TETRA TECH

RICK A.W. HOOS, R.P. Bio.

Principal Consultant - Mining Practice

EXPERIENCE SUMMARY

Mr. Hoos has more than 35 years of professional environmental, socioeconomic and major project management experience in the mining, oil and gas, pipeline industries, and with the Government of Canada. He has managed or participated in multi-disciplinary teams working on numerous major projects, particularly in Canada, the United States, and in Latin America. Through this involvement, he has become familiar with the regulatory requirements and expectations of many countries and with the international financial community.

PROFESSIONAL RECORD

2000/Present	Principal Consultant, Mining and Environmental Practices EBA, A Tetra Tech Company Vancouver, BC
1997/2000	Vice President, Environmental Services Rescan Environmental Services Ltd. Vancouver, BC
1995/1997	Manager, Environmental Services and Director, Latin American Projects Bovar Environmental Calgary, Alberta
1979/1995	Director of Environmental and Socio-Economic Services TransCanada PipeLines - Polar Gas (Mackenzie Valley Gas Pipeline) Manager/Director of Environmental and Socio-Economic Services Dome Petroleum and Amoco Canada Ltd. Calgary, Alberta
1970/1979	Coordinator of Marine Programs (British Columbia, Yukon) Environment Canada Vancouver, BC Aquatic Biologist (Nova Scotia, New Brunswick) Department of Fisheries Halifax, NS

ENVIRONMENTAL MANAGEMENT

- Coordinated the preparation of the Environmental Assessment Report for BHP's proposed three-pit development and provided environmental management and regulatory support services to BHP's EKATI™ Diamond Mine in the NWT and the Hope Bay Belt Gold Project in Nunavut.
- Coordinated the completion of the Project Description Report and an interdisciplinary environmental baseline study program for the Tibbitt to Contwoyto Winter Road for BHP Billiton, Kinross Gold Mine, Diavik Diamond Mine and other road users. This work provides the basis for future environmental management of the winter road located in the NWT and Nunavut.

Education:

M.Sc., Oceanography/ Marine Biology, University of Victoria

B.Sc., Biology/Geography, University of Calgary

Affiliations:

Adjunct Professor of Natural Resources Management, Simon Fraser University (1984 – Present)

Member, Society of Petroleum Industry Biologists

Member, Association of Professional Biologists

Member, Comité Arctique Internationale

Member, American Society of Mechanical Engineers (OMAE)

Member, College of Applied Biology, British Columbia

Other Professional Affiliations:

Director, Canadian Environmental Industry Association, B.C. Chapter, 1997 - 2000

Director, Canadian Council for Aboriginal Business, 1994 - 1998

Member, Canadian Environmental Assessment Research Council, 1987-1990

Publications/Reports:

Author of, or contributed to over 125 technical reports and publications

Languages:

English

French

Dutch

Spanish

Office:

Vancouver, BC

Years of Experience:

35

- Provided environmental management services to North American Tungsten Corporation in support of the reactivation and ongoing operation of the CanTung Tungsten Mine in the western NWT and the development of the Mactung Tungsten Mine in Yukon.
- Coordinated preparation of the Project Description and Environmental Assessment for the Diamonds North Exploration Project located on Victoria Island in the Canadian Arctic.
- Coordinated preparation of the Project Descriptions and Environmental Assessments for several junior diamond explorers in the Drybones Bay area of the NWT.
- Participated in the preparation of the Project Description Report and the Developers Assessment Report for the Tyhee Yellowknife Gold Project in the NWT.
- Coordinated preparation of the Developers Assessment Report for the Avalon Rare Metals Project in the NWT.
- Coordinated preparation of the Project Description Report for the proposed Great Bear River Bridge Project in the Northwest Territories.
- Coordinated preparation of the Project Description Reports for the annual over-wintering of the Mobile Offshore Drilling Unit Kulluk in McKinley Bay, NWT and Herschel Basin, Yukon (Beaufort Sea area) and follow-up environmental management services during project implementation.
- Coordinated several years of baseline environmental studies and preparation of the Project Description Report and Developers Assessment Report for the proposed Pine Point Pilot Project (lead/zinc mine) in the Northwest Territories and follow-up environmental management services during project implementation.
- Coordinated several years of baseline environmental studies and the preparation of the Feasibility Study and Project Proposal (EIA) for the proposed Mactung Tungsten Mine at Macmillan Pass, Yukon.
- Coordinated several years of baseline environmental studies for the proposed Roche Bay Magnetite (iron ore) Mine located near Hall Beach, Nunavut, in preparation for subsequent feasibility studies, the Environmental Impact Statement and future regulatory approvals.
- Managed environmental and regulatory scoping study for the proposed Inuvik - Tuktoyaktuk Road Project.
- Managed preparation of the Project Description Report and the Environmental Impact Assessment for the proposed Inuvik to Tuktoyaktuk Highway for GNWT Transportation, the Town of Inuvik and the Hamlet of Tuktoyaktuk.
- Participated in the preparation of the Environmental Assessment Application for the Vancouver Convention Centre Expansion Project in British Columbia to meet the needs of BCEAA and CEAA and follow-up construction-phase environmental management activities.
- Coordinated technical review of Goro Nickel Project Environmental Assessment (New Caledonia) and developed EA methodology for proposed new project.
- Coordinated the technical review of the Rio Saldania Gold dredging project in Colombia.
- Prepared a Status Report on the Nechako River Watershed for the Fraser River Management Board for dissemination to the general public.
- Peer reviewed the Syncrude Environmental Impact Assessment for the proposed Aurora Oil Sands development and participated in strategic planning for AEUB hearings.

- Participated in EMS/ISO 14001 audits for Maraven and Corpoven, two major subsidiaries of Venezuela's national oil company. The audits were conducted for oil and gas facilities in the vicinity of Lake Maracaibo and Maturin.
- Provided CEAA hearings preparation and advisory services to Atomic Energy Canada Limited for Canada's high-level nuclear waste disposal project.
- Provided environmental management and technical advice in support of various international projects including:
  - Ballena to Barranca Gas Pipeline Project, Colombia
  - Cusiana Oil Pipeline and Port Development Project, Colombia
  - SOTE Oil Pipeline Project, Ecuador
  - Qatar - Pakistan Subsea Pipeline Project, Asia
  - Songo Songo Gas Pipeline and Power Project, Tanzania
  - Back Ho Gas Utilization Project, Vietnam
- Managed all environmental, socioeconomic, regulatory and public issues associated with the future $4.5 billion Mackenzie Valley Natural Gas Pipeline on behalf of TransCanada PipeLines and Tenneco Gas.
- Provided environmental planning and regulatory approvals services for proposed new North American projects including: the Sunshine Pipeline (Florida); Mayflower Pipeline (New England), Washington 10 Underground Storage Project (Michigan) and the Hermiston Power Project (Oregon).
- Provided environmental management and oversight services to Alberta Natural Gas Company.
- Managed the regulatory approvals and environmental and socioeconomic issues associated with Dome and Amoco's Arctic Drilling programs in the Canadian and U.S Beaufort Sea.
- Directed the staff of Dome Petroleum's Environmental and Socioeconomic Services organization to achieve project approvals with appropriate environmental operating conditions for the corporation in all program areas including domestic and frontier exploration drilling, conventional, heavy oil and sour gas production operations, natural gas liquids extraction and product transportation.
- Coordinated marine environmental protection programs for the Pacific Region of Environment Canada.
- Managed marine environmental responsibilities pertaining to a wide range of Canadian Industrial developments including coastal base metal mines, oil refineries, pulp mills, dredging projects, ocean disposal activities and the assessment of new marine coal and oil terminals.
- Contributed to the development of Canada's environmental protection regulations for the base metal mining, oil refining, pulp and paper and chlor-alkali industries.

ENVIRONMENTAL IMPACT ASSESSMENT

Participated in the preparation and review of Environmental Impact assessments, Cumulative assessments or baseline studies for Canadian and international mining and oil and gas and infrastructure projects including:

- EKATI™ Diamond Mine Environmental Assessment Report, NWT, (BHP).
- Pine Point Pilot Plant (lead/zinc) Project Description Report, Developers Assessment Report, NWT (Tamerlane Ventures).

- Avalon Rare Metals Project Description Report and Developers Assessment Report, NWT (Avalon Rare Metals).
- Mactung Tungsten Mine Project Proposal, Yukon, (North American Tungsten).
- Yellowknife Gold Project Description Report and Developers Assessment Report NWT (Tyhee).
- Prairie Creek Property advanced exploration Cumulative Impact Assessment, NWT (Canadian Zinc Corporation).
- La Granja Copper Mine EIA, Peru (Cambior).
- Gross Rosebel Gold Mine EIA, Surinam (Cambior).
- El Limon Gold Mine Baseline Studies, Nicaragua (Minera de Occidente).
- Tibbitt to Contwoyto Winter Road Project Description Report, NWT/Nunavut (BHPB, Diavik, Kinross).
- Tuktoyaktuk to Source 177 All-Weather Access Road Project Description Report, NWT, (GNWT Transportation).
- Inuvik to Tuktoyaktuk Highway Project Description Report and Environmental Impact Assessment, (GNWT Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk
- Seasonal Overland Road Project Description Report, NWT (BHPB, Diavik, De Beers).
- Kulluk Mobile Offshore Drilling Unit Project Description Reports for refurbishment and overwintering activities at McKinley Bay, NWT, and Herschel Basin, Yukon (Shell Exploration and Production).
- Managed the production of the $14 million Environmental Impact Statement for Beaufort Sea/Mackenzie Delta Oil and Gas Development (BEARP) on behalf of Dome, Esso, Gulf and their forty-two industry partners.
- Provided technical input and advice in support of environmental impact assessments prepared for western Canadian oil sands developments, sour gas and heavy oil plants, critical exploratory wells and several pipelines in the United States of America.
- Coordinated the planning and completion of major field environmental assessment (BEARP) which lays the groundwork for future development of the Western Arctic hydrocarbon resources.
- Managed the completion of environmental impact assessments for Arctic offshore drilling programs, major dredging projects, new harbour and fuel storage facilities, pipelines and marine energy transportation projects.
- Participated in marine environmental studies and regulatory evaluations of marine tailings placement systems for a number of base metal mines located in coastal British Columbia.
- Coordinated the planning and completion of major field environmental sampling programs in the Canadian Arctic, on the Pacific Coast and in the Maritimes.

ENVIRONMENTAL DUE DILIGENCE AUDITS

- Conducted environmental due diligence evaluations of TransCanada PipeLines subsidiaries and affiliated companies including: the Northern Border Pipeline; Foothills, Sask. Pipeline; Great Lakes Gas Transmission; TQ&M Pipeline; Cancarb Carbon Black Plant; and the Empress III Liquids Extraction Plant.
- Conducted environmental due diligence evaluations for proposed acquisitions including: Alberta Natural Gas Company; Viking Pipeline; and Columbus III Underground Gas Storage Project.

- Managed the provision of necessary due diligence services for all Dome Petroleum corporate acquisitions and divestitures.
- Participated in the due diligence evaluation of proposed changes to the Las Cristinas Gold Mine development plan (Venezuela).
- Participated in ISO 14000 due diligence audits of Venezuelan National Oil Company (PDVSA) oil and gas field facilities in Eastern Venezuela and Lake Maracaibo (Venezuela).

PUBLIC CONSULTATION

- Managed or participated in the development and implementation of major public consultation programs in northern and western Canada, Alaska and in the mainland United States of America.
- Presented environmental issues and consultation seminars to numerous clients and forums in Canada and internationally.
- Prepared and presented lectures on environmental, regulatory and public consultation topics at academic institutions.

RESUME Richard A. Sims

RICHARD A SIMS, Ph.D., R.P.Bio., P.Biol.
Principal Scientist / Senior Environmental Scientist

EDUCATION

Ph.D., Forestry/Remote Sensing, University of British Columbia, 1983
M.Sc., Botany (Plant Ecology)/Soil Science, University of Manitoba, 1977
B.Sc., (Hons.), Biology (Ecology), Lakehead University, 1974

AFFILIATIONS

Member (R.P. Bio.), Association of Professional Biologists of British Columbia
Member (P. Bio.), Alberta Society of Professional Biologists
Member, International Society for Photogrammetry and Remote Sensing (ISPRS)
Member, Urban and Regional Information Systems Association (URISA)

Dr. Sims is EBA's Principal Scientist with a responsibility to encourage overall technical excellence with EBA, a Tetra Tech Company, in the Environment Practice in Vancouver, BC. In this role, he undertakes senior reviews and client-focussed assessments of a wide range of environmental projects throughout the company. As a Senior Environmental Scientist, he also undertakes critical project assignments, in particular Environmental Impact Assessments, but also other regulatory approval and permitting, environmental management, and applied ecological projects.

He has 32 years of experience conducting complex assessments and studies for industrial and other clients including ecological and wildlife studies, cumulative effects analyses, and the coordination of multi-faceted and multi-disciplinary projects and assignments. For many assignments, he has worked closely with industrial clients, government regulators, scientists, engineers and other professionals to develop unique mitigation approaches or innovative solutions.

RECENT ASSIGNMENTS

- Senior Environmental Scientist consulting to the BC Ministry of Transportation's Gateway Program with particular emphasis on addressing the environmental interface between Burns Bog and the proposed alignment for the South Fraser Perimeter Road. Activities include public and agency consultations, preparation of briefings, presentations for Senior Gateway staff, and working closely with other consultants on the project's design development.
- Environmental Manager for the design and construction of the $650 M Vancouver Convention Centre Expansion Project including coordination of the overall EIA process, securing permits/approvals for construction, overseeing contaminated site management plans, coordination with DFO and other regulators, and management/troubleshooting of environmental issues.
- Successfully completed environmental assessment and Canadian Environmental Assessment Agency (CEAA). Screening components for the ($110 M) Whistler Sliding Centre and ($105 M) Whistler Nordic Centre venues for the Vancouver Organizing Committee for the 2010 Winter Olympics. Coordination of associated environmental monitoring activities.
- Working for the European Space Agency (Frascati, Italy), he has completed several milestone investigations and technical reports on market development aspects for remote sensing/Earth observations services and products.

Dr Sims has worked for the past 12 years as an Environmental Consultant and, for 20 years prior to that, as a Senior Research Scientist and applied Science Coordinator for the federal government.

Dr Sims is:

- Principal Scientist for EBA with responsibility for ensuring that EBA's quality management system, in particular its Environment Practice, is in place and operational. He works with scientific and management staff throughout EBA to develop and implement tools for quality assurance, and to undertake special reviews and audits of quality practices. He works closely with senior management of the company to ensure that EBA's scientific and technical expertise is fully utilized. He is also a member of the 12-person Board of Directors for EBA, providing overall leadership for the company.

- Recognized internationally and nationally as an environmental specialist with an extensive publication record and hands-on experience in environmental assessment, forestry, wetland ecology, wildlife habitat interpretation, vegetation classification and ecosystem description, botany, soils, ecosystem-based land management, cumulative effects evaluation, and GIS/remote sensing applications.
- Recipient of an Association of British Columbia Professional Engineers and Geoscientists' Environmental Award (2006, for his professional contributions to the Vancouver Convention Centre Expansion Project) as well as several other awards, including Natural Resources Canada's National Science and Technology Achievement Award and the Canadian Forest Service's Scientific Merit Award for his scientific contributions and "technology transfer activities" related to scientific achievement.
- Frequently called upon to assist with environmental planning, provide expert opinion and advice during approvals and audits, and review reports and manuscripts for scientific publication.

EXAMPLES OF RECENT AND PAST PROJECT ACTIVITIES

- **Vegetation Ecologist for South Fraser Perimeter Road (SFPR) Environmental Assessment, With Special Reference to Burns Bog (2005 - 2007, onward).** For the Gateway Program, based in Burnaby, BC (BC Ministry of Transportation (MOT)), Dr. Sims has worked with MOT staff as a Senior Wetland Ecologist, and provided services that included:
  - Preparation of technical and scientific reporting
  - Review and edit of MOT submissions related to Burns Bog and the SFPR
  - Participation in Gateway strategic planning and route selection meetings
  - Assembly and coordination of various responses to the EAO and other agencies related to the SFPR and Burns Bog
  - Preparation for and participation in MOT design workshops and regulatory review meetings
- **Environmental Impact Assessment and Application and Ongoing Environmental Monitoring and Management for the Vancouver Convention Centre Expansion Project, Vancouver, BC (2003 - 2007, onward).** Dr. Sims led the EBA team that successfully prepared and completed a comprehensive Environmental Assessment Certification Application for the Vancouver Convention Centre Expansion Project (VCCEP) located in Vancouver's Coal Harbour. Dr. Sims and other EBA personnel were directly involved with First Nations and Public Consultation programs for the VCCEP and consulted extensively with regulatory agencies. Dr. Sims worked closely with regulatory agencies and the client (VCCEP Ltd., Province of BC and Government of Canada) to expedite the review and application process (jointly through BCEAA and CEAA). Subsequent to this, Dr. Sims managed the environmental aspects of the project throughout construction. This has included a range of environmental monitoring and management activities, regular contact with regulators and others, and coordination with the Project's design and construction teams. Through in-water phases of construction, in particular, daily on-site monitoring was conducted of the environmental aspects of all construction activities, and monitoring programs were carried out for water quality, erosion/sediment management, and the management of any contaminated fill materials. Environmental work is continuing to project completion and commissioning (2009) and beyond (e.g., post-construction marine habitat monitoring).
- **Earth Observations Market Development Projects for Mining, Pipelines and Operational Engineering Applications. European Space Agency (ESA), Frascati, Italy (2002 - 2007, continuing).** Dr. Sims has been involved in a series of Earth Observation Market Development Projects supported by ESA, the most recent of which was the PIPEMON project (www.pipemon.com), aimed at developing Earth Observation (EO) based services of value to pipeline and underground storage operators. For the PIPEMON Project, Dr. Sims worked closely with scientists from ESA and from six other companies in the UK, Italy and Germany, and with several industrial partners such as Newalta and Enbridge, National Grid UK and the British Geological Survey. The two offered services in PIPEMON were:

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- Measurement of ground motion along pipelines and over underground storage facilities using state-of-the-art satellite radar interferometry (InSAR) techniques, such as Persistent Scatterer Interferometry (PSI), conventional differential InSAR (DifSAR) and Corner Reflector InSAR (CRInSAR).
- Route planning support for pipeline planners to integrate information from multiple sources and generate a suitability map for pipeline planning with new software. Input data derived from satellite imagery included up-to-date land cover information and ground movement information.

- **CEAA Screening/Environmental Approvals and Environmental Oversight Activities for Construction of the Whistler Sliding Centre, Whistler, BC (2004 - 2007).** Dr. Sims coordinated EBA's involvement with VANOC staff to undertake a number of key activities that involved seeking and obtaining environmental approvals for the Whistler Sliding Centre (WSC). EBA and VANOC staff worked together to obtain appropriate government approvals, in particular federal CEAA Screening approvals and provincial Water Act authorizations. Under the direction of Dr. Sims, EBA continued, through Years 1 and 2 of WSC construction, to act as the "Owner's Environmental Monitor" overseeing compliance and reporting in relation to CEAA requirements (including regulatory due diligence reporting out). Dr. Sims oversaw the completion of on-site pre-construction bird nest surveys, contaminated sites/remediation investigations, and ongoing water quality monitoring investigations at the WSC (as well as all associated required reporting out to federal and provincial regulators).
- **Burns Bog Environmental Review (1999 - 2001).** For the BC Environmental Assessment Office (EAO), Victoria, BC, Dr. Sims provided key scientific and technical services for a comprehensive "ecosystem review" of Burns Bog. The Bog is an extensive raised peatland ecosystem covering approximately 3,000 ha of the Fraser River Delta in south-western British Columbia. There are many public and stakeholder issues regarding its preservation/development, and Dr. Sims assisted the EAO with the formal preparation and conduct of public "technical review sessions" to review complex ecological issues (wildlife, hydrology, ecosystem processes, local/global significance) with respect to the Bog.
- **Muskwa Predictive Ecosystem Mapping (2000 - 2003).** For the BC Ministry of Energy and Mines (MEM), Dr. Sims coordinated a large Predictive Ecosystem Mapping (PEM) project northwest of Fort St. John, BC, within the Muskwa-Kechika Management Area. The PEM project involves the mapping of 1.3 million ha of Oil and Gas Pretenure License area, using standardized protocols for ecosystem mapping in British Columbia, and specialized GIS modelling/remote sensing approaches. Under the direction of Dr. Sims, EBA staff prepared final outputs at 1:50,000 scale, including wildlife habitat mapping for several key species. The work for MEM involved the integration of TRIM-based digital terrain models, classified satellite imagery, various types of existing mapping and field plot information, extensive air photo interpretation of "bioterrain" features, and focussed field data collection.
- **Foster Creek Commercial Thermal Recovery Project, Phase 2/3 Environmental Assessment (EA) (2000 - 2004).** Dr. Sims oversaw the coordinated preparation of several key components of a major environmental assessment project for the proposed Foster Creek (Phase 2) steam-assisted gravity drainage (SAGD) oil recovery installation (processing plant, associated infrastructure and pipeline/well site configurations); the work was conducted for Alberta Energy Company in Cold Lake, AB. The EA activity included the integrated treatment of vegetation/forestry, wildlife habitat, fisheries, physical environment, cumulative effects analyses, and GIS mapping/document preparation. In addition to the coordination of field programs and the design of inventory and monitoring programs, Dr. Sims provided critical input into the integrated treatment of the EA topics, the important linkages of cumulative environmental effects concerns, and the preparation of documentation and reporting materials for licensing/permitting activities.
- **Eagle Plains Environmental Assessment (2000 - 2002).** For Anderson Exploration Ltd. of Calgary, Dr. Sims oversaw the preparation of environmental assessment and licensing/permitting applications for a proposed 275 km seismic operation planned (for winter/spring 2001 and 2002) for the Eagle Plains area of northern Yukon. The work involved the pulling together of a wide range of existing environmental data and information for the subarctic/taiga area which has some critical environmental values (Porcupine caribou wintering range, sensitive permafrost terrain, First Nations heritage, cumulative environmental effects). As well, the project involved liaison with First Nations and the Territorial Government, regular discussions with regulators and other stakeholders, and the conduct of directed fieldwork.

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- **Terrestrial Ecosystem Mapping Correlation (1997 - 2002).** Dr. Sims conducted correlation and quality assurance audits for the BC Ministry of Forests (MOF), Research Branch, over a period of several years. He has undertaken detailed audits of Terrestrial Ecosystem Mapping (TEM) projects and TEM-related interpretations throughout British Columbia, doing field and office checks, and running final deliverables through series of tests and checks. This work has involved ongoing coordination with forest industry and MOF staff.

- **Besa-Prophet Terrestrial Ecosystem Mapping (1998 - 2001).** Directed and oversaw all components of a large 1:50,000 scale TEM project in the Besa-Prophet area of northern BC. The work was conducted in association with the Ministry of Environment, Lands and Parks, and the BC Oil and Gas Commission. Completed field investigations, photo and image (SPOT, TM) interpretation, and map production for this extensive 300,000 ha+ study area. Extensive use was made of GIS-based algorithms to produce interpretive outputs. Spatial analyses were conducted to derive TEM mapping outputs using remote sensing analysis, TRIM-based digital terrain models, and other spatial and non-spatial data. In particular, TEM wildlife interpretations completed during this work are being used to monitor potential impacts of oil and gas development within the project area.

