory agencies, delivery of substantive water licence renewals with several key "wins" for the Company, environmental design and permitting of a major 10-year mine extension project, and implementation of key adaptive management programs ensuring water quality compliance.

Eric Denholm, P.Eng. EDenholm Consulting

Senior Mining Consultant, Northern Projects Gartner Lee Limited, Yellowknife, Northwest Territories 2000 to 2007

Gartner Lee Limited was a moderately-sized and successful Canadian consulting firm that was subsequently purchased and amalgamated into AECOM Canada. Eric worked exclusively on northern mining projects, providing technical, management and strategic services to a wide range of clients. Examples of projects for which Eric was the lead or played a substantive role include:

- Development and approval of reclamation plans for the Nanisivik and Polaris zinc mines. *Clients: Breakwater Resources and TeckCominco*
- Technical and strategic advice to Land and Water Boards, primarily for the EKATI and Diavik Diamond Mines. *Client: Community-Based Land and Water Boards*
- Care and maintenance and closure planning for the (closed) Faro metal mine. *Client: Deloitte&Touche (interim receiver) and DIAND (federal government)*
- Development of an Inuit-used mine reclamation costing model. *Client: Kitikmeot Inuit Association*
- Coordinating consultant for Environmental Assessment Reviews of the Doris North (gold) and Jericho (diamond) projects. *Client: DIAND (federal government)*

Environment Engineer and Environment Manager, Faro Lead-Zinc-Silver Mine Anvil Range Mining Corporation and Deloitte. (as interim receiver), Faro, Yukon Territory 1996 to 2000

The Faro Mine was a major producer of lead and zinc concentrates through the 1970's and 1980's that closed in 1998, at which time the mine entered into an extended receivership period. The 13,500 tonnes per day (ore feed) sulphide mine includes three open pits, two water treatment systems, extensive rock piles containing acid generating material and an approximately 30 ha valley-fill tailings area. Prior to and following its permanent closure, Eric managed and implemented environmental management programs including permitting and reclamation planning.

Environment Engineer, Winston Lake Zinc-Copper Mine Inmet Mining Corporation, Schreiber Ontario 1992 to 1996

The Winston Lake mine was a 1,000 tonnes per day (ore feed) underground mine located in northwestern Ontario that closed in 1998. Eric was environmental engineer primarily responsible for developing and gaining approval for the mine reclamation plan, which was successful. Eric also worked intermittently as assistant plant metallurgist, learning the basic approaches to floatation of sulphide minerals. Additionally, Eric provided technical advice on other Company projects including his previous project, Samatosum.

Mine Engineer, Samatosum Silver-Lead-Zinc Mine Minnova Inc. (subsequently Inmet Mining Corporation), Barriere, British Columbia 1988 to 1992

The Samatosum mine was a small (400 tonnes per day ore feed) and complex open pit/underground silver mine located in central British Columbia. The high-grade silver deposit (in the form of the sulphide mineral tetrahedrite) was also associated with zinc, copper and lead sulphides. Eric worked with this project through the exploration, start-up

Eric Denholm, P.Eng. EDenholm Consulting

and reclamation stages. Eric was the mine planning engineer developing open pit and underground designs and assisting in management of surface and underground mining contractors. Eric also managed land reclamation (revegetation) programs and acid rock drainage studies related to the (then) new concept of layering acid generating material within the rock pile. Eric co-authored the mine reclamation plan.

Mineral Exploration Field Assistant

Corporation Falconbridge Copper (subsequently Minnova Inc.), British Columbia

1986 to 1988

Eric assisted with mineral exploration field programs (geophysics, mapping, drilling) in southern and central British Columbia. This work included the Samatosum property which subsequently developed into a full-time position for Eric.

Student Geologist, Geco Mine

Noranda Inc., Manitouwadge, Ontario

1985 (8-month student work term)

The Geco Mine was a large massive sulphide underground mine in northwestern Ontario that has since closed. Eric worked in mine geology providing routine operational support including ore-waste marking and geology mapping. Eric also developing ore reserve projections and geology overlays for blast hole layouts.



Patrick G. Duffy

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Direct: (416) 869-5257 Fax: (416) 947-0866 pduffy@stikeman.com

Law Practice

Mr. Duffy has a project development practice that includes environmental permitting and litigation, energy regulation, and aboriginal engagement. He has considerable experience dealing with environmental assessments and other regulatory approvals in a variety of sectors, including renewable and non-renewable electricity generation, electricity transmission, mining, transit and transportation, aggregate quarries, and waste management.

Mr. Duffy is an experienced advocate and has appeared before the Supreme Court of Canada, all levels of courts in Ontario and a variety of administrative tribunals, including regular appearances before the Ontario Energy Board and the Ontario Municipal Board. Mr. Duffy has acted for both provincial and municipal governments and many of his cases involve administrative or public law issues.

Through his work in the energy sector, Mr. Duffy has developed an expertise in public procurement processes. He has been involved in all stages of public procurement processes in a number of sectors on both the customer and bidder side. He has helped draft the terms of a public procurement, assisted proponents in responding to procurements, and represented proponents in procurement related-litigation.

Professional Activities

Mr. Duffy is a member of the Law Society of Upper Canada, the Law Society of Alberta, the Advocates' Society and the American Bar Association (Section of Environment, Energy and Resources). Mr. Duffy is a member of the executive of the Aboriginal Law Section of the Ontario Bar Association. He is also actively involved with the Phillip C. Jessup International Law Moot.

Publications & Conferences

Mr. Duffy is the author of the regulatory proceedings sub-chapter in the *Ultimate Corporate Counsel Guide*. He is co-author of *Energy Regulation in Ontario* (Canada Law Book), a publication detailing analysis of legal rules, regulations and codes affecting each segment of the Ontario energy market. Mr. Duffy is also co-author of the "Canada" chapter in *The Energy Regulation and Markets Review* (Law Business Research) and editor of the firm's energy blog, *CanadianEnergyLaw.com*.

Mr. Duffy moderated the keynote panel "Moving Forward Beyond AMI Deployment in Ontario: Realizing the Value and Benefits of a Smart Grid" at EUCI's Smart Grid Return on Investment conference on May 27, 2010.

Mr. Duffy was a member of the Roundtable on Washington and Ottawa – Energy and Environmental Policy Initiatives at the New England Canada Business Council's Energy Trade & Technology Conference on November 3, 2011.

Mr. Duffy presented a session on public utility law at the Canadian Gas Association Regulatory Course on March 5, 2012.

Education

University of Alberta (LL.B. with distinction 2002), University of Lethbridge (BA with great distinction 2002).

Background

Mr. Duffy was the clerk for Mr. Justice Michael Kelen of the Federal Court of Canada, Trial Division, 2002-2003. He served as counsel for the Independent Electricity System Operator (IESO) during a one-year secondment in 2007. He has also completed the Intensive Trial Advocacy Workshop and the Canadian Gas Association's Regulatory Course and a course on Public Procurement Law.

Bar Admissions

Alberta, 2004. Ontario, 2004.