- **SC Yukon Ecological Stratification Project (1998 - 1999).** Dr. Sims coordinated the completion of an ecological stratification project for DIAND's Forestry Branch and the Yukon Territorial Government. The first phase involved the construction of a GIS-based ecological stratification for ecological land classification of a large area of SC Yukon. A range of existing databases (soils, geology, elevation, forest inventory, etc.) were brought together within a GIS and used to identify areas for field visitation and sampling. The second phase involved an intensive field data-gathering exercise to document ecological conditions at selected locations. The aim of the work, which has been continued internally at DIAND, is to produce a formal forest ecosystem classification with forest/wildlife management interpretations for this part of the territory.

- **Terrestrial Databases for National Climate Monitoring (1998 - 2000).** For the Canada Centre for Remote Sensing, Dr. Sims documented the status of present and historical forestry, environmental and aquatic databases used to monitor climate change. Conducted a thorough literature search, a wide review of web-based information, and conducted interviews and phone/email surveys to collect and compile information on terrestrial databases that might be of potential use for nationally-oriented climate monitoring. Participated in several planning/strategy meetings.

- **Slocan-Mackenzie and Slocan-Valemount TEM Projects (1997 - 2000).** Dr. Sims coordinated with consulting teams within several companies to undertake two large-area 1:20,000 "TEM with wildlife interpretations" projects. These multi-year projects were conducted for Slocan Forest Products Ltd., MELP and FRBC, and involved detailed ground checking, photo-interpretation and detailed digital mapping of over 600,000 ha of rugged and pristine terrain in north-eastern and north-central British Columbia. He was also responsible for the overall coordination and production of habitat assessments and GIS-based interpretations for 11 critical wildlife species.

- **Spatial Modelling in Ecosystem Management (1990 - 1996).** Dr. Sims applied integrated resource management concepts to forest ecosystem mapping and spatial interpretation. He developed and tested GIS-based decision support systems applied to forest management problems in Ontario and in other locations in Canada, using digital elevation models (DEMs) for spatial analyses and ecosystem process modelling. He coordinated a major multi-disciplinary research project over five years at Rinker Lake, northwest Ontario.

- **Forest Ecosystem Classification (FEC) and Site-Related Ecosystem Studies in Ontario (1983 - 1996).** Dr. Sims undertook extensive ecological land and site classification and related management interpretations of forest landbases using an integrated approach to studying soils, climate, vegetation and landform components.

- **Ecological Mapping in the Hudson Bay Lowland (1976 - 1981).** Dr. Sims carried out pioneering ecological land classification and ecological site studies, as a key member of a multi-agency, multi-disciplinary team, to describe and map wetland and upland ecosystem complexes within the Hudson Bay Lowland, northern Canada. He used field data to define ecosystems and then mapped ecosystem complexes for wildlife (especially shorebirds, waterfowl, and caribou) at 1:250,000 scale for a large, subarctic and poorly-understood region of northern Canada.

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EMPLOYMENT HISTORY

1999 - Present	Principal Scientist/Senior Environmental Scientist EBA Engineering Consultants Ltd.
1998 - 1999	President R.A. Sims and Associates
1996 - 1998	Director of Forestry/Senior Forest Ecologist Geomatics International Inc.
1976 - 1996	Senior Research Scientist/Ecologist Canadian Forest Service, Natural Resources Canada

THESIS

Ph.D. Thesis: Caribou/reindeer winter range, Tuktoyaktuk Peninsula, NT
M.Sc. Thesis: Disturbed wetland ecosystems associated with transmission line rights-of-way, northern Manitoba
B.Sc. Thesis: Ecology of epiphytic flora of American elm in northwest Ontario

SELECTED SCIENTIFIC AND TECHNICAL PUBLICATIONS

R.A. Sims and M. Riedmann. 2007. Ground Motion Monitoring Using InSAR: Example Applications for Mining and Pipeline Operations with Consideration of Potential for Developing Countries. Proc. ISPRS Conf. on Information Extraction from SAR and Optical Data, with Emphasis on Developing Countries, ISPRS Commission VII, WG2 and WG7. May 16-18, 2007. Istanbul, Turkey. 10 pp.

Riedmann, M., **R. Sims**, C. Rogg and O. Schleider. 2006. Application of ground movement and automated route planning technologies for pipeline planning and management - the PIPEMON project. Proc. 6th International Pipeline Conference. Sep. 25-29, 2006. Calgary, AB. Paper No. IPC2006-10545. 9 pp.

Mackey, B.G., Mullen, I., **Sims, R.A.**, Baldwin, K.A., Gallant, J. and McKenney, D.W. 2000. Towards a spatial model of boreal forest ecosystems: the role of digital terrain analysis. Chapter 16. pp. 391-422 in J. Wilson and J. Gallant (eds.). Terrain Analysis: Principles and Applications. Wiley and Sons, New York, USA.

Sims, R.A., Baldwin, K.A., Walsh, S.A., Lawrence, K.M., McKenney, D.W., Ford, M.J. and Mackay, B.G. 1998. The derivation of spatially referenced ecological databases for ecosystem mapping and modelling in the Rinker Lake Research Area, North-western Ontario. Can. For. Serv., Sault Ste. Marie, ON. NODA Note No. 34. 13 pp.

Ringius, G.S. and **Sims, R.A.** 1997. Indicator Plant Species in Canadian Forests. UBC Press, Univ. BC. Vancouver, BC. 224 pp. (also produced and distributed in a French-language edition).

Biggs, W., Eligh, P., **Sims, R.A.** and Wiart, R. 1997. A Business Approach to Terrestrial Ecosystem Mapping in BC. Resource Inventory Committee, Min. Forests/Min. Environ., Lands and Parks, Victoria, BC. 60 pp. (MELP File Report).

Baldwin, K.A. and **Sims, R.A.** 1997. Field Guide to the Common Forest Plants in North-western Ontario, 2nd edition. Ont. Min. Nat. Resour., Northwest Sci. & Technol., Thunder Bay, ON. NWST Field Guide FG-04. 359 pp. [1st edition published as: Baldwin, K.A. and **Sims, R.A.** 1989. Field Guide to the Common Forest Plants in North-western Ontario. Ont. Min. Nat. Resour., Toronto, ON. 344 pp.]

Sims, R.A., Towill, W.D., Baldwin, K.A., Uhlig, P.W. and Wickware, G.M. 1997. Field Guide to the Forest Ecosystem Classification for North-western Ontario, 2nd edition. Ont. Min. Nat. Resour., Northwest Sci. & Technol., Thunder Bay, ON. NWST Field Guide FG-03. 176 pp. [1st edition published as: **Sims, R.A.**, Towill, W.D., Baldwin, K.A. and G.M. Wickware. 1989. Field Guide to the Forest Ecosystem Classification for North-western Ontario. Ont. Min. Nat. Resour., Toronto, ON. 191 pp.]

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Sims, R.A., Baldwin, K.A., Walsh, S., Lawrence, K., McKenney, D.W., Ford, J. and Mackay, B.G. 1997. Deriving spatially referenced ecological databases for ecosystem mapping and modelling in the Rinker Lake Research Area, NW Ontario. Can. For. Serv., Sault Ste. Marie, ON. NODA File Report 33. 48 pp.

Sims, R.A., McKenney, D.W., Mackey, B.G. and Hutchinson, M.F. 1996. Construction of a new digital elevation model for Canada. 10th Annual Symposium. Mar. 18-21, 1996. GIS '96. Conf. Proc. (produced on CD-ROM). Vancouver, BC. 15 ms pp.

Sims, R.A., Wickware, G.M. and Nixon, D.N. 1996. Enhancement of a forest soils mapping database for north-western Ontario. 10th Annual Symposium. Mar. 18-21, 1996. GIS '96. Conf. Proc. (produced on CD-ROM). Vancouver, BC. 13 ms pp.

Cauboue, M., Strong, W., Archambault, L. and **Sims, R.A.** 1996. Terminology of Ecological Land Classification in Canada. Nat. Resour. Can., Can. For. Serv., Ste.-Foy, QC. Inf. Rep. LAU-X-114E. 62 pp.

Sims, R.A. and Mackey, B.G. 1996. Development of spatially-based ecosystem models for the Rinker Lake research area in north-western Ontario's boreal forest. pp. 516-525 in M. Heit, H. Dennison Parker and A. Shortreid (eds.). GIS Applications in Natural Resources. Volume 2. GIS World Books. Ft. Collins, CO, USA. [Also published as pp.665-674 in Decision Making with GIS; the Fourth Dimension. GIS '94 Symp. Proc. Vol. 2. Feb. 21-24, 1994. Vancouver, BC. Polaris Conference. Vancouver, BC. 906 p.]

Sims, R.A., Corns, I.G.W. and Klinka, K. (eds.). 1996. Ecological Land Classification: Global To Local. Kluwer Acad. Publ., Dordrecht, The Netherlands. 610 pp. (individual papers were also published as papers in Environ. Monitor. & Assessm. Vol. 39).

Sims, R.A., Corns, I.G.W. and Klinka, K. 1996. Ecological land classification: global to local - an introduction. Environ. Monitor. & Assessm. 39: 1-10.

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rsims@eba.ca

Claudio Bianchini, *R.P.Bio.*
Bianchini Biological Services (BBS)
11879 83 Avenue
Delta, British Columbia
V4C 2H6
(604) 219-9699
BBS@Bianchini.ca

PROFILE

1999-present	Wildlife Biologist and Principal, Bianchini Biological Services
1996-1999	Senior Wildlife Technician, Keystone Wildlife Research, White Rock
1995	Research Technician, Ministry of Forests, Kamloops
1993-1994	Wildlife Research Consultant (self-employed)
1993-1994	Wetland Technician, BC Ministry of Environment, Lands and Parks, Surrey
1991-1993	Dipl. Tech. (Fish, Wildlife & Recreation Land Management) - BC Institute of Technology

EXPERIENCE

Mr. Bianchini has over 18 years experience in the areas of environmental biology and wildlife management, as both a biologist and research technician. Most of his career has been in private consulting. In addition, he has worked two years for the BC Ministry of Environment, Lands and Parks and the BC Ministry of Forests. Claudio has extensive experience in working in remote locations as well as in urban settings. Many of these projects included both field work and report writing involving multidisciplinary teams and First Nations.

As an environmental biologist, he has a broad background in terrestrial environments. His project work has primarily been in British Columbia and Nunavut including:

- Environmental assessments of development in urban and wilderness environments,
- Assessment of potential disturbance to large mammals, furbearers, birds, amphibians, reptiles, invertebrates and vegetation,
- Wildlife use and habitat assessments in regulated watersheds,
- Environmental assessments of linear developments,
- Terrestrial Ecosystem Mapping/Predictive Ecosystem Mapping/Ecological Land Classification (TEM/PEM/ELC),
- Caribou calving and post-calving surveys in the Arctic including surveys of the Beverly, Ahiak and Qamanirjuaq herds.

The following project summaries provide a sample of Claudio Bianchini's professional scope and experience in environmental biology and impact assessment:

Linear Developments (Highways and Pipelines) – Claudio Bianchini is currently involved with assessments for the Port Mann Bridge Twinning project. Claudio has also conducted environmental assessments for a number of other linear developments including the 110 km all weather access road (AWAR) to the Meadowbank Gold Mine (Nunavut) and proposed 100 km AWAR to the proposed Kiggavik Uranium Mine (Nunavut). Mr. Bianchini also contributed to the preliminary habitat mapping for pipeline upgrades for Kinder Morgan Canada and the BC Transmission Corporation (BCTC) Northwest Transmission Line Project. Claudio has also contributed to the Sea to Sky Highway Improvements Project, South Fraser Perimeter Road, Golden Ears Bridge Crossing, Pine Pass Highway Re-alignment, Inland-Pacific Connector Pipeline and Terasen's Coldwater III Pipeline Replacement.

Mining – Since 1996 Claudio has been involved with a number of projects assessing potential impacts and disturbance to large mammals, fur bearers, amphibians, reptiles, songbirds, raptors, waterfowl, vegetation and ecological communities. These projects have included habitat assessments and inventories for carnivores, ungulates, small mammals and nesting birds in the Arctic (Agnico-Eagle Mines, Areva Canada, Cameco, Sabina Silver); grizzly bear, furbearer and songbird inventories along the Stikine, Iskut, Porcupine and Craig rivers (Teck Cominco/NovaGold, International Skyline Gold Corporation) and for carnivores, ungulates, furbearers, amphibians, reptiles and songbirds of the Chetwynd area (Cline Mining Corporation).

Ecological Land Classification (ELC)/Terrestrial Ecosystem Mapping (TEM)/Predictive Ecosystem Mapping (PEM)
Claudio has over 11 years experience with ELC/TEM/PEM. He has participated in many projects conducting Vegetation Assessments and Wildlife Capability and Suitability Ratings for:

- Aberdeen & Turqavik Uranium Projects for Cameco (Nunavut),
- Meadowbank Gold Project and 110 km road route for Cumberland Resources/Agnico-Eagle (Nunavut),
- Kiggavik Uranium Project and 100 km road route for Areva Canada (Nunavut),
- Mt. Milligan Copper-Gold Project and 125 km transmission route for Terrane Metals Corporation (Central BC),
- Hackett River Property and Bathurst Inlet Port and Road Project for Sabina Silver (Nunavut),
- Kutcho Creek Property and 125km road route for Western Keltic Mines (NW BC),
- Mount Klappan Anthracite Coal Property and 100 km road route for Fortune Minerals (NW BC),
- Galore Creek Property and 100 km road route for Teck Cominco/NovaGold (NW BC),
- Lossan Coal Property and 12 km road route for Cline Mining Corporation (NE BC),
- TFL 52 and 53 for West Fraser Mills/Dunkley Lumber (Quesnel),
- East Cariboo and Ellerslie Lake Areas for Ministry of Environment, Lands & Parks,
- Chimney, Hawks, Jones Creeks and McLease Lake for Lignum Forest Products (Williams Lake),
- Nyland/Gerami and Willow River for Weldwood of Canada (Quesnel),
- Lower Sukunka for CANFOR (Chetwynd).

For most these projects Claudio participated in the wildlife ratings, site series classifications and ground truthing used in the production and quality assurance of the mapping products. Claudio has also provided ecological aerial photo typing and developed databases used in the mapping process.

As part of BC Hydro's investigations into the potential development of Site C, Claudio completed a peer review of the Peace River Wildlife Studies: Draft Wildlife Species Accounts and TEM wildlife ratings table.

Species at Risk - Claudio has been involved in many projects where species at risk are of major concern. He is currently conducting multiple mountain beaver, Pacific water shrew, red-legged frog, Oregon forestsnail, Dun skipper, phantom orchid and Pacific waterleaf habitat assessments. He has also been a member of the Burrowing Owl Recovery Team for over 16 years.

Winter Range Mapping
Claudio has extensive experience with winter range mapping projects. These include: Adams Lake Mule Deer Winter Range Mapping and Grizzly Bear Habitat Assessment (Interfor), Mid-coast Coastal Black-tailed Deer Winter Range Mapping (Ministry of Environment, Lands and Parks – Hagensborg) and North Coast Coastal Black-tailed Deer Winter Range Mapping (Ministry of Environment, Lands and Parks – Prince Rupert).

Power Generation – Claudio has recently been involved with BC Hydro pole relocation projects in the Elk Valley and Kaslo areas of the Kootenays. In addition, Claudio was participated in the wildlife assessment for the upgrade of BC Hydro's Aberfeldie generation facility near Cranbrook as well as environmental assessments for BC Hydro works on Mt. Pocahontas, Texada Island and the Boundary Bay Airport. Past power generation projects have included assessing power generation impacts on historical wildlife populations for the Bridge-Coastal Compensation Program. In addition Claudio was involved with the BC Hydro Power Supply Terrestrial Issues Project. This project included site visits and identification and ranking of environmental issues at all BC Hydro generation facilities in British Columbia.

Claudio has also conducted waterfowl surveys of Cold Lake Alberta (Alberta Energy Commission) and breeding bird surveys in the Peace River region (Westcoast Energy, Peace Williston Compensation Program). Claudio was also involved in the Nahwitti and Stothard Power Wind Generation Projects near Holberg, BC. Claudio was responsible for habitat mapping, wildlife capability and suitability ratings, Marbled Murrelet surveys and bat capture and identification. Claudio has also participated in environmental assessments for many run-of-the river projects throughout BC.

Water Use Planning – Claudio Bianchini has been involved in the wildlife aspects of water use plan preparation for several BC Hydro power generation facilities. These include Shuswap, Campbell, Jordan, Cheakamus, and Coquitlam generation facilities. The analysis entailed reviews of existing wildlife information (documented and anecdotal), air photo interpretation of riparian ecosystems, and implications to wildlife and wildlife habitat due to alterations to current operations.

Small Business Forestry Environmental Assessments
Claudio has been involved with many Small Business Forestry Environmental Assessments for the Ministry of Forests (Bella Coola) including: Ickna Creek, Snass Lake and Four Lakes on King Island. These projects required the identification of critical wildlife habitats and recommendation of harvesting areas and timing.

Fraser Estuary - Since 1993, Claudio has been involved in various Fraser River Estuary projects. These included the Vancouver International Airport Third Runway Compensation Project and the Burns Bog Ecosystem Review (bears, small mammals, waterfowl and Sandhill Cranes).

SELECTED PROFESSIONAL DEVELOPMENT AND VOLUNTEER POSITIONS

- Burrowing Owl Recovery Team (1994-present)
- South Coast Conservation Program Workshops on Best Management Practices for Species at Risk: Pacific Water Shrew, Rare Plants (2008-2012)
- Emergency First Aid - Industry Level 1 (2009)
- Level A CPR (2009)
- First Aid Transportation Endorsement (2009)
- South Coast Conservation Program Species at Risk Conservation Workshop (2007)
- Environmental Best Management Practices Workshop (2005)
- Stanley Park Ecology Society Board of Directors (2003-2004)
- North Gulf Oceanic Society Alaska Whale Research (2003)
- RIC Wildlife Habitat Ratings (1999)
- RIC Introduction to Wildlife Species Inventories (1999)
- BC Electrofishing Certification (1996)
- Bear Safety Training (1995)

SELECTED REPORTS

Bianchini, C. 2011. **Review of Peace River Wildlife Studies: Draft Wildlife Species Accounts Vol. 2.** Report to Anré McIntosh, BC Hydro, Vancouver, BC.

Bianchini, C. 2010. **Terrestrial Wildlife Assessment for the Proposed Milford Creek to Lardeau Pole Relocation Projects 1, 4, 5, 7 and 9 along Highway 31, Kaslo, BC.** Report to Andrew Walter, BC Hydro, Burnaby, BC.

Bianchini, C. 2009. **Terrestrial Wildlife Assessment of the Proposed Pole Relocation Works along Highway 31 and Meadow Creek, Meadow Creek, BC.** Report to Andrew Walter, BC Hydro, Burnaby, BC.

Bianchini, C. 2008. **Review of Peace River Wildlife Studies: Draft Wildlife Species Accounts and Ratings Table.** Report to Anré McIntosh, BC Hydro, Vancouver, BC.

Bianchini, C. 2007. **Environmental Assessment of the Proposed BC Hydro Subterranean Powerline Works on Mt. Pocahontas, Texada Island, BC.** Report by Scott Resource Services Inc. to Manny Poonie, BC Hydro, Burnaby, BC

Bianchini, C. and K. A. McIntosh. 2006. **Environmental Assessment of the Proposed 60L281 Pole Relocation Works Along the Elk River,** Elko, BC. Report by Robertson Environmental Services Ltd. to Andrew Walter, BC Hydro, Burnaby, BC.

Bianchini, C. and D.S. Power. 2005. **Lossan Wildlife Habitat Suitability Ratings.** Draft report to Rescan Environmental Services Ltd., Vancouver, BC.

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Fraker, Mark, C. Bianchini, and I. Robertson 1999. **Burns Bog Ecosystem Review: Small Mammals.** Delta Fraser Properties and the British Columbia Environmental Assessment Office. Victoria, BC.

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Summers, K.R., C Bianchini, M.J. Kostamo, S.P. Wilkins 2002. **Power Supply Environment Terrestrial Issues (PSTI) 2001.** Report to Ed Hill, BC Hydro, Burnaby, BC.

RESUME Robert E. Draho

Robert E. Draho, B.Sc.
Senior Project Scientist

EDUCATION

B.Sc., Electrical Thermodynamics, Lakehead University, Thunder Bay, ON, 1977

British Columbia Institute of Technology, Instrumentation Technology Certificate, 1982

British Columbia Institute of Technology, Environmental Engineering Program, 2000

EDUCATION

First Aid, WHMIS, Defensive Driving, ATV/Quad Training, Supervisor Safety, ACSA Leadership, H2S Alive, Pleasure Craft Operator

AWARDS

Association of Professional Engineers and Geoscientists of British Columbia - 2002 Environmental Award - Influence of Limnology on Domestic Water Intakes

Updated: March 7, 2011

Mr. Draho is a Senior Project Scientist and Instrumentation Specialist with over 33 years of experience in electronics, data acquisition, field study design, and the implementation and operation of hydraulic models. He has worked extensively in field data studies and laboratory analysis related to the mining, pulp and paper, fisheries, and environmental sectors.

He has been responsible for the design and implementation of numerous hydrology, meteorology, limnology, and oceanographic field studies, as well as instrument selection and procurement, scheduling, and client liaison for individual projects. Over the years, he has built up an extensive inventory of field and laboratory instrumentation, and data recording equipment.

Mr. Draho is in charge of supervising and implementing field studies and data analysis techniques with EBA, A Tetra Tech Company

RIVER ENGINEERING PROJECTS

- **Department of Fisheries and Oceans - Hell's Gate Study, Fraser River, BC.** In the late 1940s, a 30 m long tunnel was cut through one of the headlands at Hell's Gate Canyon, to provide a low-energy passageway for adult salmon returning to spawn. However, during each freshet proceeding the spawning season, the tunnel fills with gravel and cobbles, rendering it ineffective as a fish passageway. Fisheries and Oceans engaged EBA's acquired company, Hay & Company Consultants (Hayco), to conduct a detailed hydraulic analysis of this sedimentation problem. Work included reconnaissance surveys, monitoring the growth and decay of the deposition in the tunnel and water levels at either end, and development of an exploratory numerical model (H3D), to determine possible remedial action.
- **Fraser River Port Authority - Numerical Model of Lower Fraser River-Phase II, Fraser River, BC**. Mr. Draho designed and implemented ADCP and CTD field studies for the calibration of Hayco's in-house 3-D model (H3D) which was implemented for the lower Fraser River in order to study the causes of recent shoaling in the navigational channel. The field data was used for a detailed calibration/validation process, to prepare the numerical model for predictions based on site-specific conditions.
- **Department of Fisheries and Oceans - Hell's Gate Fish Tunnel Observation Program, Fraser River, BC.** Hay & Company Consultants was engaged to continue and augment a field program for the collection of sediment and current velocity data within the Hell's Gate fish tunnel on the Fraser River. This program was carried out as part of a large study investigating sedimentation problems within the tunnel.
- **Department of Fisheries and Oceans - Hell's Gate Data Assembly, Hell's Gate, BC.** Hay & Company Consultants were engaged to conduct studies into the sedimentation process and prepare recommendations for mitigative measures. Work involved mapping of the deposited depth of sediment, measurement of fluctuating water levels at each end of the tunnel, and development of a preliminary 3D numerical model.

- **P.T. Hatfindo Prima - Kiani Diffuser Study, Berau Estuary, Indonesia.** Detailed current meter and salinity data were collected to support an analytical study of hydrodynamic conditions in the lower Berau estuary in Borneo. The study was undertaken to provide prototype velocity conditions for the design of a pulp mill diffuser.
- **Ministry of Transportation and Highways - Dredge Hole Migration Study, Fraser River, BC.** Several existing numerical models of sediment transport were reviewed to develop a steady state model of bed development in the 25 km Main Arm of the Fraser River between New Westminster and Steveston, BC. The model used empirically derived coefficients for calibration against prototype soundings after varying freshet conditions. The model was used to study infilling and movement of dredged holes and their effect on downstream structures.
- **Public Works Canada - Acoustic Doppler Current Profiles, Steveston, BC.** Complete cross-sectional velocity profiles were obtained at three transects in Steveston Bend using an Acoustic Doppler Current Profiler (ADCP) for two 24-hour periods during the Early Stuart Run in early July. The data was obtained prior to construction of the present berm, and served as a benchmark for subsequent velocity profile comparisons following completion of the proposed Steveston Bend training wall.
- **Scott Paper - Effluent Plume Delineation, New Westminster, BC.** Scott Paper discharges effluent into the North Arm of the Fraser River downstream of trifurcation. Delineation of the effluent plume was required for given river discharge and tidal conditions to reconstruct a previous discharge event.
- **Sandwell Inc. - Velocity Profiles, Hope, BC.** A series of velocity profiles were collected using an Acoustic Doppler Current Profiler (ADCP) to determine the magnitude and direction of the river flow vectors as it approached the bridge piers. The data was used to aid in the modification of the existing bridge and pier structures.
- **Cewe Gravel Ltd. - Frozen Core Sediment Sampling, Coquitlam, BC.** Two substrate projects were undertaken for riverbed sampling using the frozen core technique, one each on the Columbia and Coquitlam Rivers. Liquid carbon dioxide was utilized to freeze a sediment sample in situ, which was subsequently extracted intact. This technique preserves the fine components and any stratification in the sample. Also, the sampler does not contaminate the sample in any fashion so tests for trace materials can be undertaken.
- **P.T. Hatfindo Prima - Kiani Diffuser Study, East Kalimantan, Indonesia.** A detailed field study was undertaken on the Berau River in East Kalimantan to collect data for the design of a pulp mill effluent diffuser. The estuary exhibited distinct two-layer flow due to the influence of the tides. Stationary current meters, an acoustic Doppler meter, and salinity and temperature gauges were used to collect data. A 2-D kinematic model was implemented to generate velocity fields, which were then used as input to an effluent model to investigate dispersion and provide design recommendations for the outfall.
- **Ministry of Transportation and Highways - Castlegar-Robson Bridge Hydraulic Model Study, Castlegar, BC.** A numerical hydraulic model was used to assist in the hydraulic design process of the bridge. The bridge length was dependent on the feasibility of constructing a fill from the north shore to a small island formed as part of the Norns Creek delta. The fill was believed to affect fish habitat and spawning areas. Flow and velocity patterns were investigated to develop an acceptable scheme.

COASTAL ENGINEERING PROJECTS

- **Canadian Coast Guard - Fraser Foreshore Sediment Tracing, Richmond, BC.** Dyed sand samples were collected from 12 locations across Sturgeon Bank and Roberts Bank to trace the migration of deposited sediments, and the results were correlated with prevailing tidal, wave and current conditions to determine the dominant coastal processes and sediment movement rates on the foreshore.

PORTS AND HARBOURS ENGINEERING PROJECTS

- **Al-Afandi Establishment - Seaweed Study in Al-Buhairat City, Saudi Arabia.** Mr. Draho assisted in the determination of the causes for excessive seaweed growth in a man-made lagoon system for a luxury condominium/hotel complex located in Al Buhairat City, Saudi Arabia. He generated the numerical model grid, as well as reducing client water quality data to a form suitable for the calibration of the H3D numerical model. This model was used to investigate circulation and nutrient concentrations causing excessive seaweed growth in the waterways.

bdraho@eba.ca

HYDROLOGY PROJECTS

- **Cewe Gravel Ltd. - Sediment Control, Coquitlam, BC.** Hydrology and sediment production at a gravel mining operation were investigated to develop interim and long-term sediment control programs. Studies included field data collection for sediment concentrations, sediment discharge, water discharge, and precipitation at the site and in adjacent streams. The efficiency of settling basins at the site was monitored. Sediment control techniques were assessed including experiments with laminar settlers and coagulants. A long-term monitoring program was undertaken. The adequacy of the company's policy was successfully defended in court.

- **Placer Dome Incorporated - Hydrology Monitoring Program for the Boac River Rehabilitation, Marinduque, Philippines.** Mr. Draho was involved in the design of a data collection program, installation of field instruments, on-site training of personnel, and the data analysis associated with monitoring the rehabilitation of the Boac River on the island of Marinduque, Philippines. This study was in response to the accidental spill of mine tailings into the headwaters of the river system.

- **Placer Dome Incorporated - Las Crucitas Mine, Costa Rica.** Design and implementation of a hydrologic and sedimentologic data collection program for a potential mine site in Costa Rica. The project included deployment of instruments, training field staff, data analysis, and recording.

- **Placer Dome Incorporated - Environmental and Hydrological Field Data Collection, Las Cristinas Gold Concession, Venezuela.** Mr. Draho spent over a year on the Las Cristinas Gold Concession in Venezuela setting up and maintaining a number of experiments and data collection programs. Some of the programs included river stage-discharge curve generation, water quality collection and measurement, monitoring and maintaining an automated meteorological station, rehabilitation studies, and suspended sediment studies. Dataloggers were installed and maintained for the purposes of monitoring river elevations.

- **Tyhee Development Corp. - Hydrometeorological study for the Yellowknife Gold Project, Northwest Territories.** Hay & Company Consultants was contracted to conduct a two-year hydrology and climate study as part of the feasibility study for a potential gold mine located about 75 km north of Yellowknife. The study involved installing and monitoring three hydrometric stations, each measuring flows from a separate drainage basin. Stage discharge relationships were produced for each station to enable determinations of the various creeks' time history of discharges. As part of the study, a complete meteorological station was installed and recorded weather data on a 15 minute interval.

- **Seabridge Gold Inc. - Matthews Creek Hydrology, Northwest Territories.** Mr. Draho conducted a four-year hydrology study on Matthews Creek as part of the feasibility study for a potential gold mine located about 150 kilometres northeast of Yellowknife. The study involved installing and monitoring a hydrometric station to measure outlet flows from Matthews Lake. Matthews Creek stages were recorded by the station datalogger at a 15 minute sample period. A stage discharge relationship was produced for the station to enable determinations of the creek's time history of discharge.

- **Cline Mining Corporation - Hydrological Study of the Lodgepole Coal Mine Project, Fernie, BC.** Hay & Company Consultants, in cooperation with EBA, was contracted to conduct a two-year hydrology study on the mine site as part of the feasibility study for a potential coal mine located near Fernie, BC. The study involved installing and monitoring two hydrometric stations, each measuring creek flows from separate drainage basins. Creek stages were recorded by the station data logger at a 15 minute sample period. Stage discharge relationships were produced for each station to enable determinations of the creek's time history of discharges over the period of record.

- **Overland Resources Pty - Hydrometeorological study for the Andrew Property Project, Yukon Territory.** Hay & Company Consultants, a division of EBA Engineering Consultants, was contracted to conduct a multi-year hydrology and climate study as part of the feasibility study for a potential lead-zinc mine located in the central Yukon Territory of northern Canada. The study involved installing and monitoring 10 hydrometric stations, each measuring flows from a separate drainage basin along a 75 kilometre stretch of proposed all-weather road. Stage discharge relationships were produced for each station to enable determinations of the hydrographs. A temperature sensor was included at each station to enable the determination of a time history of water temperature. As part of the study a complete meteorological station

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was installed and recorded weather data for the site at 15 minute intervals. An all-weather precipitation gauge was included with the meteorological station installation.

- **Platina Resources Ltd. - Hydrometeorological study for the Skaergaard Project, Mikis Fjord, Greenland.** Hay & Company Consultants, a division of EBA, A Tetra Tech Company, was contracted to conduct a multi-year hydrology and climate study as part of the feasibility study for a potential platinum mine located near Mikis Fjord on the east coast of Greenland. The study involved installing and monitoring two hydrometric stations, each measuring flows from a separate drainage basins. Stage-discharge relationships were produced for each station to enable determinations of the hydrographs. A temperature sensor was included in the station to enable the determination of a time history of water temperature. A tide station was also installed in Mikis Fjord, and records tide elevations and water temperature every 15 minutes. As part of the study, a complete meteorological station, including an all-weather precipitation gauge, was installed to record weather data for the site at 15 minute intervals. The meteorological station has Iridium satellite communication instrumentation, enabling communication with the station from anywhere in the world. This particular area of Greenland is often fogged-in; therefore, by polling the meteorological station the weather conditions at site can be determined prior to the departure of flights from Iceland to the site.
- **Roche Bay PCL - Hydrometeorological study for the Roche Bay Project, Nunavut.** Hay & Company Consultants, a division of EBA, A Tetra Tech Company, was contracted to conduct multi-year climate research as part of the feasibility study for a potential iron ore mine located near Roche Bay, Nunavut, south of Baffin Island. The study involved installing and monitoring a meteorological station at the site. In addition to the standard meteorological instruments, the station includes an all-weather precipitation gauge, a digital camera, which is used for monitoring visibility at the site, as well as Iridium satellite communication instrumentation. This particular area of Nunavut is often fogged-in; therefore, by means of the remote polling abilities of the station, the weather conditions and a photo of the landing strip, can be viewed prior to the departure of flights to the site. Weather data for the site is recorded at 15 minute intervals.
- **Hawthorne Gold Corp. - Hydrometeorological study for the Fraser Gold Property Project, British Columbia.** Hay & Company Consultants, a division of EBA, was contracted to conduct a multi-year hydrology study as part of the feasibility study for a potential mine located in southcentral British Columbia. The study involved installing and monitoring four hydrometric stations, each measuring flows from a separate drainage basin. Stage discharge relationships were produced for each station to enable determinations of the hydrographs and time histories of water temperature.
- **Shell Exploration and Production Company - Meteorological study for the Kulluk oil drilling platform, Beaufort Sea.** Hay & Company Consultants, a division of EBA, was contracted to install a temporary meteorological and ice monitoring station during the winter period on the Beaufort Sea ice near the location of the platform. The study involved the monitoring of Beaufort Sea ice formation by means of a thermistor temperature string to monitor the ice growth and the ambient weather conditions provided by the meteorological station. A second task was the measurement of Kulluk Cabin temperatures and relative humidities in selected areas on board the drilling platform. The purpose was to determine the range of temperature and relative humidity during the winter period, when the Kulluk is left unheated and unattended.

INSTRUMENTATION AND FIELD STUDIES PROJECTS

- **British Columbia Science Council - Gorge Harbour, BC.** Mr. Draho conducted the field portion of this project to obtain velocity data using an ADCP and water quality measurements using a CTD in conjunction with a chlorophyll meter to measure phytoplankton abundance. The data was used to calibrate a numerical model of Gorge Harbour to optimize production of oysters in the harbour waters.
- **Keystone Environmental - Fraser River Main and North Arm Discharge Survey, British Columbia.** Mr. Draho developed and supervised a program of two 96-hour continuous ADCP surveys. River discharges and velocities were collected along five transects across the main and north arms of the Fraser River. DGPS was also incorporated into the survey. The two portions of the survey were conducted at different river flows: a high river flow during freshet, and a much lower flow. The data was used to calibrate a numerical model for river velocities and tidal elevations for the area.

bdraho@eba.ca

- **British Columbia Department of Fisheries - Theodosia Harbour, BC.** Mr. Draho conducted the field portion of this project to obtain water quality measurements using a CTD in conjunction with a chlorophyll meter to measure phytoplankton blooms. The data was used to calibrate a numerical model of Theodosia Harbour to determine the impact of re-establishing natural flows in the Theodosia River.
- **Canada Mortgage and Housing Corporation - Greywater Monitoring, Quayside Village, North Vancouver, BC.** Hay & Company Consultants performed inspection and monitoring of a greywater reclamation system. The monitoring program provides data for the assessment of system operation, user acceptance, and the conservation benefits of residential greywater reclamation systems.
- **ENSR Consulting & Engineering - Model Instrumentation, Rocky Reach Dam, WA.** Load cell instrumentation for a hydraulic model study related to fish bypass facilities on the Rocky Reach Dam, Columbia River.
- **City of Welland, Ontario - Velocity Instrumentation, Welland, ON.** Velocity Pitot cylinders were designed, constructed and calibrated to measure velocity profiles and to monitor flows in the city's water mains and supply distribution system. The battery-operated system will function unattended for two to three months before batteries require recharging.
- **Amax of Canada - Kitsault Outfall Design, Alice Arm, BC.** Western Canada Hydraulics Labs (WCHL), a subsidiary of Hay & Company Consultants, undertook conceptual design of a gravity seawater dilution outfall system for disposal of molybdenum-copper tailings into Alice Arm. A de-aeration chamber was developed to control air entrainment at the mixing stage and potential release of air at the terminal of the outfall. A computerized numerical model of the gravity dilution outfall system was developed. A physical model examined seawater entrainment in the tailings jet. A second physical model studied percolation of stream flow through an onshore tailings dam constructed of waste rock. The designs were presented at hearings held for the project.
- **Teck Corporation - Pogo Mine Site Instrumentation, Fairbanks, AK.** Hay & Company personnel were engaged for the installation of a rain gauge, two water level monitoring stations, collection of site data, streamflow gauging, and preparation of an operations manual for the Pogo Mine Site in Alaska.
- **Vancouver Convention Centre Expansion Project (VCCEP) - Turbidity Monitoring, Burrard Inlet, BC.** To ensure minimum impact on Burrard Inlet during the marine construction phases of the expansion project, two water quality-monitoring buoys were installed in Burrard Inlet just outside of the turbidity screen. Each buoy contained two multi-parameter sondes, which monitored water quality data at 0.5 and 4.5 m depths. Turbidity, dissolved oxygen, salinity, water temperature, and GPS buoy position data were recorded at 15 minute intervals, and radio transmitted to the shore base station. Mr. Draho's responsibilities included supervision of the installation, maintenance and calibration of the instrumentation packages, as well as the generation of weekly data summaries for the Department of Fisheries and Oceans.
- **Enbridge Pipeline Inc. - Douglas Channel Meteorological Study, British Columbia.** Hay & Company Consultants were contracted to install two meteorological stations in the eastern portion of Douglas Channel located in the northern part of the west coast of British Columbia. Mr. Draho was responsible for the design and installation of the meteorological stations, as well as their maintenance and data downloading and analysis. The data is the start of a long-term meteorological database for the area. Eventually the stations will be part of a larger network of stations providing real-time wind observations for navigation purposes. The stations collect data every 15 minutes on wind speed and direction, air temperature and relative humidity, incident solar radiation, and tide levels.

OCEANOGRAPHY AND LIMNOLOGY PROJECTS

- **Hatfield Consultants Ltd. - Gibraltar Mine Outfall, Williams Lake, BC.** Using "VisualPlume" the USEPA's numerical model for plume modelling, Mr. Draho examined the mixing zone required for a proposed outfall of mine wastewater from the Gibraltar Mine, discharging into the Fraser River. The outfall is associated with a proposed, small, hydroelectric plant. Modelling using PLUMES and H3D was done to determine the mixing region for concentrations to return to water quality standards, and then to river background levels.

bdraho@eba.ca

- **Crew Development Corporation - Nalunaq Gold Project, Nanortalik, Greenland.** Mr. Draho spent over a year in Nanortalik in southern Greenland conducting a physical oceanographic study as part of the feasibility study for the implementation of a submarine tailings outfall. The study included biweekly CTD casts of up to 400 m depth in Fjord waters in the vicinity of the proposed mine. Measured water parameters included conductivity temperature depth and PAR. The other main area of research involved the deep-water deployment of a 75 kHz ADCP. The device used to measure three-dimensional water velocities was deployed and recovered successfully from ocean depths up to 300 m deep. A fully equipped meteorological station was also installed and maintained by Mr. Draho over the study period. Also over the course of the project, stage discharge measurements were collected on a creek running through the mine property. This included installation of a river level logging system and physical measurement of the creek discharges over the duration of the project in order to produce river discharge data at 15 minute intervals.

- **Canadian Department of the Environment - Semiahmoo Bay Circulation Study, British Columbia**. Mr. Draho conducted the field portion of this project to obtain velocity data using an ADCP and water quality measurements using a CTD. The field program consisted of continuous measurements of velocity and water quality along a single transect over a period of 48 hours. The data was used to calibrate a numerical model of Semiahmoo Bay. This provided data for the calibration of a numeric model of circulation in the bay to be used for the prediction of flushing of Semiahmoo Bay.

- **City of Kelowna - Limnology Study of Okanagan Lake, British Columbia.** Mr. Draho conducted a series of field trips to Lake Okanagan for the purpose of measuring the change in water temperature profiles over time and the effects that weather conditions have on the temperature structure of the lake. The program consisted of a series of CTD casts along the entire length of the lake and the deployment and recovery of thermistor strings in 60 m of water depth. The data was used for the calibration of a numerical model of the temperature and water movements in the variations of the lake under various weather conditions.

- **Sherritt International Corporation - Moa Nickel Pedro Sotto Alba Nickel Mine, Cuba.** Mr. Draho spent over a year in Moa Cuba conducting a physical oceanographic study as part of the feasibility study for the implementation of a submarine tailings outfall. The study included biweekly CTD casts of up to 600 m depth in waters just offshore of the Town of Moa. Measured water parameters included conductivity temperature depth transmissivity, pH and PAR. The other main area of research involved the deep-water deployments of 75 kHz and 300 kHz ADCP. The devices were used to measure three-dimensional water velocities and were deployed and recovered successfully from ocean depths up to 2,000 m. A fully-equipped meteorological station was also installed and maintained by Mr. Draho over the study period.

- **Placer Dome/Placer Pacific - Misima Submarine Tailings Disposal Outfall, Papua New Guinea.** Mr. Draho was the Instrument Specialist responsible for ROV and current meter deployment. This was for a detailed technical review of the existing Misima submarine tailings outfall to determine its operating characteristics and design details. The performance of the system was determined for the existing mill production and projected for future increases in mill production and process modifications.

- **Avenor Inc. - Gold River Plume Delineation, Gold River, BC.** Hay & Company was engaged to design and implement a rhodamine dye study to determine the 1% and 5% dilution limits for Avenor's Gold River effluent diffuser.

- **Ministry of Agriculture, Food and Fisheries - Oyster Carrying Capacity, Baynes Sound, BC.** Hay & Company conducted a study into oyster carrying capacity in Baynes Sound, including the potential impact of upwelling in the adjacent Lambert Channel. Components of the study included an ADCP survey, collection of water property profiles, and a suite of numerical models to examine circulation, phytoplankton production, and oyster metabolism/growth. The numerical modelling was based on H3D, and provided flow fields and salinity and temperature distributions for model validation and a separate module (DEMS: Dynamic Ecological Modelling System) for computing phytoplankton, herbivore, and nutrient dynamics. The field component also involved oyster filtering experiments, so that the relative rates of filtering and phytoplankton consumption by the oysters in Baynes Sound, the rate of phytoplankton production and consumption of zooplankton, and the rate of replacement of phytoplankton by advection from the Strait of Georgia could be evaluated.

bdraho@eba.ca

HYDRAULIC ENGINEERING PROJECTS

- **Hatfield Consultants Ltd. - Powell River Pulp Mill Effluent Plume Modelling, British Columbia.** Mr. Draho conducted modelling studies of effluent discharged from Norske Canada's pulp mill at Powell River, BC using "VisualPlume" the USEPS plume modeling software.
- **Greater Vancouver Regional District - Lulu Island Waste Water Treatment Plant Diffuser Studies, British Columbia**. Mr. Draho created software to calculate head losses throughout a multi-port effluent diffuser to determine reasons why the diffuser was not as initially designed. The diffuser was designed to facilitate increased flows to the year 2010 as the plant capacity was increased due to population growth in the greater Vancouver area. As the diffuser was not operating to specification under reduced plant flows it was necessary to determine a revised maximum diffuser discharge.
- **Placer Dome Inc. - Cuyuni Diffuser, Venezuela.** Treated mill effluent from the proposed Las Claritas Mine in Venezuela will be discharged to the Cuyuni River. Hay & Company undertook the preliminary design of the diffuser and discharge system, evaluating such issues as bed load, navigation, water quality, and low-river flows.
- **Capital Regional District - Saanich Peninsula Wastewater Treatment Plant Outfall Diffuser Performance Study, British Columbia.** Hay & Company Consultants conducted a plume delineation study for the CRD Saanich Peninsula Wastewater Treatment Plant outfall diffuser. The study involved adding dye, over a one-hour period, to the effluent as it leaves the plant, and mapping the resulting dye distribution in Bazan Bay using an in situ instrument deployed from a survey vessel. The objective of the study is to evaluate movement, dilution and trapping depth of the wastewater plume. Three separate and distinct dye studies were conducted over the survey period, each corresponding to a different phase of the tide.

PHYSICAL MODELLING PROJECTS

- **BC Hydro - Salmon River Fish Screens, British Columbia.** The Salmon River Diversion Canal diverts water from the Salmon River Watershed to the Campbell River Watershed. In 1986, a screen to bypass out-migrant juveniles and kelts was constructed and operated well, but better bypass efficiencies were thought possible. Hay & Company Consultants undertook laboratory and numerical studies to determine methods for improving flow conditions to decrease fish mortality rates.
- **Terminal City Iron Works - Hydrant Valve Chatter, BC.** Test program was completed to find reasons for and eliminate chatter in the hydrant when it is first cracked open. A new sleeve was developed which eliminates the chatter.
- **Syncrude Canada - Extraction Feed Distributor, Fort McMurray, AB.** A new extraction feed distributor is under design by Syncrude Canada Ltd., to blend oil sands from the hydro-transport process with those of the conventional tumbler process. The distributor will receive feed slurries from a maximum of six supply lines and will discharge by gravity to four primary settling vessels (PSVs) and two auxiliary settling vessels (ASAs). Concerns regarding the distributor operating level and its effect on discharge distribution led to the construction and operation of a 1:7.5 scale model at WCHL, a division of Hayco.
- **Greater Vancouver Regional District - Effluent Minimum Velocity Study, Vancouver, BC.** A hydraulic investigation to establish safe operating velocities of effluents containing up to three-inch diameter rocks in six-inch diameter horizontal and vertical pipelines for a secondary sewage treatment plant.
- **Syncrude Canada Ltd. - Venturi Aerator Testing, Fort McMurray, AB.** Tests were undertaken at 1:9, 1:3 and 1:1 scales to investigate suitable modelling techniques and optimize design dimensions of an air-assisted water entrainment jet for an oil sands recovery process.
- **Public Works Canada - River Bend Training Structures, Steveston, BC.** Hydraulic model studies were undertaken to determine the feasibility of bendway weirs in establishing minimum navigation depths and to optimize the weir scheme for minimum cost.

bdraho@eba.ca

- **Syncrude Canada Ltd. - T.O.R. Feedwell and Distributor, Fort McMurray, AB.** Model studies at 1:6 scale investigated and eliminated unsatisfactory vortex action in a slurry feedwell, which had caused back pressures and overflowing of a distributor emergency weir.
- **Monenco Agra - Sundance Cooling Pond Extension, Alberta.** The scope of the hydraulic model study was to optimize the performance of the cooling pond with respect to residence time and cost construction of several proposed internal diking arrangements and dike openings.
- **ATC Engineering Consultants - Hydraulic Model Studies of Energy Dissipation Structure, Denver, CO.** Hydraulic model studies were undertaken of twin 42 inch hooded fixed cone valves discharging up to 600 cfs each into an irrigation canal via an energy dissipation structure. Calm canal conditions were required to permit reliable discharge measurements over a broadcrested weir downstream of the fixed cone valves.
- **Supply and Services Canada - Caisson Floating Breakwater Studies, Vancouver, BC.** A 1:10 scale study was undertaken to determine the effect of varying hydrodynamic parameters on the efficiencies of caisson type floating breakwaters. Incident and transmitted wave heights past breakwaters were measured and analyzed. Design curves and methodology were developed.
- **Large-Scale Pump Intake Studies.** A number of model studies were undertaken, in co-operation with Bechtel Corporation, of emergency core cooling systems of nuclear power plants for the following clients: Detroit Edison Co., Alabama Light & Power, California Edison Co., Consumers Power Co., Arizona Power & Light Co. and Texas Utilities Services Inc.
- **Public Works Canada/Department of Justice - Hydraulic Investigation into Hawser Forces - "Swiftsure Prince" Barge Accident, Vancouver, BC.** Hydraulic model studies were conducted to determine prevailing tidal and river currents at the time a log barge broke free of its moorings. Studies were conducted to measure wind and current effects on hawser forces and to assess the sequence of hawser breakage and motion of the barge during the ensuing release.

EMPLOYMENT HISTORY

2004 - Present	Senior Project Scientist EBA, A Tetra Tech Company Formerly Hay & Company Consultants a Division of EBA Engineering Consultants Ltd. Vancouver, BC
1994 - 2004	Senior Project Scientist Hay & Company Consultants Inc. Vancouver, BC
1977 - 1994	Principal Western Canada Hydraulics Laboratories Vancouver, BC

COURSES AND AWARDS

1979 - 1981	Fluid Measurement Technology Certificate, British Columbia Institute of Technology
1981	Fluid Mechanics Measurement, University of Minnesota
1991	Acoustic Doppler Current Profiler course, RD Instruments, California
1999 - Present	Environmental and Hydraulic Engineering Courses, British Columbia Institute of Technology
2002	Association of Professional Engineers and Geoscientists of British Columbia Environmental Award - Influence of Limnology on Domestic Water Intakes

RESUME Ed M. Grozic

Ed M. Grozic, M.Eng., P.Eng
Senior Project Manager

EDUCATION

M.Eng., University of Alberta, Geotechnical Engineering ,1997
B.Sc., University of Alberta, Civil Engineering,1994

AFFILIATIONS

Licensee, Association of Professional Engineers, Geologists, and Geophysicists of the Northwest Territories and Nunavut (NAPEGG)
Member, Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA)
Member, Canadian Geotechnical Society (CGS)
Executive Member, Cold Regions Geotechnology Division (CRGD) of the Canadian Geotechnical Society
Member, Geotechnical Society of Calgary (GSC)

Mr. Grozic is a Senior Engineer within EBA's Engineering Practice specializing in permafrost and geotechnical engineering projects in Arctic environments. He has extensive experience working in remote locations throughout northern Canada for Oil and Gas explorers, producers, mining clients, and for the Department of National Defence on the Distant Early Warning (DEW) Line Cleanup project.

DEW LINE CLEANUP

- Project Engineer responsible for carrying out geotechnical site investigations at Distant Early Warning (DEW) sites across the Canadian Arctic in support of the cleanup of 21 military DEW sites. Sites include FOX-M (Hall Beach), CAM M (Cambridge Bay), CAM 2 (Gladman Point), CAM 4 (Pelly Bay), CAM 5 (Mackar Inlet), and BAR 4 (Nicholson Peninsula). Investigations involved items related to site cleanup, including existing landfills, proposed new landfill locations and granular borrow sources using both geotechnical and geophysical investigative techniques.
- Senior Engineer responsible for Landfill Monitoring assessments at CAM-M (Cambridge Bay), CAM-4 (Pelly Bay), and FOX-5 (Broughton Island), and FOX-M (Hall Beach) DEW Line Sites to assess post-construction geotechnical performance of remediated and newly constructed landfills
- Senior Engineer responsible for the 2008 Landfill Monitoring assessment at the FOX-M (Hall Beach) DEW Line Site to assess post-construction geotechnical performance of remediated and newly constructed landfills.
- Senior Engineer responsible for the 2007 Landfill Monitoring assessments at CAM-4 (Pelly Bay), and FOX-5 (Broughton Island) DEW Line Sites to assess post-construction geotechnical performance of remediated and newly constructed landfills.
- Senior Engineer responsible for the 2004 and 2005 Landfill Monitoring assessments at CAM-M (Cambridge Bay) DEW Line Site following cleanup to assess post-construction geotechnical performance of remediated and newly constructed landfills.
- Project Engineer responsible for the design of contaminated soil disposal facilities, demolition waste landfills, and a leachate containment remediation system for existing landfills at the CAM-2, CAM-4, CAM-5 and FOX-M DEW Line sites.
- Resident Project Engineer during construction of the leachate containment systems for the abandoned landfills at the CAM-M (Cambridge Bay) DEW Line Site. Work involved constructing saturated granular containment berms around the perimeter of existing landfills that when frozen became low-permeable ice-saturated containment barriers, and installing a geosynthetic liner system for secondary containment. Also responsible for construction of a contaminated soil disposal facility and a demolition waste landfill on site.

ARCTIC OIL AND GAS

- Senior Engineer responsible for preparing Pit Development & Reclamation Plans for 30 Borrow Sites along the proposed natural gas pipeline right-of-way for the Mackenzie Gas Project (MGP). Prepared pit development and reclamation concepts and guidelines, including qualitative and quantitative interpretations of granular source materials. Work completed as secondment to ColtKBR (2005).
- Geotechnical Field Manager for several MGP Geotechnical Investigation Programs in the Mackenzie Valley, including the Winter 2007 Program (Sahtu Tulita District), the Winter 2005 Program (Gwich'in Settlement Area), and the Winter 2004 Program (Gwich'in Settlement Area). The work involved investigations at prospective infrastructure sites, borrow sites, and river crossings, in support of preliminary engineering and regulatory applications.
- Geotechnical Field Manager and Lead Engineer for the Mackenzie Gas Project Winter 2007 drilling program conducted in the Sahtu Settlement Area, NT in support of preliminary engineering and regulatory applications. The program involved geotechnical and geophysical data collection and the Saline River and Great Bear River Crossings, granular sources along the right-of-way and at proposed infrastructure sites.
- Geotechnical Field Manager and Lead Engineer for the Winter 2005 drilling program conducted in the Gwich'in Settlement Area and Inuvialuit Settlement Region, NT in support of preliminary engineering and regulatory applications for the Mackenzie Gas Project. The program involved geotechnical and geophysical data collections at river crossings, granular borrow sources, locations along the proposed pipeline right-of-way and at the proposed Inuvik Area Facility location.
- Geotechnical Field Manager and Lead Engineer for the Winter 2004 drilling program conducted in the Gwich'in Settlement Area, NT, for the Mackenzie Gas Project. Program involved data collection along the proposed pipeline alignment, river crossings and granular borrow sources.
- Senior Engineer responsible for accessing the extent of salt contamination of a sump at the Itiginkpak F-29 well-site for Devon Canada Corporation (Devon) and providing recommendations for remediation of the area and for re-establishing containment of drilling wastes in the sump.
- Senior Engineer responsible for assessing the preliminary bearing capacity and settlement of the existing soil cap on the D-20 drilling waste sump and of an insulated granular pad that will be constructed over the sump as part of the proposed development of the Parsons Lake gas field by ConocoPhillips Canada.

NORTHERN TRANSPORTATION

- Project Manager and Senior Lead Engineer responsible for developing a "Best Practices Guide for Engineering Design, Construction, and Maintenance of Winter Snow/Ice Roads on Permafrost" for ConocoPhillips Canada (CPC). The document is intended to be a guide that can be used by practitioners planning, designing, building, and maintaining northern winter snow/ice roads on permafrost for resource development purposes. The work included providing cost information for the construction and maintenance of alternative types of winter snow/ice roads (2008-2009).
- Senior Engineer providing helicopter-based reconnaissance-level field environmental, engineering, geotechnical and archaeological surveys geotechnical and permafrost engineering services to the Hamlet of Tuktoyaktuk and Town of Inuvik in support of a Project Description submission to construct an all-weather road linking the communities.
- Senior Engineer responsible for providing helicopter-based geotechnical and permafrost engineering services to AREVA Resources Canada Inc. (AREVA) for a proposed all-weather road from the Kiggavik-Sissons Uranium mining project to a proposed port site near Baker Lake, NU (2008). The study involved evaluating several alignments and embankment material sources to the north and south of the Thelon River.
- Senior Engineer responsible for examining all-weather road route options and realignments around the town of Baker Lake from the Kiggavik Mine site to proposed port locations east of the Hamlet on the north shore of Baker Lake. Helicopter based field reconnaissance completed August/September 2009.

egrozice@eba.ca

- Senior Engineer responsible for providing geotechnical and permafrost engineering services to the Seasonal Overland Road (SOR) Project, a perennial winter road route extending from Tibbitt Lake to Lockhart Lake, NT to predominantly support the diamond mining industry in the central Arctic.
- Senior Engineer participating in a helicopter-based airborne route reconnaissance program and responsible for providing geotechnical permafrost expertise for routing along 300 km of a proposed all-weather road and related transportation infrastructure in the Slave Geological Province, NT for the Izok Mine Project, Zinifex. July, 2008.
- Prepared a preliminary feasibility design of a 68 km long winter access road from the Boston Gold Property to an arctic port at Roberts Bay in Melville Sound, Bathurst Inlet, and a preliminary feasibility design of an airstrip sized to support Lockheed C-130 Hercules and Boeing 737 aircraft for BHP World Minerals at the Boston Gold Project, NT.

MINING

- Project Engineer for the geotechnical site investigations of water retention dams and dike at the Beartooth and Sable kimberlite pipe developments at the Ekati Diamond Mine™, NT. Completed a winter drilling program using a diamond drill with circulating chilled brine to obtain intact frozen core samples.
- Participated in preparing Waste Rock Management Plans for the Sable, Pigeon and Beartooth kimberlite developments at the Ekati Diamond Mine™, NT.
- Project Engineer for a winter geotechnical drilling program of a proposed tailings disposal facility at the BHP Boston Gold Project, Bathurst Inlet, NU.
- Participated in the preparation of the Wastewater and Processed Kimberlite Management Plan for BHP Billiton Diamonds Inc. in support of water licence requirements for the Ekati Diamond Mine™, NT.
- Conducted large strain consolidation analyses to predict the self-weight consolidation of kimberlite tailings for the NWT Diamonds Project, NT. Parameters were obtained from laboratory constant strain and step load testing.
- Project Engineer for the West Long Lake Watershed Diversion Structures at the Ekati Diamond Mine™, NT.
- Prepared water and solids balances for the Long Lake Tailings Facility as part of the wastewater and tailings management plan for the NWT Diamonds Project, NT. Prepared stage-storage relationships and storage/discharge requirements.
- Project Engineer for the Grizzly Creek Remediation Program, NWT Diamonds Project, NT. Designed and constructed an interceptor channel to capture water from a natural creek and direct it into an existing diversion channel.
- Prepared water/material balances for proposed drill cutting and processed kimberlite containment facilities for Monopros Limited at Kennady Lake, NT.
- Project Engineer responsible for design and construction of a fuel tank farm for Miramar Mining Corporation - Hope Bay Gold Inc. at the Boston exploration property located east of Bathurst Inlet, NU.
- Resident Engineer for construction of a rock storage pad at the Pogo Gold Project, Alaska to store mineralized rock generated from an advanced subsurface exploration and bulk-sampling program.
- Site Engineer for construction of the Long Lake Intermediate Dikes at the Ekati Diamond Mine™, NT. The dikes subdivide the Long Lake Tailings Facility into five cells for progressive filtering of the processed kimberlite mine tailings.
- Site Engineer for construction of the Outlet Dam at the NWT Diamonds Project, NT - a zoned, frozen-core rockfill dam.

egrozic@eba.ca

GEOTECHNICAL

- Project Manager and Senior Engineer responsible for providing geotechnical and permafrost engineering services for a Satellite Tracking Station near Inuvik, NT for the Swedish Space Corporation. A rock-socket anchor foundation system was proposed to accommodate the loading conditions and satisfy strict deformation tolerances. (2008).
- Project Engineer responsible for the design of a rock-socket anchor foundation system for a VESTAS V-47, 660 KW Wind Turbine (47 m blade diameter) for the Yukon Energy Corporation, Whitehorse, YK.
- Prepared geotechnical foundation designs for the construction of the bridge abutments and approach embankments for the Paul Lake Bridge, and for the Nero-Nema stream crossing at the Ekati Diamond Mine, NT.
- Carried out the installation of rock socket piles using an ODEX drilling method for the foundation of the Tr'ondek Hwech'in Cultural Centre in Dawson City, Yukon.
- Participated in a study to evaluate drill platform options for Anderson Resources Ltd. in support of a proposed offshore exploration program in the Beaufort Sea.
- Conducted laboratory testing to determine frozen and unfrozen thermal conductivities of diamond tailings for the NWT Diamonds Project, NT.
- Conducted laboratory testing using Time Domain Reflectometry (TDR) to estimate unfrozen water content in diamond tailings for the NWT Diamonds Project, NT.
- Conducted laboratory testing at the University of Alberta to establish design parameters for frozen ground for the tunnelling of the South Boston Piers Transitway Project in Boston, Massachusetts, USA. Time Domain Reflectometry was used to estimate unfrozen water content in frozen marine clay samples (Master of Engineering Thesis).
- Conducted laboratory testing using Time Domain Reflectometry (TDR) to estimate unfrozen water content in frozen soils. The laboratory work was performed at the University of Alberta. Master of Engineering Degree in Geotechnical Engineering, Department of Civil and Environmental Engineering, University of Alberta.

EMPLOYMENT HISTORY

2006 - Present	Senior Project Engineer and Market Director Oil & Gas (Arctic), Engineering Practice EBA Engineering Consultants Ltd. Calgary, Alberta
2001 - 2006	Senior Project Engineer, Circumpolar (Arctic) Group EBA Engineering Consultants Ltd. Calgary, Alberta
1997 - 2001	Geotechnical Project Engineer, Arctic Frontier Division EBA Engineering Consultants Ltd. Edmonton, Alberta
1996 - 1997	Masters Graduate Student University of Alberta
1995 - 1996	Project Engineer, Construction Services Group EBA Engineering Consultants Ltd. Edmonton, Alberta
1994 - 1995	Project Engineer, Forestry Group EBA Engineering Consultants Ltd. Vancouver, British Columbia

egrozice@eba.ca

RESUME Cameron Kulak

Cameron Kulak, B.Sc., Dipl.T., B.I.T.
Biologist

EDUCATION

B.Sc.	University of Alberta	2001	Biology
Dipl.T.	British Columbia Institute of Technology	2006	Fish, Wildlife and Recreation Technology

AFFILIATIONS

Member	College of Applied Biology
Member	Association of Professional Biologists of British Columbia (APBBC)
Rescue Diver	Professional Association of Diving Instructors (PADI)

Mr. Kulak is a Biologist with 5 years of environmental consulting experience and he is registered in British Columbia as a Biologist in Training. Mr. Kulak's experience focuses on terrestrial and aquatic ecology, marine biology, fisheries and wildlife management including species at risk and invasive species management. Mr. Kulak also has an understanding of legislation and government regulations that are applied in the environmental assessment and permitting field for private and public sector clients. Projects have been completed in British Columbia, the Northwest Territories and Saskatchewan and involve wildlife habitat assessments and inventories, fish and fish habitat assessments, fish habitat enhancement and creation, stream setback assessments and environmental monitoring and erosion and sediment control for construction projects.

ENVIRONMENTAL ASSESSMENT

- Conducted 1:20,000 Fish Habitat Assessments in various municipalities of the Lower Mainland and Fraser Valley, BC, SK and NWT.
- Conducted terrestrial habitat assessments including small mammal trapping and salvage, and assessments for species at risk.
- Conducted aquatic and terrestrial inventories according to British Columbia Resources Information Standards Committee protocols.
- Completed riparian enhancement and planting plans for development projects.
- Completed Erosion and Sediment Control design and monitoring.
- Conducted water quality and marine habitat monitoring at the Vancouver Convention Centre Expansion Project (construction phase), downtown Vancouver, BC.
- Conducted environmental monitoring of various construction projects for both the private and public sector in proximity to aquatic habitats in several municipalities of the Lower Mainland, BC.
- Terrestrial environmental review and planning for the City of Surrey Roberts Bank Rail Corridor Grade Separation Project, Surrey BC.
- Fish and fish habitat assessment related to the Inuvik to Tuktoyaktuk Highway Project, NWT.
- Preparation of Environmental Management Plans for specific development projects, Lower Mainland BC.

EMPLOYMENT HISTORY

2007 – Present Biologist

EBA, A Tetra Tech Company

Vancouver, BC

2006 – 2007 Junior Fisheries Biologist

Pacific Land Group Inc.

Surrey, BC

2006 Park Worker

Metro Vancouver Regional Parks

Maple Ridge, BC

2005 Park Worker

Fraser Valley Regional Parks

Chilliwack, BC

COURSES AND AWARDS

2006 Ozmer Catt Memorial Scholarship Award, BCIT

2006 Riparian Area Regulation Workshop, Malaspina University College

2008 Crew Supervisor, Electrofishing Certificate, Malaspina University College

2008 Species at Risk: Application of Best Management Practices, South Coast Conservation Program

2010 Dive Accident Management

2010 Erosion and Sediment Control, Vancouver Island University

2011 DAN O_2 Provider

ckulak@eba.ca

RESUME Jeff Matheson

JEFF MATHESON, M.Sc., R.P. Bio., P.Biol.
Project Director - Environment

EDUCATION

M.Sc., Ecology, University of Guelph, 1995
B.Sc. (Hons.), Biology (minor Ecology), University of Guelph, 1992

AFFILIATIONS

Member, BC College of Applied Biology (Registered Professional Biologist)
Member, Alberta Society of Professional Biologists (Professional Biologist)
Member, Society for Conservation Biology
Member, Canadian Society of Environmental Biologists
Member, The Wildlife Society

Mr. Matheson is a Project Director with EBA, a Tetra Tech Company, in the Environment Practice. His focus is on environmental assessment, biophysical inventories, and applications of Geographic Information Systems (GIS) in environmental management. He has extensive experience with field studies of birds, mammals and amphibians, wildlife habitat assessment, ecosystem mapping, and wildlife habitat modelling. He has worked throughout British Columbia, Alberta, Yukon Territory, Northwest Territories, Nunavut and Ontario.

His work has included inventory and assessment of various types of development projects including linear corridors (highways, railways, and transmission lines), residential, commercial and civic facilities, mines, and oil and gas developments. Mr. Matheson's project work has required detailed knowledge of Provincial and Federal environmental legislation such as the Wildlife Act, the Species at Risk Act (SARA) and the Canadian Environmental Assessment Act (CEAA), and with environmental guidelines and best management practices for rural and urban land development and resource development.

Much of Mr. Matheson's work has involved the use and application of GIS for management, analysis, and communication of geographic information. Working closely with GIS and remote sensing specialists, he has developed procedures for automated land classification, wildlife habitat modelling, and assessment of project impacts using spatial analyses. Other projects have involved the use of web-based applications to communicate information and interactive mapping with clients, regulators and the public.

Mr. Matheson's work has required close collaboration with industrial clients, government agencies, other scientists, engineers and other professionals to develop integrated and comprehensive solutions for a wide range of projects and applications.

RESOURCE DEVELOPMENT (MINING AND OIL AND GAS)

- First Coal Goodrich Property Proposed Coal Mine - Responsible for wildlife baseline and effects assessment for small coal mine application.
- Wildlife Modelling for DeBeers Canada Ltd. Gahcho Kue Diamond Project - Completed wildlife habitat mapping for the environmental assessment of this proposed diamond mine in the Northwest Territories. Also applied a least cost path (or friction analysis) model to predict migration pathways for barren ground caribou in the vicinity of the proposed mine.
- Jackpine Mine Expansion and Pierre River Mine Project Oilsands Mine Application – Part of Alberta Environment's team conducting review of Shell's oil sands application.
- Baseline Inventories for Tyhee Development Corporation Gold Exploration Property - Part of the team that completed intensive, multi-year baseline inventories for wildlife, vegetation, and fish and water quality in this gold exploration property in the Northwest Territories.
- Mountain Goat Behavioural Monitoring During a Heli-Portable Seismic Operation - This project in northeast British Columbia involved monitoring the response of mountain goats to helicopter activities during a heli-portable seismic program. The seismic company was allowed to operate near mountain goats, provided that the goats did not respond negatively.

- Independent Third-Party Review of WCCC Brule Large Mine Application, on Behalf of First Nations. Conducted third-party review of wildlife component.
- Environmental Programs for Kennady Lake - EBA completed a baseline environmental study for an area northeast of Yellowknife, NT. Mr. Matheson completed the vegetation mapping using air photos and IKONOS satellite imagery.
- Bonanza Ledge Project, British Columbia. Responsible for wildlife baseline and effects assessment for small mine application.
- Granular Assessments for Mackenzie Valley Pipeline - Site classification and identification of broad vegetation types and wildlife habitat assessment along the proposed Mackenzie Valley Pipeline.
- Foster Creek Environmental Assessment - Environmental Assessment of heavy oil extraction facility in north-eastern Alberta. Mr. Matheson was responsible for the wildlife component including extensive wildlife inventories, analysis and completion of the impact assessment.
- Ferguson Lake Wildlife Surveys - Conducted breeding bird and aerial caribou and muskox surveys at a proposed metal mine in Nunavut.
- Winter Road Information Management System - Mr. Matheson is currently coordinating the development of a web-based information management system for a seasonal road in Northwest Territories. The system includes web-based mapping and access to relational databases.

URBAN AND RURAL LAND DEVELOPMENT

- Wildlife Management Plan for Boundary Bay Airport - Completed a synthesis of all known wildlife information for the airport, identified species at risk and those protected either provincially or federally under SARA, completed risk assessment scores for priority species and developed an airport wildlife management plan.
- Environmental Assessment of the Whistler Sliding Centre - Completed baseline inventories, assessment of impacts, provided site design input, and conducted construction monitoring for this Vancouver 2010 Olympic venue.
- Burns Bog Ecosystem Review - EBA assisted with technical services for a scientific “ecosystem review” of Burns Bog conducted by the BC Environmental Assessment Office. Mr. Matheson assisted with the preparation of public “technical review sessions” with invited experts and with the preparation of summary documents.
- Olympic Nordic Centre at Callaghan Valley - Completed the cumulative effects assessment for this Olympic venue as part of the BCEAA environmental application.
- Vancouver Convention Centre Expansion Project - Part of the team that completed the environmental application under the auspices of BCEAA.
- Environmental Baseline for the Pemberton Benchlands Neighbourhood Concept Plan - EBA completed biophysical inventories and mapping to identify development constraints and habitat protection and enhancement opportunities for a new subdivision in the Village of Pemberton, British Columbia.
- Union Bay Resort Development - Completed biophysical inventories directed at identifying environmental opportunities and constraints for this large residential and resort development near Courtney, BC.
- Biodiversity in the Lower Mainland Region: Issues and Strategic Directions Research - EBA, in partnership with Axys Environmental Consultants, provided an issues analysis, institutional review, identification of regional socio-economic benefits of conserving biodiversity, and determination of priority directions for the GVRD Biodiversity Conservation Strategy. As part of the process, EBA and Axys conducted interviews with municipal, Provincial and Federal Government representatives, inter governmental agencies, and stewardship groups to identify the status of biodiversity conservation.

jmatheson@eba.ca

TRANSPORTATION AND LINEAR CORRIDORS

- BC Ferries Terminal Security Enhancements - Conducted CEAA Screenings for security enhancement projects at seven marine terminals.
- Biophysical Assessment of the Fox Creek Transmission Line - Environmental assessment and development of environmental management plan for a 57 km electricity transmission line in northeast BC.
- Tibbitt to Contwoyto Winter Road Ecosystem Classification and Mapping - Ecological Land Classification and mapping of the 700 km Tibbitt to Contwoyto Winter Road in Northwest Territories using orthophotography, DEM, field data, and on-screen digital capture and regional mapping using Landsat TM.
- Preliminary CEAA Screening of the Kingcome Inlet Road - Completed the biophysical impact assessment of a road in a remote area of the British Columbia Central Coast containing sensitive fish and wildlife habitat.
- Highway No. 3 Realignment and Skagit and Skaist River Bridge Replacement - Undertook an environmental screening and impact assessment for the realignment of a section of Highway No. 3 in Manning Park and the replacement of highway bridges over the Skagit and Skaist River Bridges.
- Highway 1/Dougan Lake Section Upgrade CEAA Environmental Screening - Identified environmental sensitivities and constraints for this highway widening and realignment project near Duncan, BC.
- Highway No. 1 and 192nd Ramp Project, CEAA Environmental Screening and Regulatory Agency Permitting - EBA completed baseline surveys of vegetation, wildlife and aquatic resources, and then prepared the environmental assessment report followed by site specific best management practices for construction.
- Environmental Assessment of Highway Twinning from Aspen Grove to Courtney Lake - Impact assessment of new highway right-of-way on wildlife habitat. Involved making recommendations on wildlife underpass and gate placement.

OTHER PROJECTS

- Muskwa-Kechika Ecosystem Mapping with Wildlife Interpretations - EBA completed ecosystem mapping and wildlife interpretations for a 1.1 million hectare area in the Muskwa-Kechika Area of Northeast British Columbia. Mr. Matheson developed wildlife habitat suitability models and maps for 11 wildlife species.
- Northern Wildlife Harvest Data Survey - EBA coordinated a community-based survey of First Nation hunters. Mr. Matheson assisted with the design and conducts of a training course for First Nation community interviewers and was responsible for managing and summarizing the survey results.
- Workshop on Mathematical Modelling Approaches to Wildlife Habitat Ratings - Organized workshop in association with BC Ministry of Sustainable Resource Management to bring together experts to consider various approaches to wildlife habitat rating/modelling and to develop a mathematical modelling framework for habitat ratings in British Columbia.
- Valemount TEM Wildlife Habitat Interpretations - Mapping wildlife habitat for another area in British Columbia, this one located in both the central Rocky Mountains and Columbia Mountains near the town of Valemount, BC. Mr. Matheson is responsible for the field wildlife habitat assessments and the development of wildlife habitat models based on the ecosystem and terrain mapping for the study area.
- Small-Scale Ecosystem Mapping of the Central and North Coasts and the Queen Charlotte Islands LRMP areas - This project involved a seamless ecosystem map product for a 7.5 million ha area using an innovative Predictive Ecosystem Mapping (PEM) approach. Input coverages included Landsat TM satellite imagery, TRIM-based DEM-derived products (aspect, slope, and derived moisture classes), Forest Cover mapping, and Biogeoclimatic linework. The map product with map reliability data was subsequently incorporated into a web-based map presentation tool.
- Columbia Basin Habitat Map Comparison for Ministry of Forests - Comparison and accuracy assessment of two habitats mapped generated using different approaches.

jmatheson@eba.ca

- Problem Analysis on Reliability, Quality Control, and Validation of Predictive Ecosystem Mapping (PEM) - Co-author of report for TEM Alternative Task Force, Resource Inventory Committee.

EMPLOYMENT HISTORY

1999 - Present	Biologist EBA Engineering Consultants Ltd.
1999	Biologist R.A. Sims and Associates
1996 - 1999	Biologist Geomatics International Inc.
1992 - 1996	Research Associate and Teaching Assistant Department of Botany, University of Guelph

CERTIFICATIONS

Describing Ecosystem in the Field, Resources Inventory Committee of BC
SCUBA, ACUC

TECHNICAL PUBLICATIONS AND PRESENTATIONS

Matheson, J. 1995. Organization of Bird and Small Mammal Communities of the Niagara Escarpment, Canada. M.Sc. Thesis. University of Guelph.

Matheson, J. 1997. Wildlife Trail Study in Mackenzie TSA. Unpublished report prepared by Geomatics International and submitted to Slocan Forest Products. Mackenzie Division.

Matheson, J. and Larson, D.W. 1994. Structure and Ecological Role of Birds and Small Mammals on Cliff faces of the Niagara Escarpment in Proceedings of Leading Edge '94: A Conference Linking Research, Planning and Community in the Niagara Escarpment. Ontario Ministry of Environment and Energy.

Matheson, J.D. and Larson, D.W. 1998. Influence of cliffs on bird community diversity. Can. J. Zoo. 76(2):278-287.

R.A. Sims and Associates. 1998. Terrestrial Ecosystem Mapping (TEM) with Wildlife Habitat Interpretations of the Besa/Prophet Area. Part 2: Wildlife Report. Unpublished report submitted to Ministry of Environment, Lands and Parks.

Sims, R.A. and Matheson, J. 1999. Problem Analysis on Reliability, Quality Control and Validation of Predictive Ecosystem Mapping (PEM). TEM Alternative Task Force, Resource Inventory Committee.

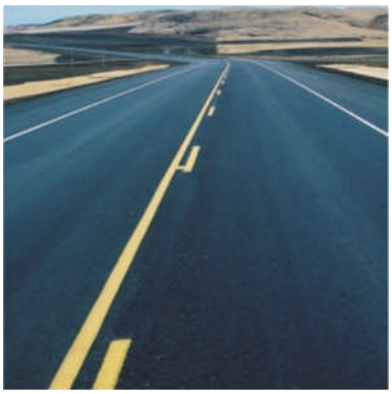
Sims, R.A., Matheson, J. and Yazvenko, S. 2000. Technical Review Meetings in Support of the Burns Bog Ecosystem Review. Summary Report. Environmental Assessment Office, Victoria, BC.

Taylor, M. and Matheson, J. 1997. Comprehensive Environmental Impact Assessment and Management Plan for Caledon East. Prepared by Geomatics International for the Town of Caledon East.

Taylor, M. and Matheson, J. 1999. A comparison of the African and Asian mongooses in the genus Herpestes (Carnivora: Viverridae). Mammalia 63 (4): 449-464.

jmatheson@eba.ca

RESUME Robyn V. McGregor



Robyn V. McGregor, M.Sc., P.Eng.
Senior Transportation Engineer & Principal Consultant – Circumpolar/Arctic

- **24 YEARS OF EXPERIENCE**

Ms. McGregor is a Senior Transportation Engineer and a Principal Consultant with expertise in the area of construction, operations and project management for seasonal and all weather roads and highways in the Circumpolar/Arctic Region. Her fields of specialization include planning, design, construction, and operations of public and private roadways, including risk assessment, requirements for roadway safety, design and construction in permafrost environments, adaptation relative to the impacts of climate change, and rural/remote application of Intelligent Transportation Systems (ITS).

RELEVANT EXPERIENCE

Ms. McGregor has served as Project Manager and Lead Engineer for such projects as:

- Preparation of preliminary designs and Project Description Report for three segments of the proposed 1000 km extension of the all-weather Mackenzie Highway (NWT Hwy No. 1) in the Northwest Territories including; 138 km from Inuvik to Tuktoyaktuk through the Inuvialuit Settlement Region, 181 km through the Gwich'in Settlement Area, and 285 km through the Tulita District of the Sahtu Settlement Area.
- Strength Analysis and Engineering Study (Corridor Planning) for the Liard Trail (NWT Hwy No. 7), 254 km all-weather highway from the junction with NWT Hwy No. 1 to the Alberta/British Columbia border.
- Planning and feasibility study of a 20 km all-weather road from the Hamlet of Aklavik to the Willow River Gravel Source in the Northwest Territories.
- Field investigation and preliminary design for a 360 km all-weather road, mine site aviation facilities, and a deep draft Arctic port to support project proposal and prefeasibility studies for the Izok Mine in Nunavut.
- "Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions", a 2010 publication by the Transportation Association of Canada. Overall Project Manager, contributing author and editor.
- Functional planning study (conceptual design and construction/operating cost estimates) for northern road and port options serving mining prospects in the Northwest Territories and Nunavut. Three all-weather road alignments ranging from 270 km to 357 km from the midpoint of Canada's Slave Geologic Province to three subject port sites on the Arctic coast.
- Ice Road Route Study, Parson's Lake, NT. This study involved estimating construction and operating costs for hauling overweight and over dimension loads along two 50 km alignments on ice and seasonal overland roads between the Inuvik/Tuktoyaktuk ice road and Parson's Lake, NT.

Ms. McGregor has authored papers for publication and presentation at various conferences held by the Transportation Research Board, Transportation Association of Canada, the Canadian Association of Road Safety Professionals, ITS Canada, and the ITS World Congress. Ms. McGregor co-authored a paper entitled "The Importance of Permafrost, Ice and Seasonally Frozen Ground to Road Systems in Canada" that was published at the 2007 World Road Congress.

EDUCATION

M.Sc., Transportation Engineering, University of Calgary

B.A.Sc., Civil Engineering, University of Waterloo

Diploma, Civil and Structural Technology, British Columbia Institute of Technology (BCIT)

SUMMARY OF EXPERIENCE

Ms. McGregor has spent most of her career living and/or working in the North. Prior to her move to EBA in 1998, Ms. McGregor was the Assistant Director of the Engineering Division for the Department of Transportation in the Northwest Territories.

AFFILIATIONS

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

Member, Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA)

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

Member, Road Safety Standing Committee, Transportation Association of Canada

Member, Canadian Association of Road Safety Professionals (CARSP)

Affiliate Member, Transportation Research Board

rmcgregor@eba.ca

RESUME Travis Miguez

Trevor Miguez, B.Sc.
Project Scientist

- **3 YEARS OF EXPERIENCE**

Mr. Miguez is a Project Scientist with EBA, A Tetra Tech Company, in the Vancouver office, and specializes in meteorology and hydrology. His certification in the EPA-approved air dispersion model Calpuff has increased his expertise in dispersion modelling of various hydrocarbon evaporation scenarios such as tailings ponds and oil spills, in addition to typical stack emission regulatory-type applications. His desktop studies have included a variety of baseline air quality and climate change assessments, particularly in northern environments for regulatory permitting.

Mr. Miguez's fieldwork has included the installation and maintenance of hydrometric and meteorological stations, and standard and alternative method stream gauging for the purpose of supporting baseline studies for clients such as mining exploration companies.

RELEVANT EXPERIENCE

Mr. Miguez's studies at the University of British Columbia have provided him with a background of a wide range of specializations in the fields of environmental and earth sciences, including climatology, meteorology, hydrology and fluvial geomorphology, terrain assessment, snow and ice processes, mineralogy, petrology, and structure.

Some highlights of Mr. Miguez's work include the following:

- Mid- to long-range transport of evaporated hydrocarbons for a host of oil spill scenarios in the Strait of Georgia and Fraser River
- Emissions modelling in support of a regulatory approval process of a proposed biomass boiler facility in Dawson, YT
- Near-field dispersion modelling of by-products of bitumen processing near Fort McMurray, AB
- The installation of a meteorological station on the Beaufort Sea ice and subsequent data analysis for the purpose of providing Shell with baseline information regarding potential aircraft access to an oil rig during the winter
- Development and application of salt-dilution stream gauging techniques for under-ice flow determination in Yukon Territory
- Wind resource feasibility studies on the implementation of wind turbine/diesel generator hybrid power systems for mining operations and northern communities
- The installation of wind monitoring equipment for the purpose of wind resource assessment
- Site supervision of rip-rap erosion and flood protection works on the Oyster River for the District of Campbell River, BC, and on the Fraser River for Bedford Landing Development in Fort Langley, BC
- Bathymetry survey on Kamloops Lake for a proposed marina

EDUCATION

B.Sc., Physical Geography and Geological Sciences, University of British Columbia, Vancouver, BC

SUMMARY OF EXPERIENCE

Air pollution modelling

Baseline air quality assessments

Northern climate change scenarios

Installation of hydrometric and meteorological stations

Alternate hydrometric stream gauging techniques

Wind resource assessment

Site supervision

TRAINING/CERTIFICATION

Calpuff Air Dispersion Modelling Lakes Environmental

Level 1 First Aid

ATV and Snowmobile

tmiguez@eba.ca

RESUME Brian Miller

BRIAN L. MILLER, M.A.
Senior Environmental Planner

EDUCATION

B.A., Geography (Natural Resource Mgmt.), University of Victoria, 1989
M.A., Geography (Environmental Assessment), Carleton University, 1992
Certificate, ISO 14000 Lead Auditor, MGMT Alliances, 2001

AFFILIATIONS

Canadian Institute of Planners, BC Chapter
International Association of Impact Assessment
Canadian Environmental Auditing Association
Canadian Association of Geographers
Industry Council for Aboriginal Business

Mr. Miller is a Senior Environmental Planner with EBA, a Tetra Tech Company. He has over sixteen years experience as an environmental planner conducting EIA's, SEIA's and environmental audits in a variety of natural resource sectors including the power generation, natural gas, mining, water, transportation, fisheries, recreation, and tourism. Specific expertise has been gained as a land use planner, in the coordination of environmental assessments, in undertaking socio-economic assessments, and in conducting environmental audits. Brian has excellent project management, problem solving, consultation, and communication skills. He is reliable, service oriented with a solid understanding of business and politics. He has traveled extensively in SE Asia, Japan, Western Europe, North and Central America.

POWER GENERATION

- Completed EA scoping, land use planning and socio-economic constraints analysis for the siting of waste energy facilities in New Westminster and Port Moody, BC.
- Project team member for Ontario Power Generation's Upper Mattagami run-of-river EA near Timmons, ON. Responsible for writing project description, alternatives to the proposed undertakings, and hydrological setting.
- Participated in an EA review for BC Hydro gas-fired cogeneration project in Fort Nelson, BC, to convert municipal power services from diesel electric to natural gas. Responsible for reviewing studies for geotechnical, hydrology, access management socioeconomics and public consultation.
- Coordinated EA review for Cascade Falls run-of-river hydro-electric project at Christina Lake, BC. Responsibilities included review of hydrology, aquatic, hydrogeology, geotechnical, terrestrial, land use, socio-economic, cultural, and First Nations issues.

NATURAL GAS

- Coordinated permitting for first biogas project in BC for Catalyst Power. Responsible for land use planning and socio-economic constraints analysis, liaison with regulators, and overseeing air quality and risk assessment studies
- Project team member for Enbridge Gas Distribution's York Region 80 km looping pipeline from Richmond Hill to Lake Simcoe, ON. Prepared route selection, constraint screening options paper and baseline physiographic description for EA submission to the OEB.
- Managed environmental and socio-economic baseline studies for Westcoast Energy's proposed $750,000 natural gas processing facility and 120 km pipeline from Tumbler Ridge to Summit Lake, BC. Baseline studies included forestry, trapping, guide outfitting, land use, access management, and socio-economics. Managed public consultation program including chairing the South Peace Consultation Group and discussions for First Nations benefit agreements.
- Prepared post-construction socio-economic audit of the $320,000 Pine River Gas Plant EA Expansion Project at Hasler Flats

MINING

- Coordinated the EA review for Luscar Coal's proposed Telkwa coal mine near Telkwa, BC. Responsible for reviewing studies on geology, hydrology, hydrogeology, terrestrial and aquatic impacts, health effects, socio-economic conditions, heritage resources, and First Nations issues.
- Participated in EA reviews for a talc mine and an aggregate quarry on First Nations lands in southern Ontario on behalf of DIAND.

WATER

- Coordinated EA review for the District of Squamish's municipal back-up drinking water system in Squamish, BC. Responsible for reviewing studies on hydrology, hydrogeology, terrestrial and aquatic impacts, health effects, socio-economic impacts, heritage resources, and First Nations issues.
- Provided strategic advice and developed terms of reference for an EA to site a 250,000,000 L/y bottled water processing facility in BC's eastern Rockies. Activities included examining water licences, hydrology and hydrogeology studies, transportation logistics, socio-economics and writing a report on the state of the bottled water industry in BC.

TRANSPORTATION

- Coordinated EA review of the BC Ministry of Transportation's Greenville to Kincolith Highway. Responsible for reviewing land use, geotechnical, terrestrial, fisheries, wildlife, aquatic, socio-economic, cultural, and First Nations issues.
- Prepared transportation impacts study for an EA to site a waste energy facility in Port Moody, BC.

ENVIRONMENTAL AUDITING AND MANAGEMENT SYSTEMS

- Participated in five year review of the Yukon Environmental and Socio-Economic Assessment Act. Responsible for developing review plan, conducting interviews, and writing components of final report.
- Conducted three major environmental audits of BC government programs responsible for administering contaminated sites, drinking water source protection, and wild salmon habitat. Reviewed over sixty government programs, and conducted over three hundred interviews with senior provincial officials, private sector executives, and non-governmental organizations.
- Considerable experience with environmental legislation, regulations, and programs involving land use planning, environmental assessment, power generation, waste management, aquatic biology, fish habitat, terrain analysis, hydrology and hydrogeology. Extensive experience with the BC Environmental Assessment Act, Environmental Management Act, Forest and Range Practices Act, Drinking Water Protection Act, Water Act, Mines Act, and Petroleum and Natural Gas Act.
- Participated in compliance audits of Hamilton Steel's EMS system in Hamilton, Ontario, and Coca-Cola's production facility in Vancouver, BC.
- Audited the environmental assessment, operational, and management practices and policies of a Victoria, BC construction company being bought by Katlor Technologies of Vancouver, for submission to the U.S. Securities and Exchange Commission.

bmiller@eba.ca

FIRST NATION RELATIONS

Some of the First Nations organizations Mr. Miller has worked with on EA/environmental planning assignments:

- Assembly of First Nations
- Canadian Aboriginal Minerals Association
- Canadian Aboriginal Forestry Association
- Native Brotherhood of British Columbia
- Nautsa'mawt Resources Group
- Nisga'a Lisim Government
- Nuu-chah-nulth Tribal Council
- Squamish First Nation
- West Moberly First Nation
- Lheit Lit'en First Nation
- Kelly Lake Cree Nation
- Saulteau First Nation
- Tsimshiam First Nation
- Duncan's First Nation

EMPLOYMENT HISTORY

2009 – Present	Principal Specialist/Senior Environmental Planner EBA Engineering Consultants Ltd. Nanaimo, BC
2006 – 2009	Senior Environmental Planner SENES Consultants Limited Vancouver, BC
1998 – 2005	Environmental Assessment Coordinator/Environmental Auditor Government of British Columbia (BCEAO and Auditor General) Victoria, BC
1995 – 1998	Marketing Consultant DotCom Marketing Corporation Vancouver, BC
1993 – 1995	Land Use Planner/Socio-Economic Analyst Westcoast Energy Vancouver, BC
1989 – 1993	Land Use Planner Government of Canada, Dept. of Indian Affairs and Northern Development Economic Development Division, Natural Resource Development Directorate Ottawa, ON

bmiller@eba.ca

RESUME Steve M. Moore

STEVE M. MOORE, B.E.S., B.A.
Senior Wildlife Biologist / Environmental Scientist

EDUCATION

B.E.S., Environment and Resource Studies (Honours), University of Waterloo
B.A., Economics, University of Waterloo
Diploma, Fish and Wildlife Management, Sir Sandford Fleming College

AFFILIATIONS

Mr. Moore is a wildlife biologist with more than 17 years of experience in northern, western and eastern Canada. For the past 10 years Steve has been based in Yellowknife working primarily on arctic projects for government, industry, aboriginal and non-government clients. Steve has extensive experience carrying out field environmental baseline and monitoring surveys in northern Canada for birds (waterfowl, passerines, raptors), mammals (grizzly bears, carnivores, caribou, bison, and other species), aquatic resources, and vegetation/wildlife habitat, using a variety of ground and aerial techniques. In recent years he has carried out such baseline studies for a number of mining and oil and gas clients and other developments in the Northwest Territories and Nunavut. In addition, Steve is experienced with data analysis, the application of Landsat and GIS and report preparation.

WILDLIFE RESEARCH

Mr. Moore is experienced in population surveys for big game, fish populations, plankton counts, amphibians, birds, small mammals, snowshoe hares, endangered plants, deer, hunter harvest, etc. Has gained experience in capturing, immobilizing and collaring bears, coyotes, and raccoons. He has also gained experience in radio tracking animals on the ground and in the air; Landsat and photo interpretation of biologically important areas in the Northwest Territories. Responsibilities have included collecting, managing and analyzing biophysical and socio-economic data using different databases.

RESEARCH AREAS

- Birds
  - Environmental Monitoring for BHP (raptors, breeding birds, waterfowl);
  - Experienced in conducting avian surveys in north and south Canada;
  - Tree climbing and banding young bald eagles;
  - Experienced in conducting migratory seabird surveys, winter waterfowl monitoring, banding ducks, collaring geese, and leadshot poisoning survey for waterfowl; and
  - Population Surveys for birds, hunter harvest surveys to monitor spring waterfowl hunt.
- Mammals
  - Environmental Monitoring for BHP (grizzly bears and carnivores);
  - Beaver population studies and control, aerial and ground surveys of muskoxen, Peary caribou, and bison;
  - Experienced in conducting mammal, avian, botanical and habitat surveys in north and south Canada; and
  - Population Surveys for big game animals in the arctic, fish populations, plankton counts, salamander densities, birds (grouse and MSB), small mammal, snowshoe hare, endangered plants, deer, hunter harvest, etc.

- Fish
  - Population surveys for cold water fish species, lake and river surveys, fish habitat assessment, fish tagging, morphometric measurements, water chemistry, benthic density and diversity.
- Other
  - Population surveys for big game animals in the arctic, plankton counts, salamander densities, birds (grouse and MSB), small mammal, snowshoe hare, endangered plants, deer, hunter harvest, etc;
  - Experience in capturing, immobilizing and collaring bears, coyotes, and raccoons;
  - Have experience in radio tracking animals on the ground and in the air;
  - Animal energetics (animal behaviour studies: ducks and elks);
  - Trophic analysis in aquatic ecosystems;
  - Considerable limnological work: river and lake surveys;
  - Landsat and photo interpretation of biologically important areas in the Northwest Territories; and
  - Responsible for collecting, managing, and analyzing biophysical and socio-economic data using different data bases (DBase IV, DBase III, Rbase, and Rbase System V).

BOTANICAL RESEARCH

Extensive background identifying plants in the boreal forest, Canadian arctic, and in eastern Canada. Has practical skills in conducting habitat inventories and classifications in many areas across the Northwest Territories, Ontario and PEI.

- Experienced in conducting botanical and habitat surveys in north and south Canada;
- Have designed and written two computerized taxonomic plant keys. For own use and not published;
- Extensive background identifying plants in the high arctic, eastern arctic, western arctic, low arctic, alpine areas, high boreal forest, low boreal forest, deciduous forest and Acadian forest (terrestrial, aquatic, and wetland);
- Established a herbarium for the Department of Renewable Resources, GNWT;
- Quantitative botanical analysis;
- Guided botanical hikes in the high boreal forest zone for individuals and large groups up to 25 people for Environment Week and the Canadian Nature Federation;
- Have practical skills in conducting habitat inventories/classifications in many areas across the Northwest Territories, Ontario and PEI; and

Plant Inventory:

- Line intercept, quadrat, point-quarter;
- Timber cruising, forest composition, horizontal and vertical habitat analysis; and
- Biomass sampling and estimations.

REMOTE SENSING

Landsat and photo interpretation: grizzly bear denning assessment and wildlife habitat classification (eastern arctic, Mackenzie Bison Sanctuary, Horn Plateau). Employed Landsat techniques to identify and separate different habitat types. Attended Landsat training courses. Extensive photo interpretation experience in the Northwest Territories, New Brunswick and PEI. A trainer in the acquisition of photogrammetry skills. Has taught college level photogrammetry for many years.

smoore@eba.ca

DATA COLLECTION

Collecting, managing and analysing biophysical and socio-economic data using different data bases DBase III, DBase IV (MSDOS and Windows versions) RBase, RBase System V, Quattro Pro Package Ver. 6.0, Shazam, Statsgraphic

Analysed data for hunter harvest statistics, bird surveys, plant surveys, invertebrate surveys, small mammal surveys, fish surveys, amphibian surveys, large mammal surveys, etc., and general ecology.

DISSECTIONS

Very strong background in anatomy, dissecting, collecting and calculating condition factors; doing stomach analysis (birds, coyotes, fish); scat analysis (fox, coyote, grizzly bear, etc.); and reproductive analysis.

- Necropsies (trained for several years at the Atlantic Veterinary College at UPEI) to try to establish cause of death
- Collecting morphological measurements for studying minute differences between populations (in fish, muskox, mice, plant seeds, etc.)

EMPLOYMENT HISTORY

2001 to Present	Wildlife Biologist EBA Engineering Consultants Ltd. Yellowknife, NT
1999 to 2001	Wildlife Biologist Rescan Environmental Services Yellowknife, NT
1998 to 1999	Wildlife Biologist Golder Associates Ltd. Yellowknife, NT
1995 to 1998	Wildlife Biologist Rescan Environmental Services Yellowknife, NT
1990 to 1994	Program Coordinator/Wildlife Instructor Holland College Summerside, PEI
1993 to 1994	President Bedeque Bay Environmental Management Association Summerside, PEI
1988 to 1991	Project Manager CPSMEC Stratford, ON
1987 to 1988	Wildlife Harvest Technician Department of Renewable Resources Yellowknife, NT

smoore@eba.ca

1983 to 1987	Habitat Management Technician Department of Renewable Resources Yellowknife, NT
1982	Tourism and Parks, G.N.W.T. Yellowknife, NT Researched, developed and constructed two self-guided interpretive rails. Wrote and published brochures for both trails.
1982	Project Manager Northern Frontier Tourism Association Yellowknife, NT
1981	Environmental Technician Ministry of the Environment Dorset, ON

PUBLICATIONS

Moore, Steve. A Pragmatic Approach Towards Conservation: The Stratford Experience. E.S. newsletter, Faulty of Environmental Studies, University of Waterloo. December 1990. 3 pages.

Moore, Steve, 1987. An Annotated Summary of Recent Literature on the Effects of Human Disturbance on Caribou. Northwest Territories Department of Renewable Resources File Report No. 62.

Moore, Steve. Future Conservation: The Stratford Experience. (has been submitted to the Natural Areas Journal).

Joint Authors

Moore, S., J. Virgl, M. Raine and D. Melton. 1998 Wildlife Monitoring Program, Construction Phase, Ekati Diamond Mine™.

Moore, S., D.A. Melton and M.M. Mears, 1997. Environmental Impact Assessment for the Fort Liard Exploratory Drilling Project. Golder Associates, Yellowknife. 52 pp.

Moore, S., D.A. Melton and M.M. Mears, 1998. Environmental Impact Assessment for the Fort Liard Additional Exploratory Drilling Project. Golder Associates, Yellowknife. 42 pp.

Banci, V. and S. Moore, 1997. 1996 Wildlife Studies, BHP Diamonds Inc., Lac de Gras, N.W.T. 187 pgs.

Reynolds and Moore, 1996. Note on the first earthworm record from the Northwest Territories, Canada. Megadrilogica 6(10): 96.

McAskill, J.D., J. Ouellette, R. Curley, G. Schneider, and S. Moore, 1993. Monitoring Frogs, Toads, Salamanders, and Snakes. Natural History Society of Prince Edward Island's Island Naturalist # 129:3.

Mychasiw, Len and Steve Moore, 1989. Range Assessment for Wood Bison in the Mackenzie Bison Sanctuary, NT. Northwest Territories Department of Renewable Resources.

Hines, J., and S. Moore, 1987. Progress report on the basic resource inventory, Auyuittuq National Park Reserve, 1986-87. Unpublished report. Northwest Territories Department of Renewable Resources, Wildlife Management Division. Yellowknife, Northwest Territories.

Hines, Jim and Steve Moore, 1988. Observations of Wildlife and Wildlife Habitat in Auyuittuq National Park Reserve, Baffin Island, 1985-87. Northwest Territories Department of Renewable Resources File Report No. 79.

smoore@eba.ca

Hines, Jim and Steve Moore, 1988. Ecological land classification in Auyuittuq National Park Reserve, Baffin Island. Northwest Territories Department of Renewable Resources File Report No. 80.

Hines, Jim and Steve Moore, 1988. The vegetation and flora of Auyuittuq National Park Reserve, Baffin Island. Northwest Territories Department of Renewable Resources File Report No. 74.

Hines, J.E., R.F. Decker, and S. Moore, 1988. Observations of wildlife and wildlife habitat in Auyuittuq National Park Reserve, Baffin Island, 1986-87. Northwest Territories Department of Renewable Resources File Report Number 79. Yellowknife, Northwest Territories.

Hines, J.E., S. Moore, and L.J. Wilkinson, 1988. Ecological land classification in Auyuittuq National Park Reserve, Baffin Island. Unpublished report. Northwest Territories Department of Renewable Resources. Yellowknife, Northwest Territories.

Hines, J.E., M.A. Fournier, S. Moore, K.H. Seidel, M. Sutherland, and L.J. Wilkinson, 1988. A Natural Resource Survey of Auyuittuq National Park Reserve, Baffin Island. Contract Report Number 4. Northwest Territories Department of Renewable Resources. Yellowknife, Northwest Territories.

Mychasiw, Len and Steve Moore, 1984. Extrapolative Methods for Assessing Barren-ground Grizzly Bear Denning Habitat and Preliminary Mapping of Denning Habitat in the Mackenzie Delta Area. Northwest Territories Department of Renewable Resources Manuscript Report.

ARTISTIC DESIGN, LAYOUT, AND ILLUSTRATIONS FOR:

Ferguson, Robert S, 1987. Wildlife Areas of Special Interest to the Department of Renewable Resources. Northwest Territories Department of Renewable Resources.

BROCHURES

Moore, Steve, 1995. Contaminants in Wildlife in the Northwest Territories.

Moore, Steve, 1982. Ingraham Trail Northern Frontier Travel Association.

Moore, Steve, 1982. Follow The Trail of The Early Prospector. Northern Frontier Travel Association.

Moore, Steve, 1982. Prelude Wildlife Trail. Northern Frontier Travel Association.

smoore@eba.ca

RESUME David L. Morantz

DAVID L. MORANTZ, B.Sc. (Hons.), M.Sc., R.P. Bio.
Senior Biologist

EDUCATION

B.Sc. (Hons.), Zoology, University of Manitoba (1972)
M.Sc., Biology, Dalhousie University, 1976

AFFILIATIONS

Member, Association of Professional Biologists of British Columbia (APBBC)
Member, International Association for Impact Assessment, Western and Northern Canada Affiliate

Mr. Morantz is an aquatic biologist with 30 years of experience conducting fish habitat research, habitat management, aquatic impact assessments, and government-industry liaison. His research focused on salmonid habitat and microhabitat requirements and selection while with the Department of Fisheries and Oceans (DFO). As well, Mr. Morantz worked as Chief-of-the-Evaluation and Mitigation Division in the Scotia-Fundy Habitat Management Branch, where he coordinated and conducted the review and assessment of a wide variety of project proposals for their potential risk to fish and fish habitat. As a consultant, Mr. Morantz has designed and implemented fish and habitat assessment programs primarily for the mining industry, negotiated fish habitat compensation, and has evaluated riverbank, riparian, and land use and water quality conditions in relation to fish habitat. In addition, he has worked with government and industry to develop guidance and policy documents intended to facilitate and improve information and data gathering, and industry understanding of fisheries environmental legislation and policies.

FISH AND FISH HABITAT EVALUATIONS AND IMPACT ASSESSMENT

- Assessment of potential impacts to fish and fish habitat from a coal slurry spill at the Quintette mine near Tumbler Ridge, BC.
- Assessment of effects of a coal slurry spill on fish and fish habitat at the Bullmoose mine near Tumbler Ridge, BC.
- Evaluation of fish and fish habitat in streams within proposed Western Canadian Coal Corporation coal mine footprint areas in the Wolverine River and Burnt River drainages in north-eastern British Columbia.
- Assessment of fish populations and fish habitat in streams within the watershed of the proposed Cogburn magnesium mine, near Harrison Lake, BC.
- For the proposed BHP Diamonds development in the Northwest Territories which is now Ekati Diamond Mine, conducted an assessment of potential impacts to fish and fish habitat from proposed diamond mining activities at three small lakes in the BHP Diamonds claim block, developed an associated fisheries monitoring study, including a site visit and information exchange with an Inuk elder, managed project finances, human resource requirements, research and monitoring protocols for the environmental assessment, and provided advice regarding legal and environmental issues including presentations before an environmental review panel.
- Assessment of past impacts from the existing Tibbitt to Contwoyto winter road on streams and lakes.
- Developed an aquatic sampling protocol related to a proposed seasonal overland route (SOR) north of Yellowknife, carried out data analysis, contributed to the aquatic environmental report and the project description report, and participated in meetings with regulators concerning the SOR project, 2007.
- Assisted in the development of an aquatic sampling protocol related to a proposed seasonal overland route (SOR) to be used to service diamond mines north of Yellowknife. Carried out data analysis and contributed to the aquatic environmental report and the project description report prepared for this project, and participated in meetings with regulators concerning the SOR project.

- Risk assessment of a proposed road and bridge crossing at Kingcome Inlet, using the Risk Management Framework, 2009.
- Planned and conducted a preliminary assessment of potential aquatic impacts from a proposed 130 km road route to Tuktoyaktuk, NT, and planned and managed a spring fish and fish habitat baseline sampling program to permit more detailed assessment for regulatory review, 2009-2010.
- Developed and conducted an aquatic sampling program and impact assessment study related to construction of a hydroelectric storage reservoir dam on the Yellowknife River, NT, 2009.
- Managed the environmental assessment program on behalf of the City of Surrey for road-rail separation projects (bridge construction) as part of the Roberts Bank Rail Corridor Program, 2009-ongoing.
- Planned and directed the Environmental Effects Monitoring program on behalf of the North American Tungsten Corporation Cantung Mine, NT, and prepared the interpretative report for regulatory approval under the Metal Mining Effluent Regulations, 2009-2010.

RESEARCH INITIATIVES

For the Department of Fisheries and Oceans:

- Planned, coordinated, and conducted a multi-year research study into the microhabitat requirements of juvenile Atlantic salmon in selected streams in Nova Scotia and New Brunswick.
- Feasibility study for the certification/licensing of environmental professionals.
- Identification of DFO roles and responsibilities in the Georgia Basin.
- Planning and facilitating a joint DFO - Environment Canada workshop to improve collaborative ecosystem management of the Georgia Basin.
- Research into fisheries co-management strategies for the DFO Panel Study Partners.
- Review and make recommendations regarding the relationship between DFO's Environmental Science and Habitat Management Divisions.
- Completed a riparian habitat study on the Nicola River, BC.
- Conducted a riparian habitat survey on the Nicola and Coldwater rivers for DFO, in conjunction with the Department of Geography, Simon Fraser University, Burnaby, BC.

HABITAT TRAINING PROGRAM

- Development of a curriculum for a habitat training course being offered at the Technical University of Nova Scotia, Halifax, NS.

DISCUSSION PAPERS AND STRATEGIC PLANNING

- Research on coastal visual and auditory quality issues related to tourism for the British Columbia Ministry of Small Business Tourism and Culture.
- Development of a growth strategy for the tourism industry in British Columbia.
- Research and documentation of stewardship initiatives in British Columbia for the Oceans Blue Foundation and the City of Vancouver.

dmorantz@eba.ca

For DFO:

- Preparation of a discussion paper and public brochure on the regulation of marine environmental quality under the Canada Oceans Act (1999). This document provided research and documentation of potential national and international legislative constraints on the Oceans Act definition and regulation of marine environmental quality.
- Habitat Management Operational Guidelines for the Wild Salmon Policy (1999). This habitat management guideline document provided background information to explain the role of habitat in salmon conservation and enhancement, the legislative basis for habitat management, and a summary of prevailing risks to the quality and quantity of salmon habitat in the Pacific region of Canada.
- Discussion Paper: Decision framework for the determination and authorization of harmful alteration, disruption, or destruction of fish habitat. This discussion paper was intended to serve as the strategic implementation plan for the Habitat Enforcement Charter (2000).
- Review of the process and effectiveness of certification for aquatic habitat professionals (2001). The purpose of this review was to assess the effectiveness of the DFO Maritimes Region certification program at meeting its objectives, and to determine whether there is an appetite for certification in other regions.
- Consolidation and discussion of guidelines pertaining to the mitigation of the effects of developments and works on fish habitat (2003).
- Background paper for the Department of Fisheries and Oceans Pacific Region Freshwater Riparian Workshop (2003). This paper provided background information regarding riparian management practices to assist in the development of scientifically defensible and realistic guidelines and specifications.
- Information Requirements Guide (2008). This draft was prepared for Habitat Management in the Pacific Region as a comprehensive guide for project proponents on the information required by DFO to initiate and complete project assessments. The guide includes a stepwise procedure to be followed based on the location, nature, and complexity of the project.

INTERPRETATION BULLETIN FOR HYDROELECTRIC GENERATION FACILITIES

- The Canadian Electricity Association and the Department of Fisheries and Oceans (2004-2007). Researched and prepared an interpretation bulletin to explain the consequences of hydroelectric development on fish and fish habitat, to discuss DFO policies and legislation related to hydro developments, and to identify strategies to mitigate adverse effects.

PUBLICATIONS

Gray, R.W., D.L. Morantz and J.D. Cameron. 1980. Size, distribution and significance of the commercial by-catch of Atlantic salmon (Salmo salar L.) in mainland Nova Scotia. Can. Manuscript Report of Fisheries and Aquatic Sciences No. 1583.

Jessop, B.M. and D.L. Morantz. 1982. A survey of the Atlantic silverside fishery of Prince Edward Island, 1979. Can. Man. Rep. Fish. Aquat. Sci. 1639.

Morantz, D.L. 1978. A review of existing information on the Fisheries of the Shubenacadie-Stewiacke River Basin Bd. Technical Report #1.

Morantz, D.L. 1978. The Fisheries of the Shubenacadie-Stewiacke River Basin. Shubenacadie-Stawiacke River Basin Bd. Technical Report #6.

Morantz, D.L. and B. Sabean. 1982. Trout, salmon, and silt. N.S. Conservation. Vol. 6(1).

Morantz, D.L., S.E. Barbour, and R.K. Sweeney. 1985. Source of error in water velocity measurements for aquatic studies. Can. J. Fish. Aquatic. Science. 43:893-896.

dmorantz@eba.ca

Morantz, D.L., C.S. Shirvell, R.K. Sweeney, and D.A. Longard. 1987. Selection of microhabitat in summer by juvenile Atlantic salmon (Salmo salar). Can. J. Fish. Aquatic. Science. 44 (1): 120-129.

Shirvell, C.S, and D.L. Morantz. 1983. Assessment of the instream flow incremental methodology for Atlantic salmon in Nova Scotia. Transactions of the Canadian Electrical Association, Engineering and Operating Division. Vol. 22, 83-H-108, 22p.

dmorantz@eba.ca

Walter J. Orr B.Sc. (Eng.), P. Eng.

Civil Engineering

Mr. Orr is Senior Civil Engineer with more than 22 years experience in northern civil, municipal, petroleum, transportation, structural and environmental engineering throughout the Northwest Territories, and since 2002 also in the Russian Far East. His responsibilities involve design and design coordination, project management, project personnel coordination and control, contract administration and client relations. Projects he has completed include municipal upgrading, land development, water supply, airports and highways, fuel storage facilities and pipelines, sewage and solid waste disposal, environmental assessments, building structural and mechanical works.

Walter's strengths are his versatility and creativity, together with his broad experience across almost all facets of Civil Engineering. His background allows him to both work directly in specific areas of specialization at a senior level and also to interface intelligently with specialist consultants across all disciplines.

EDUCATION

B.Sc. (Civil Engineering), University of Saskatchewan, Saskatoon, Saskatchewan, 1991

MEMBERSHIPS

Member, Association of Professional Engineers and Geoscientists of Saskatchewan

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

Past Director, Association of Consulting Engineering Companies-Canada

Past President, Consulting Engineers of the Northwest Territories

Member, Northwest Territories Association of Professional Engineers and Geoscientists

PROJECT EXPERIENCE

Airports & Aviation

New Fire Fighting Air Tanker Bases, Haines Junction, Dawson City and Carmacks, Yukon

New Fire Fighting Heliports, Mayo and Carmacks, Yukon

Whitehorse, Hay River, Inuvik, Ft. Simpson, Norman Wells and Iqaluit Airports, Northwest Territories
Preparation of civil engineering components of master and/or development plans.

Review of Location of Existing Air Terminal Building and Recommendations for New Air and Groundside Improvements, Tuktoyaktuk, Northwest Territories

Runway Extension, ACAP Design Submission, Cambridge Bay, Nunavut

New Groundside Parking Facilities and Groundside Drainage Improvements for New Air Terminal Building, ACAP Design Submission, Iqaluit, Northwest Territories

Airport Apron 1 and Taxiway A Reopening, ACAP Design Submission, Iqaluit, Northwest Territories

Airport Groundside Parking Facilities, Groundside Drainage Improvements and Upgrading Existing ATB, Yellowknife, Northwest Territories
Survey layout and inspection services.

Gulf Beaudril Air Terminal Building, Tuktoyaktuk, Northwest Territories
Conceptual design, evaluation and detailed design for the refurbishment of the existing air terminal building.

Airport Planning Study, Apron & Access Road Design, Clyde River, Nunavut

Bridges

Two New Bridges: Saline River Bridge (128m long) and Steep Creek Bridge (64m long) (Design Team Leader)

** denotes projects completed with other firms*

Walter J. Orr B.Sc. (Eng.), P. Eng.

Civil Engineering

Civil Engineering
Zima Village Municipal Services, Sakhalin Island, Russian Federation
Design of new 100 Unit subdivision, new roads, sidewalks parking lots and underground services for Shell Oil.

1999 Miscellaneous Services Program – City of Yellowknife, Northwest Territories

Community Institutional
Town of Inuvik Pile Remediation, Inuvik, Northwest Territories
Inspections and design completed for 4 buildings:
- *Inuvik Next To New Pile Remediation – 62 piles*
- *Inuvik Youth Center Pile Remediation – 35 piles*
- *Inuvik Food Bank Pile Remediation – 73 piles*
- *Inuvik Turning Point Pile Remediation – 52 piles*

Arviat Seniors Center Pile Remediation, Arviat, Nunavut (Senior Structural Review)

Community Garage Fire Remediation, Whale Cove, Nunavut (Senior Structural Review)

Corporate / Office
Commercial Office Building, Yellowknife, Northwest Territories
Design of complete interior demolition and renovation for 10,000 sq. ft. commercial office building.

Cultural & Religious
Church of Christ Foundation Remediation, Yellowknife, Northwest Territories

Education
Sir Alexander Mackenzie Structural Pile Remediation, Inuvik, Northwest Territories

Samuel Hearn School Structural Pile Remediation, Inuvik, Northwest Territories

AC Shop Structural Pile Remediation, Inuvik, Northwest Territories

Emergency Structural Remediation, Wha Ti School Tank Room, Wha Ti, Northwest Territories

SAM School Lateral Stability Remediation, Inuvik Region, Northwest Territories

Environmental Site Assessments Phase I, II, III
Enhanced Phase 1 Assessments for 50 Lots in Fort Norman, Fort Good Hope & Deline, Northwest Territories

Fuel Storage and Distribution
Refueling Services for Heliports, Inuvik, Wrigley and Fort McPherson, Northwest Territories
Project management and design services.

DND Float Base Fuel Resupply Upgrading, Yellowknife, Northwest Territories
Design and inspection services.

New Fuel Transfer Pipelines form Lower to Upper Tank Farm and Replacement of all Compound Fuel Piping – CFB Alert

Truck Fill Station & Reservoir, Hay River Reserve, Northwest Territories

Evaluation and Reporting the Environmental Condition of Fuel Tankage, All Facilities – Government of Canada, DND, Yellowknife, Northwest Territories

Roadways
20km New Highway Construction for Shell Oil, Sakhalin Island, Russian Federation
Design and engineering construction team management.

New Landfill Baler Access Road, Yellowknife, Northwest Territories
Designed construction layout.

Upgrade of Existing Hay River Subdivision and Downtown Core Roads, Iqaluit, Northwest Territories
Roadway, sidewalk, curb and gutter design.

Mackenzie Highway #1 Reconstruction of km 106 to 126, Northwest Territories (Engineering and Survey Management)

Conceptual Roadway Design for the Proposed Acklands Site Redevelopment, ,, Yellowknife, Northwest Territories

Sports and Athletic Facilities
Resolute Bay Arena, Resolute Bay, Nunavut (Senior Structural Review)

** denotes projects completed with other firms*

Walter J. Orr B.Sc. (Eng.), P. Eng.

Civil Engineering

Structural Engineering
New Dock – Wha Ti & Government of Canada, DFO, Yellowknife, Northwest Territories

New Breakwater, Clyde River, Nunavut

Structural Upgrade of Existing Wharf, Iqaluit, Northwest Territories

New Dry Goods Barge Landing, Rankin Inlet, Nunavut

Volatile Building Structural Pile Remediation, Inuvik, Northwest Territories

DFO Dock Structural Design, Yellowknife, Northwest Territories

Inuvik Pile Remediation Project, Inuvik Region, Northwest Territories
- *Arctic College Volatile Building Pile Remediation – 24 piles*
- *Arctic College Mechanics Shop Pile Remediation – 120 piles*
- *Family Medical Center Pile Remediation – 48 piles*
- *Aklavik Nurses Residence Pile Remediation – 84 piles*

Wekweti Dock Structural Design, Wekweti, Northwest Territories

Jak Park Tower Pile Remediation, Engineering Support Services, Inuvik, Northwest Territories

** denotes projects completed with other firms*

Walter J. Orr B.Sc. (Eng.), P. Eng.
Civil Engineering

PUBLICATIONS

Authored Municipal Works Procedures Manual", which provides Technical Assistance to Small Northern Communities. *GNWT*, 2011.

RESUME Tania Perzoff

Tania Perzoff, M.Sc., R.P.Bio.

Mine Permitting and Project Management

- **17 YEARS OF EXPERIENCE**

Ms. Perzoff is a Senior Biologist and Project Manager with EBA, a Tetra Tech Company, in the Vancouver-based mining group. Her areas of expertise include environmental impact assessment, regulatory and permitting support, vegetation baseline study design and implementation, and project management. She has worked on numerous development projects in British Columbia, the Arctic, the Dominican Republic, Saskatchewan, Mexico, and Argentina. Regulatory and permitting experience includes working with standards and guidelines administered by the BC Environmental Assessment Office (BC EAO), Canadian Environmental Assessment Agency (CEAA), Mackenzie Valley Environmental Impact Review Board (MVEIRB), Yukon Environmental and Socio-economic Assessment Board (YESAB), Nunavut Impact Review Board (NIRB), and World Bank International Finance Corporation (IFC).

RELEVANT EXPERIENCE

Project experience for Ms. Perzoff includes the following:

- Preparation and coordination of environmental impact assessment submissions in several jurisdictions across a range of industries, particularly mining
- Participation in meetings with regulatory agencies, stakeholders, and First Nations to develop baseline data collection programs, present findings, and clarify information requirements as part of the regulatory process
- Design and implementation of baseline and supporting studies in accordance with applicable provincial/territorial standards, *Acts*, and Regulations
- Project management including client liaison, regular progress reporting, budget tracking using earned value management, and management and coordination of multi-disciplinary teams throughout the environmental assessment process
- Mining projects include:
  - Bonanza Ledge Project (BC – permitted)
  - Galore Creek Project (BC – permitted)
  - New Afton Project (BC – permitted)
  - Davidson Project (BC)
  - Ketza River Project (YT)
  - Minto Mine Phase IV Expansion (YT)
  - Thor Lake Rare Earth Element Project (NT – undergoing review)
  - Tyhee Yellowknife Gold Project (NT – undergoing review)
  - Gahcho Kué Project (NT)
  - Pueblo Viejo Project (Dominican Republic – permitted)
  - Agua Rica Project (Argentina)
  - Review of the High Lake EIS (NU)
- Transportation projects include:
  - Inuvik to Tuktoyaktuk Highway Project (NT)
  - All-weather road and marine facility at Kingcome Inlet (BC)
  - All weather road between Contwoyto Lake and Bathurst Inlet (NU)
- Other projects include:
  - Heritage Secure Landfill (BC)
  - Review of the Mackenzie Green Energy Facility EA (BC)

EDUCATION

Applied Project Management Certificate, Langara College, Vancouver, BC

M.Sc., Botany, University of British Columbia, Vancouver, BC

B.Sc., Plant Ecology, University of British Columbia, Vancouver, BC

SUMMARY OF EXPERIENCE

Environmental assessments for mining and infrastructure development

Project management

Participation in regulatory agency and client meetings

Design and implementation of ecosystem mapping and vegetation baseline programs

Integration of GIS into environmental programs

Data analysis, reporting, and presentation

AFFILIATIONS

Member, Association of Professional Biologists of British Columbia (APBBC)

Member, College of Applied Biology (CAB)

Member, International Association for Impact Assessment (IAIA), Western and Northern Canada Affiliate

tperzoff@eba.ca

RESUME Samuel A. Proskin

SAMUEL A. PROSKIN, Ph.D., P.Eng.
Senior Project Engineer

EDUCATION

Ph.D., Geotechnical Engineering, University of Alberta, 1998
M.Sc., Geotechnical Engineering, University of Alberta, 1989
B.Sc., Geotechnical Engineering, University of Manitoba, 1983

AFFILIATIONS

Member, Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA)
Licensee, Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories and Nunavut (NAPEG)
Member, Canadian Geotechnical Society (CGS)
Member, ASTM International, Committee D18.19 on Permafrost

Dr. Proskin is a senior project engineer in the Geotechnical Group with EBA, a Tetra Tech Company, in the Edmonton, AB office, and has worked over 14 years as a consultant and three years as a university research associate. This includes 11 years in EBA's Arctic Group where he provided geotechnical and permafrost engineering services for mining, oil and gas, and infrastructure construction projects in the Canadian Arctic.

His technical specialties include geotechnical engineering (site investigation, earthworks, foundations, instrumentation, earthworks quality assurance), winter road engineering (allowable loads on ice and snow for transportation and construction), and geotechnical laboratory testing (thermal properties of soils, plastic concrete testing, and geosynthetics testing).

Dr. Proskin has also managed construction quality assurance of Diavik's A154 NW Wall Depressurization Program, Diavik's A154N Cemented Rockfill Capping, Resolution Island Clean Up project, and various ice engineering projects.

ICE COVER AND WINTER ROAD ENGINEERING

- Managing an ongoing multi-year project (2002 to present) that provides engineering advice to the Tibbitt to Contwoyto Winter Road Joint Venture Management Group on the operations of the 600 km long winter road. This entails review of ice profiling data, road observations, and analyses to optimize loading and locations of ice crossings. Given several presentations to contractors and trucking companies on technical aspects of ice crossings and risk management.
- Served as a technical resource to an Advisory Committee that developed a Best Practice for Building and Working Safely on Ice Covers in Alberta for Work Safe Alberta that was released November 2010.
- Managing a Transportation Association of Canada initiative to develop Best Practice for Building and Operating Winter Roads.
- Conducted a feasibility study of building a winter road along a river to transport large loads (over 100 metric tons) to a remote site in north-western British Columbia.
- Carried out and reviewed engineering analyses of the static bearing capacity of ice pads used for mineral bulk sampling operations for Diavik Diamond Mines Inc., Peregrine Diamonds Inc., and BHP Billiton. These analyses allowed them to maximize their sampling of ore targets by coordinating rig operations. Ice safety plans were provided to minimize risk during these operations.
- Carried out and reviewed engineering analyses of the static bearing capacity of ice pads used for coring of overburden and mineral deposits for Diavik Diamond Mines Inc., Foundex, and DOSECC.
- Provided expert opinion to Alberta and Manitoba government inquiries into fatalities associated with ice crossings and ice bridges.

- Developed a special permit procedure for GNWT ice roads that allows non-highway legal vehicles (heavy loads) to use ice covers. The procedure requires engineering analyses that demonstrate that the proposed vehicles can safely drive over the ice cover.
- Provided ice covering engineering services and interpretation of EBA ice profiling and bathymetric data of the Colomac Winter Road (2006 to 2010), Victor Project Winter Road, (2006 and 2007), and the Athabasca River ice bridge (2007 to 2010). Analyses permitted operators to optimize the payloads and the length of the operating season.
- Supervised analyses to provide ice bearing capacity recommendations for various ice road operations equipment for Nuna Logistics, the winter road contractor for the TCWR. These recommendations allow Nuna to safely deploy its equipment during construction, which is usually the riskiest time to use the ice road.
- Supervised a program to re-evaluate the allowable speeds and loads for vehicles that transport goods and fuel over floating ice covers. A field experiment was used to collect deflection data from a seven axle, 34,000 kg side dump truck that travelled over a test section on the TCWR. Employed ground motion seismometers to monitor ice cover movement along with traditional wireline deflectometers which adapted data acquisition system for cold temperature (-20°C) environment.
- Supervised the ice capacity analyses conducted for various clients operating different pieces of equipment or vehicles on fresh water floating ice covers: BG-24 crawler (Nuna); mineral exploration drill (Foundex).
- Conducted ice capacity analyses for Tower Arctic for operating excavation equipment on a floating sea ice cover at Polaris Mine during decommissioning and for vibroseis equipment operating on sea ice for Delta Trace.
- Supervised analyses and provided technical advice for the safe operations of oil exploration rigs and equipment working and moving on fresh water ice for Shaker Services, the Mackenzie Delta Infrastructure Group, and Devon Corporation.

GEOTECHNICAL SITE INVESTIGATIONS

- Participated in several geotechnical site investigations to provide the permafrost, overburden soil, and rock mass data required to design dikes and related infrastructure for the Diavik Diamonds Project. This involved logging ground ice conditions and logging bedrock lithology, RQD, and fracture orientation. Also carried out in situ testing to determine hydraulic conductivity of soil and rock masses using falling head and packer tests. Have written several reports providing geotechnical recommendations based on these investigations.
- Managed a geotechnical investigation for the grade widening and realignment of Alberta Highway 32:08/10.
- Supervised site investigation for Qikiqtani General Hospital, Iqaluit, where a diamond drill rig was used to investigate rock conditions.
- Investigated the ground ice conditions for a drilling fluid sump in the Mackenzie Delta for Devon Canada. Also monitored the closure of the sump and installed ground temperature cables to monitor sump freeze-back and effect on surrounding area.
- Participated in a site investigation for the foundation for Waste Rock Dam, EKATI Diamond Mine.
- Conducted a geophysical survey by using resistivity/conductivity and magnetic methods for a subsurface investigation of the Lancaster Park munitions dump, CFB, Edmonton.
- Conducted electromagnetic survey (Ohm Mapper) and magnetometer surveys to delineate buried debris DEW Line Clean up sites PIN-3 and CAM-3. Contoured and plotted these data using SurferTM plotting software.
- Conducted a geotechnical site investigation for a proposed port facility for the BHP Boston Gold Project. Wrote a report that provided geotechnical recommendations for onshore structure foundations, an offshore floating ramp, and ship mooring.
- Performed geotechnical site investigations using rotary rigs and SPT split spoon and Shelby tubes in Edmonton.

sproskin@eba.ca

GEOTECHNICAL AND MATERIALS LABORATORY TESTING

- Supervised large diameter (300 mm) permeameter testing of bentonite-gravel core material and gravel filter materials to determine hydraulic conductivity.
- Supervised a materials testing program to evaluate the mechanical properties of kimberlite rock for BHP Billiton's mud rush assessment for the Ekati Diamond Mine.
- Managed several testing programs to determine the properties of controlled low strength materials (plastic concrete and jet grout mixes) used as diaphragm cut-off wall in the A154 rockfill dike, Diavik Diamonds Project. Specialized testing was performed to measure the uniaxial tensile strength, erosion properties, frost heave, and unfrozen water content of these materials.
- Managed a laboratory program for Advanced Geotechnology Inc. that required high pressure triaxial testing to determine the Young's Modulus, Mohr-coulomb strength parameters, and hydraulic conductivity of petroleum reservoir rock.
- Conducted and supervised laboratory test programs to determine the thermal conductivity and unfrozen water content by time domain reflectometry (TDR) of frozen and unfrozen soils, including arsenic trioxide dust for SRK.
- Conducted a proof-test program of a Roctest extensometer subjected to high temperature and pressure simulating conditions during extraction of bitumen using cyclic steam stimulation.
- Investigated the application of freeze-thaw in the dewatering of oil sands fine tailings. This involved an extensive laboratory test program to determine the large strain consolidation properties of the chemically altered fine tailings, and a large-scale field program over two years to evaluate freeze-thaw dewatering for both Suncor and Syncrude fine tailings. Also conducted thermal analyses, post-thaw consolidation, and settlement analyses to predict field behaviour and to provide design guidelines for commercial operations.
- Designed and conducted various laboratory tests to evaluate the design properties of geosynthetic materials. These included interfacial friction tests for geosynthetic-soil configurations for Golder Associates, EMCON Associates, and Terrafix; permittivity and transmissivity tests for evaluating hydraulic properties of geosynthetics for Nova Geotech, Thurber Consultants, and Wardrop Engineering; and pull-out tests of Reinforced Earth reinforcement metal strips for Hardy BBT.

GEOTECHNICAL ANALYSIS AND DESIGN

- Led a team that developed geotechnical recommendations for the relocation of a rain water impoundment basin at Imperial Oil's Strathcona Refinery. This included stability analyses of the natural and excavation slopes, temporary shoring, and foundations.
- Provided geotechnical analysis of EBA's multi-channel analysis of surface waves (MASW) data for three wind tower projects in southern Alberta. Included development of dynamic and static elastic moduli.
- Participated in the design of the Tier II hazardous waste landfill for PCB waste at BAF-5 in Resolution Island, NU. This included thermal analysis of the frozen core earthfill berm and stability analysis of the geosynthetic liner.
- Foundation design for various projects in the Canadian Arctic, including Hay River, Iqaluit, and Old Crow, YT.
- Conducted thermal analyses using EBA's proprietary software Geotherm to evaluate the effect of different design scenarios for various earthworks for the Diavik and BHP projects.
- Conducted slope stability calculations for various earth and rockfill embankment projects.
- Conducted thermal analyses for (a) the design of a drill rig ice pad foundation for the Vankor Project; and (b) a study of the effect of producing oil wells on the overlying permafrost for the Timan Pechora Oil Field Project.
- Provided foundation recommendations for clients in Edmonton, AB.

sproskin@eba.ca

CONSTRUCTION QUALITY ASSURANCE PROJECT MANAGEMENT

- Co-Project Manager for Diavik Diamond Mines Inc. (DDMI) during construction of a cemented rockfill cap for their A154 North pipe. Involved the production and placement of 16,000 m3 of cemented rockfill cap to permit underground mining of kimberlite from A154N pipe.
- Co-Project Manager for Diavik's program to depressurize the northwest wall of the A154 pipe. Involved installing a monitoring network of piezometers along the pit crest and on the 280 bench and depressurization wells on the 280 m bench.
- Supervised CQA program for the construction of the Tier II hazardous waste landfill at BAF-5 in Resolution Island, NU.
- Conducted landfill inspections and provided remedial recommendations for BAR-1, BAR-2 PIN-1, and PIN-2 DEW sites in Yukon and Northwest Territories for the DEW line Clean-up Project.
- Conducted a CQA coring program to verify the quality and extent of the seepage cut-off wall at the A154 rockfill dike, Diavik Diamonds Project. This entailed developing a logging scheme for describing the low strength plastic concrete and jet grouted soils that made up the cut-off wall. It also required working with the driller to optimize core quality and recovery in these materials using the S Geobor core barrel.
- Provided construction quality assurance for the installation of a geomembrane liner for a brine storage pond for Dow Chemical, Fort Saskatchewan, AB.
- Provided quality assurance for the installation of rock socketed piles for a mill expansion at the Anvil Range Mine, Faro, YT, and the installation of driven steel pipe piles for a bridge foundation for the Minto Mine, Minto, YT.
- Provided quality assurance for cast-in-place and driven timber piles in northern Alberta.

GEOTECHNICAL FIELD INSTRUMENTATION

- Assisted in the supervision of geotechnical instrumentation installation and monitoring for the Northeast Anthony Henday Ring Road project.
- Installed vibrating wire piezometers and TDR cables in the slopes of Diavik's A154N pit to monitor groundwater pressures and wall displacement. These involved installations varying from 50 to 550 m deep.
- Installed geotechnical instrumentation for monitoring the performance of the A154 dike for the Diavik Diamonds Project, NT. These included ground temperature cables, Casagrande piezometers, vibrating wire piezometers, inclinometers, and extensometers in both the dike rock fill and the plastic concrete cut-off wall for Lac des Gras Constructors (Kiewit/Nuna).
- Installed groundwater monitoring wells at the hazardous waste landfill in Ryley, AB, for Laidlaw Environmental Services and at the Distant Early Warning (DEW) Line Clean Up at Cape Parry, NT, for Defence Construction Canada.
- Installed ground temperature cables to depths of 15 to 150 m as a part of various site investigations in permafrost.

RESERVOIR GEOMECHANICS

- Analyzed small volume hydraulic fracture treatment data (mini or micro-fracs) to determine the in situ stresses in oil sands reservoirs (M.Sc. thesis).
- Analyzed cyclic steam stimulation oil production for Phases III and IV at Imperial Oils Cold Lake operations for ESSO Resources.
- Supervised and conducted specialized high temperature and high pressure laboratory tests of Diatomite and oil sands reservoir rock for determining mechanical and hydraulic properties necessary for modelling of reservoir behaviour during oil extraction.

sproskin@eba.ca

SPECIAL SKILLS AND KNOWLEDGE

- Permafrost Geotechnical Engineering: properties of frozen and thawed soils; foundation design; laboratory tests (unfrozen water content, thermal conductivity, frost heave); and site investigation.
- Winter Road Engineering: bearing capacity of ice for temporary and stationary loads, fresh water, and sea ice properties.
- Oil Sands Mature Fine Tailings: consolidation and freeze-thaw properties.
- Site Investigation: permafrost logging; rock mass logging; plastic concrete and soilcrete logging; and packer (Lugeon) testing.
- Special Geotechnical Testing: thermal properties of soils (thermal conductivity and unfrozen water content, frost heave); high temperature and high pressure oedometer and triaxial testing; and geosynthetics testing (interfacial friction, geogrid pull-out).

EMPLOYMENT HISTORY

2002 - Present	Senior Project Engineer EBA Engineering Consultants Ltd. Edmonton, AB
1996 - 2002	Project Engineer EBA Engineering Consultants Ltd. Edmonton, AB
1993 - 1996	Teaching Assistant University of Alberta, Department of Civil Engineering Edmonton, AB
1990 - 1992	Research Engineer University of Alberta, Department of Civil Engineering Edmonton, AB
1989 - 1990	Research Engineer University of Alberta, Geosynthetics Research Centre Edmonton, AB
1988	Engineer EBA Engineering Consultants Ltd. Edmonton, AB
1985 - 1986	Teaching Assistant University of Alberta, Department of Civil Engineering Edmonton, AB
1985 (summer)	Summer Student Esso Resources Canada Ltd. Oil Sands Reservoir Engineering Section

ADDITIONAL TRAINING

2004	Career Builders Management Training
2004	PSMJ Project Managers Boot Camp
2002	Permafrost Engineering short course, Department of Civil and Environmental Engineering, University of Alberta
1996	Risk Assessment in Geotechnical Engineering and Geo-Environmental Engineering, Geotechnical Society of Edmonton
1995	Remediation Guidelines for Storage Tank Sites, Geotechnical Society of Edmonton
1986	Stability and Bifurcation in Geomechanics, Geotechnical Group, Department of Civil Engineering, University of Alberta

sproskin@eba.ca

SAFETY TRAINING

Standard First Aid Level B CPR
Alberta Construction Safety Association Leadership for Safety Excellence (ACSAL)
Canada Safety Council ATV Training
EBA Supervisor Safety Training Course

TECHNICAL PUBLICATIONS

A Geotechnical Investigation of Freeze Thaw Dewatering of Oil Sands Fine Tailings. 1998. Ph.D. Thesis. University of Alberta. 309 p.

Field Test of Freeze Thaw Dewatering of Oil Sand Fine Tails. 1996. In Proceedings, Second International Congress on Environmental Geotechnics. Osaka, Japan. November 5 to 8, 1996 (with D.C. Sego).

Field Tests Evaluating Freeze-Thaw Dewater of Fine Tailings. 1996. In Tailings in Mine Waste 96, Fort Collins, CO. pp. 189-200 (with D.C. Sego and R. Burns).

Freeze-Thaw Dewatering of Oil Sands Fine Tailings. 1995. In Advances in Oil Sands Tailings Research. Vol. 3. D.E. Sheeran (ed.). Fine Tailings Fundamentals Consortium, Alberta Department of Energy, Edmonton, AB. pp. III-29 to III-45 (with D.C. Sego, and R. Burns).

Volume and Permeability Changes Associated with Steam Stimulation in an Oil Sands Reservoir. 1994. Journal of Canadian Petroleum Technology. 33 (7): 44-52 (with J.D. Scott and D. Adhikary).

Interpretation of the Minimum Principal Stress from Microfrac Tests. 1990. In Rock at Great Depth. Edited by V. Maury and D. Fourmaintraux. A.A. Balkema, Rotterdam. pp. 509-1520 (with H.S. Chhina and J.D. Scott.).

In Situ Stress Measurements in Oil Sands by Hydraulic Fracturing. 1989. M.Sc. Thesis. University of Alberta. 263 p.

CONFERENCE PAPERS AND PRESENTATIONS

Use of Air Launched Soil Nails (ALSN) for Slope Stabilization. 2009. Paper for the Transportation Association of Canada Conference, Vancouver, BC (with Jermain Smith and Chris Gräpel).

Properties of Cemented Rockfill Used in an Open Pit Mine. 2008. Paper for the Canadian Geotechnical Conference. Edmonton, AB (with B.K. Shrestha, D.D. Tannant, J. Reinson, and S. Greer).

An Overview of Ice and Bathymetric Profiling using Ground Penetrating Radar (GPR). 2008. Paper for the 19th IAHR International Symposium on Ice. Vancouver, BC (with P. Finlay and N. Parry).

Ice Road Assessment, Modeling and Management. 2008. Paper for the Annual Conference of the Transportation Association of Canada, Toronto, Canada (with Darel E. Mesher, and Erik Madsen).

Managing the Safety of Ice Covers Used For Transportation in an Environment of Climate Warming. 2008. Paper for the 4th Canadian Conference on Geohazards, Quebec City, PQ (with Don Hayley).

Ice Road Assessment, Modeling and Management. 2008. Paper for the 7th International Conference on Managing Pavement Assets, Calgary, AB (with Darel Mesher and Erik Madsen).

An Overview of Ice Profiling using Ground Penetrating Radar. 2008. Paper for the 21st Symposium on the Application of Geophysics to Engineering and Environmental Problems, Philadelphia, PA (with Patrick Finlay, Neil Parry, and Robert Mickle).

Use of Ice Covers for Construction and Transportation. Presentation to the 2007 Cold Climate Construction Conference and Expo, Edmonton, AB.

sproskin@eba.ca

Design and Construction of Filter Zone for the A154 Dike at Diavik. 2004. Canadian Dam Association Conference. Ottawa, ON (with A. Rattue, S. Rice and J. Reinson.).

Enhancement of Solids Content of Oil Sand Fine Tails by Chemical Treatment and Freeze-Thaw. 1993. Proceedings of the 45th Annual Canadian Geotechnical Conference, Saskatoon, SK. 10 p (with D.C. Sego and R. Burns).

The Relationship Between Absolute Permeability and Stress State in Heavy Oil Sands. 1991. Proceedings of the 1991 Eastern Oil Shale Symposium. Lexington, Kentucky. 12 p. (with J.D. Scott and D. Adhikary).

Current Practice in the Interpretation of Microfrac Tests in Oil Sands. 1990. Proceedings of the 1990 California Regional Meeting of the Society of Petroleum Engineers. Ventura, CA. SPE 20040 (with J.D. Scott and H.S. Chhina.).

sproskin@eba.ca

RESUME Tara J. Schmidt

Tara J. Schmidt, MCIP
Regulatory Permitting and Project Manager

EDUCATION

B.Sc., Environmental Planning, University of Northern British Columbia, 1999
M.A., Environment and Management, Royal Roads University, 2011
Certificate in Public Participation, International Association of Public Participation, 2009

AFFILIATIONS

Member, Canadian Institute of Planners
Member, Planning Institute of British Columbia
Member, International Association of Public Participation
Member, International Association of Impact Assessment, British Columbia Chapter

Ms. Schmidt is an accredited Environmental Planner specializing in regulatory permitting and project management. She has over ten years of experience in regulatory permitting, project management, public and Aboriginal Peoples consultation, socio-economic assessments, traditional knowledge studies, and environmental and land use planning. Ms. Schmidt has successfully completed projects in British Columbia, Alberta, Yukon, Northwest Territories and the Philippines.

REGULATORY PERMITTING

- Currently preparing proponent responses to conformity review and information requests for the Inuvik to Tuktoyaktuk Highway Project and Thor Lake Project.
- Prepared sections of the Project Description Reports for the Gwich'in and Tulita Districts of the proposed Mackenzie Valley Highway on behalf of Mackenzie Aboriginal Corporation and 5658 NWT Ltd., NWT.
- Prepared an Environmental Impact Statement for a proposed all-season highway between the Hamlet of Tuktoyaktuk to the Town of Inuvik, on behalf of the Hamlet of Tuktoyaktuk, Town of Inuvik, and Government of Northwest Territories Department of Transportation, NWT.
- Prepared Project Description Reports for the reactivation (Phase 1) and mobilization (Phase 2) of the Kulluk mobile offshore drilling unit from the Northwest Territories (Canada) to Alaska (United States), on behalf of Shell Exploration and Production Company.
- Prepared a Project Description Report for a proposed all-season highway between the Hamlet of Tuktoyaktuk to the Town of Inuvik, on behalf of the Hamlet of Tuktoyaktuk, Town of Inuvik, and Government of Northwest Territories Department of Transportation, NWT.
- Prepared a Project Description Report for a proposed 19 km all-season road between the Hamlet of Tuktoyaktuk and Gravel Source 177, on behalf of the Hamlet of Tuktoyaktuk, NWT.
- Prepared consultation sections of the Facility Applications and/or Commitment Books for the following AltaLink Management Ltd.'s projects: the construction of 908L transmission line, construction of substation 12S and transmission line 1054L, replacement of overhead shield wire for 942L/943L transmission line, and restringing and tower installation for 902L/913L transmission line, AB.
- Assisted in the preparation of a major mine application under the YESAA for Mactung Mine, on behalf of North American Tungsten Corporation Ltd., Yukon.
- Assisted in the preparation of a Comparative Ecological Risk Assessment for the Cantung mine, on behalf of North American Tungsten Corporation Ltd., Yukon.
- Assisted in the preparation of a Small Mines Permit Application for First Coal Corporation, BC.

PROJECT MANAGEMENT

- Coordinated the compilation of various Project Description Reports and Environmental Impact Statements for several mining and transportation-related projects.
- Coordinated multiple consultation programs for electrical transmission lines in Alberta on behalf of AltaLink Management Ltd.
- Coordinated the environmental baseline field activities and reporting for a small mines application for First Coal Corporation.
- Coordinated a coastal zone development program for small farmers and fisherfolk, involving the following:
  - Organizational development and capacity building
  - Strategic planning (program and organizational)
  - Economic diversification
  - Land and water protection
  - Empowering community organizations to advocate for themselves
  - Trainings on good governance, planning, project management, etc.
- Created program and fund policies
- Developed project and organizational policies

SOCIO-ECONOMIC ASSESSMENT

Prepared socio-economic sections for the following documents:

- Project Description Report for the proposed Gwich'in and Tulita District sections of the proposed Mackenzie Valley Highway on behalf of Mackenzie Aboriginal Corporation and 5658 NWT Ltd., NWT.
- Project Description Report and Developers Assessment Report for the proposed Yellowknife Gold Project on behalf of Tyhee NWT Corp., NWT.
- Developers Assessment Report for the proposed Thor Lake/Nechalacho Rare Metals Mine on behalf of Avalon Rare Metals, Inc., NWT.
- Project Description Report and Environmental Impact Statement for a proposed all-season highway between the Hamlet of Tuktoyaktuk to the Town of Inuvik, on behalf of the Hamlet of Tuktoyaktuk, Town of Inuvik, and Government of Northwest Territories Department of Transportation, NWT.
- Project Description Report for a proposed 19 km all-season road between the Hamlet of Tuktoyaktuk and Gravel Source 177, on behalf of the Hamlet of Tuktoyaktuk, NWT.

PUBLIC AND ABORIGINAL CONSULTATION

- Provide senior review of the consultation section of Ketza River Holding Ltd.'s Ketza River Mine.
- Conducted several public and agency consultation programs (multi-year) for the development of, or upgrades to, electricity transmission lines and substations in Parkland County, Sturgeon County, Strathcona County, and Regional Municipality of Wood Buffalo, Alberta on behalf of AltaLink Management Ltd. Projects include the construction of 908L transmission line, construction of substation 12S and transmission line 1054L, replacement of overhead shield wire for 942L/943L transmission line, and restringing and tower installation for 902L/913L transmission line, construction of substations and transmission lines for the Christina Lake Area developments, and construction of transmission lines for Sunday Creek. Consultation included open houses, individual landowner consultations, agency and stakeholder consultation, and Aboriginal Peoples consultation.

tschmidt@eba.ca

- Conducted a Traditional Knowledge Study in Lutsel K'e, Dettah and N'Dilo, NWT for the proposed Thor Lake/ Nechalacho rare metals mine, on behalf of Avalon Rare Metals Inc.
- Designed a Traditional Knowledge study for the proposed Roche Bay Mine in Nunavut, on behalf of Advanced Explorations Inc.
- Annually updated the Tibbitt to Contwoyto Winter Road Emergency Response Plan for distribution to drivers and regulatory agencies on behalf of the Joint Venture, NWT.
- Conducted public consultation and developed stakeholder notices for a proposed gold mine near Wells, BC for International Wayside Gold Ltd.
- Prepared a presentation to the Town Council, public notices, newspaper advertisements, public open house, site tour, and community celebration for a mine reclamation project near Osoyoos, BC on behalf of the Ministry of Energy, Mines and Petroleum Resources (MEMPR).
- Designed a consultation program for a solid waste management plan for the Yukon Territory, on behalf of the Yukon Government.
- Facilitated several mining career fairs around British Columbia for the MEMPR
- Facilitated open houses for Highway 19 Area Structure Plan in Nisku, AB on behalf of Leduc County, AB.
- Facilitated workshops, open houses and Council presentations for two Area Structure Plan processes for the Municipal District of Opportunity, AB
- Facilitated issues and design workshops and designing exit surveys for an Area Redevelopment Plan for the City of Medicine Hat, Medicine Hat, AB
- Facilitated a series of workshops for the Municipal Development Plan in Mountain View County, Didsbury, AB
- Facilitated workshops for Phase I of the Official Community Plan process for the City of Vernon, BC.
- Conducted surveys for a Socio-Economic Report for the Wetaskiwin Regional Airport, AB.
- Co-facilitated an economic development strategic plan for the Halalt First Nation and Naut'sa mawt Tribal Council.
- Prepared a communication strategy to address multi-stakeholder watershed issues for the Naut'sa mawt Tribal Council.
- Organized and co-facilitated the Bonsall Creek Watershed Committee workshop to create a draft Strategic Plan and action plan, on behalf of the Naut'sa mawt Tribal Council.
- Prepared a community survey and co-facilitated public workshops for the City of Vernon's Official Community Plan Review (Phase I).
- Developed a community engagement module (based on Participatory Rural Appraisal methods) to collect social, political, environmental, cultural and economic data from Philippine villagers.
- Facilitated several feasibility planning sessions for micro-lending projects in the Philippines.
- Coordinated and facilitated numerous community planning sessions in the Philippines.

ENVIRONMENTAL AND LAND USE PLANNING

- Annually update the Tibbitt to Contwoyto Emergency Response Plan on behalf of the Joint Venture (2008 to 2011).
- Prepared a gap analysis of solid waste management infrastructure as part of the Growth Management Plan for the Alberta Capital Region.
- Municipal Development Plan (Official Community Plan) for Mountain View County, AB.

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- Calling Lake and Red Earth Creek Area Structure Plans for the Municipal District of Opportunity No. 17, AB.
- River Heights/Hospital Area Redevelopment Plan for the City of Medicine Hat, AB.
- Leduc Highway 19 Area Structure Plan for Leduc County, AB.
- Sustainable mining framework and plan for the BC Ministry of Energy, Mines and Petroleum Resources.
- State of Sustainability Report for the Regional District of Nanaimo, BC.
- Core waste infrastructure gaps for the Alberta Capital Region Alliance, AB.
- Five Airport Land Use Plans for the Municipal District of Mackenzie No. 23, AB.
- Airport Development Plan for the Wetaskiwin Regional Airport, AB.
- Socio-Economic Opportunity Assessment for the Wetaskiwin Regional Airport, AB.
- Concept Site Plan for recreational vehicle park, Harrison Hot Springs, BC.
- Area Structure Plan within the County of Newell, AB.
- Water Management Plan for the District of Ucluelet, BC.
- Emergency Drought Consequence Plans for the District of Ucluelet and the Village of Tahsis, BC.
- Drought Impact Assessment for Greater Vernon Services, BC.
- Strategic program planning and program development in the Philippines.
- Barangay (village) socio-economic and development plans in the Philippines.
- Participated in the BC Peace Region's Land and Regional Management Planning (LRMP) process.
- Provided recommendations for Official Community Plan amendments to incorporate Riparian Area Regulations for the Town of Ladysmith, BC.
- Identified an Amenity Bonusing Strategy for the City of Nanaimo, BC.
- Identified the solid waste generation and disposal rates in the Alberta Capital Region and compared that to available infrastructure to determine the requirements for current and future waste diversion facilities.

RESEARCH

- Conducted research on energy efficient solid waste management practices.
- Identified current volumes of recycling processing in Alberta for Alberta Environment.
- Working with a hydrogeologist, developed a set of groundwater indicators and corresponding methodology in order to identify the state of sustainability for groundwater use within the Regional District of Nanaimo.
- Identified current population trends, water availability and water demand, in order to develop estimates for future water demands of a projected population, to be used as a basis for treaty negotiations.
- Identified concepts used in community-based planning in British Columbia for use in developing appropriate international community-based planning techniques.
- Coordinated a research project of women's lives in remote, rural communities of the Philippines, which included designing the methodology, conducting the data gathering and developing the report outline.

tschmidt@eba.ca

EMPLOYMENT HISTORY

2005 - Present	Environmental Planner and Consultation Specialist EBA Engineering Consultants Ltd. Nanaimo and Vancouver, BC
2001 - 2004	Deputy Program Coordinator and Development Communications Manager Mennonite Central Committee/Developers Foundation Aklan, Philippines
1996	Planning Assistant Ministry of Energy, Mines, Petroleum Resources Fort St. John, BC

ADDITIONAL TRAINING

2010	Emotion, Outrage and Public Participation
2010	Building Consultants – Building Teams
2009	Building Consultants – Interpersonal Skills
2008	Solid Waste Management Conference (Edmonton, AB)
2007	Social Impact Assessment
2006	Project Management Course (Part II)
2005	Project Management Course
2003	Management Course for Sustainable Integrated Area Development - Philippines
2001	Conduct and Practices Handbook Course
2000	Canadian Securities Course
1996	Cross-Cultural Training with the Carrier First Nations

tschmidt@eba.ca

RESUME Jamie R. Stirling

Jamie R. Stirling, M.Sc., P.Geo.
Geomorphologist

EDUCATION

M.Sc., Physical Geography, University of Toronto, 1998
B.A., Geography, York University, 1994

AFFILIATIONS

Member, Association of Professional Engineers and Geoscientists of British Columbia
Member, Canadian Association of Geographers
Member, Canadian Water Resources Association
Member, Canadian Geomorphological Research Group
Member, Western Canadian Association of Geographers
Member, Division of Engineers and Geoscientists in the Resource Sector

Mr. Stirling is a Professional Geoscientist with 14 years of consulting experience with EBA, A Tetra Tech Company. His area of expertise is fluvial geomorphology and he specializes in hydrological processes, water management, stream and watershed assessments, channel rehabilitation, geohazard assessments, and hazard and risk assessments. Many of these projects have been managed by Mr. Stirling.

Mr. Stirling has a wide range of experience with a multitude of field and laboratory studies including aerial photo interpretation, deployment of meters and instruments, laboratory techniques, and sampling studies. His field experience encompasses mountain, fluvial and coastal geomorphology, glaciology, sedimentology, pedology, hydrology, and erosion and sedimentation studies.

Mr. Stirling has carried out numerous geohazard assessments, several of which have included hazard and/or risk assessments. The geohazard assessments have typically focused on issues such as landslides, debris flows, debris floods, rockfall, flooding, erosion, and sediment deposition. The hazard and risk assessments have typically involved a combination of river processes (flooding and erosion) coupled with slope stability concerns (landslides) in proximity to infrastructure or communities.

Over the past five years, Mr. Stirling has been involved in numerous projects throughout northern British Columbia, the Northwest Territories, Nunavut, and the Yukon. Most of these projects have been in the oil and gas industry, the mining sector and for First Nations. As a result, Mr. Stirling is experienced with carrying out fieldwork in northern conditions and has a good understanding of how unique these areas are with respect to hydrological processes and geohazards, which can create unique hazards and risks that often require specific mitigation.

WATERSHED AND RIVER RESTORATION PROJECTS

- **Rover and 49 Creek Channel Conditions and Prescriptions Assessment** - Assessment of watershed conditions, sediment production and channel morphology. Rehabilitation prescriptions were developed and costed for watershed and channel stabilization and sediment control.
- **Renata Creek Integrated Channel Conditions, Prescriptions Assessment and Fish Habitat Assessment Procedure** - Assessment of watershed conditions, sediment production, channel morphology, and fish habitat. Rehabilitation prescriptions were developed and costed for erosion protection and habitat enhancement.
- **Bowron River Watershed Fish Habitat and Riparian Assessment** - Channel restoration prescriptions for nine creeks of the Bowron Watershed with the objective to increase channel stability and improve fish habitat that was affected due to harvesting activity.
- **Italy and Sutherland Creek Channel Conditions and Prescriptions Assessment** - Assessment of watershed conditions, sediment production, and channel morphology. Rehabilitation prescriptions were developed and costed for watershed, channel stabilization, and sediment control.

- **Scotia River Coastal Watershed Assessment Procedure** - Assessment to provide recommendations for forest development plans, based on an assessment of the potential for cumulative hydrological effects from forest harvesting, and road building.
- **Deroche Creek Integrated Watershed Restoration Plan** - A plan to define the overall scope of effective restoration activities by dealing with roads, hillslopes, riparian areas, streams, and fish habitat.
- **Indian River Channel Assessment and Rehabilitation Prescriptions** - Assessment of channel stability and development of rehabilitation prescriptions, including prioritization for construction, timing, anticipated costs, logistics, and risk levels. Project included construction supervision and inspection.
- **Salween Creek Habitat Compensation** – Surface water fed side channels were designed and constructed as habitat compensation for the construction of the Wilson Road Dike. The side channels included rearing and spawning habitat with wetland benches, large woody debris and riparian vegetation.
- **Ed Leon Slough Habitat Compensation** - Groundwater fed side channels were designed and constructed as habitat compensation for the construction of the Chehalis River Dike. Habitat creation included two large rearing channels with ponds and a large spawning channel. Habitat enhancement included large woody debris placement at five sites. All sites were planted with riparian vegetation.
- **Katzie Slough Habitat Compensation** - A groundwater fed side channel was designed as habitat compensation for the construction of the Gateway Highway Project. Habitat creation included a rearing channel with pond, wetland benches, large woody debris and riparian vegetation.

CHANNEL STABILITY PROJECTS

- **MacMillan Provincial Park Hydrological Assessment** - Assessment of blowdown of large trees by field review, air photo interpretation, and remedial measures for bank and channel repair.
- **Fraser River (North Arm near Big Bend) Channel Stability Assessment** - Assessment of scour, flooding and erosion included an historical analysis of channel conditions with a determination of currents and scour potential based on a survey and numerical modelling.
- **Tsolum River Watermain Protection** - Assessment of historical variations with respect to lateral and vertical stability and assessment of bank protection and flood control works.
- **Fraser River Hazard Assessment at Mission Mill Site** - Fraser River hazard assessment included a site-specific analysis of historical air photos, channel stability, bank erosion, 200-year flood levels, and bank protection requirements.
- **Fraser River (Bishops Reach) Channel Stability Assessment** - An erosion and seismic review included a bathymetric and terrestrial survey, geotechnical investigations, and bank protection designs.
- **Options for Passing Flows through the Cheslatta Fan** - Description and evaluation of various options for passing flows through the Cheslatta Fan included documentation of the geomorphology, water quality, and impact on fish habitat.
- **Cutthroat Creek Channel and Drainage Improvements** - Detailed designs for channel stability and drainage improvements on the Shaughnessy Golf Course were prepared with a focus on replacing a failing retaining wall.
- **Fraser River Forcemain Crossing Scour Protection** - Scour analysis and protection design including a geomorphologic assessment of channel stability to facilitate design optimization. Review of technical specifications and drawings was also performed.
- **Indian River Bar and Bank Stabilization** - Bars and banks on the Indian River were stabilized using willow stem cuttings. Tasks included submission of application for instream works, coordination, and supervision of harvesting and planting.

jstirling@eba.ca

- **Cheekeye Creek Survey (Pre- and Post-October 2003 Flood)** - An analysis of channel changes was carried out from topographic surveys on Cheekeye Creek upstream of Highway 99. The surveys occurred before and after the major flood event of October 15, 2003.
- **Crest Creek Diversion Review Project** - Review of the impacts of the proposed decommissioning of the Crest Creek Diversion to the Elk River in the Campbell River system and participation in a panel discussion.
- **Mahon Park - Wagg and Mission Creek Rehabilitation** - Study included erosion inventory; design of mitigative solutions for eroding banks and unstable slopes. Included construction supervision, environmental monitoring, and a three-year monitoring program.
- **Fort Nelson Water Intake Study** - An assessment was carried out of the risks to the water supply intakes in the Muskwa River. Project included a channel stability assessment and development of mitigation measures.
- **Qualicum River Estates Channel Design** - A channel and detention pond was designed to convey and store the 200-year event on a small drainage basin.
- **Brunette River Sedimentation Study** - A constructed flood by-pass channel on the river has resulted in sedimentation issues. This study evaluated the aggradation of fines and provided recommendations for mitigation and further studies.

GEOHAZARD ASSESSMENT PROJECTS

- **Deroche Creek Flood Hazard Management Study** - Study of flood hazards and debris flows on the alluvial fan included lood magnitude and potential magnitude of debris flows and debris floods.
- **Flood and Erosion Damage Mitigation Plan for BC (Zone 1): Coastal BC** - Assessment of the risk to 95 First Nations' reserves due to flooding and erosion included referred options to mitigate the risks and estimates of capital costs.
- **Inventory of Flooding and Erosion Sites on the BC Coast** - Provincial inventory project included identification, description, and mapping of coastal sites prone to flooding and erosion. Study included recommendations for mitigative work.
- **Fort George Indian Reserve Flood Protection** - Review of flood levels included assessment of flood evaluations due to ice jam, review air photos, erosion hazards, and an investigation and recommendation of flood hazard mitigation measures.
- **Chehalis River Flood Hazard Management Study** - Study of flood hazards and debris flows on the alluvial fan included flood magnitude and potential magnitude of debris flows and debris floods.
- **Chehalis I.R. No. 5 Flood Protection** - Design of flood protection works on Chehalis River included river surveys, hydraulic and sedimentation analysis, dike design, Capital Funding submission, cost estimates, permits, and construction supervision.
- **Official Community Plan Update for the District of Hope** - Compilation and mapping of flooding and erosion hazard data from the Fraser and Coquihalla Rivers, Silverhope Creek, and Kawkawa Lake for updating the Official Community Plan for the District of Hope.
- **Musqueam Creek Outlet Rehabilitation** - Rehabilitation designs for the creek outlet were developed with the objective to improve fish access at all tide levels and mitigate the existing flood hazard.
- **Roberts Bank Foreshore Study** - An air photo analysis was carried out to document historical changes in the tidal flat area in proximity to the BC Ferries Causeway and the Coalport Terminal Causeway. The study was for litigation purposes.
- **Little Qualicum River Bank Protection** - Protection was provided for a large eroding bank adjacent to the groundwater wells for the Town of Qualicum Beach. Project included river survey, design, permits, and construction supervision.
- **Point Grey Foreshore Study** - An historical assessment of Point Grey erosion was provided including a review of regulatory requirements and environmental and hydraulic issues, for the installation and operation of a storm sewer outfall.

jstirling@eba.ca

- **Argenta-Johnson's Landing Watershed Inventory and Hydrologic Assessment** - The results of the assessment carried out by the geomorphologist were used to complete a geohazard assessment of the study area. In turn, the results of the hazard assessment were the basis for the detailed risk assessment.
- **Anderson Creek Terrain Stability and Channel Morphology Assessments** - The location and types of unstable and potentially unstable areas were identified and assessed in detail. A hazard and risk assessment was carried out and priority areas for future works were ranked.
- **Ford Creek Hazard Assessment** - An assessment of geohazards was carried out for a development permit on the lower fan. Potential hazards include flooding, erosion, landslides, debris flows and debris floods.
- **Stave Lake Landslide** - A landslide which occurred on private property deposited material on another property causing damage. An assessment was carried out of the slide to determine the cause of the event and recommend mitigation to reduce the possibility of future events.

HYDROLOGY / HYRAULIC PROJECTS

- **Cominco's Kudz-Ze-Kayah (Tag) Project** - Analysis of extensive climatic and hydrologic data included a new recommended data collection procedure and provided an overview of the site climatology.
- **Cleveland Dam East Abutment Environment Impact Assessment** - Assessments of proposed remedial options for East Abutment repair included analysis of turbidity, sedimentation and fish hatchery water supply.
- **Analysis of Dredge Grade Standards for the Fraser River Deep-Sea Channel** - Calculation of dredge grades for the deep-sea channel on the Fraser River were determined by incorporating tidal data, upstream and downstream vessel transit times, and high and low water profiles.
- **Courtenay River Dredge Grade Analysis** - Dredge grade standards for the lower Courtenay River were derived from backwater curves based on available stage, tidal, and discharge data.
- **Connor Creek Watershed Hydrologic and Geomorphologic Assessment** - A field evaluation to assess potential impacts the development may have on the geomorphic and hydrologic regime. Mitigative measures were recommended to stabilize the area.
- **Report on Historic Streams of Southeast False Creek** - Documented evidence of the existence of natural watercourses in proximity to the study area either in historical or contemporary times.
- **Tibbitt to Contwoyto Seasonal Overland Road, Northwest Territories** - Carried out the necessary engineering, environmental, socioeconomic and archaeological baseline studies, including routes analyses, field investigations, preliminary design, and consultations to support the preparation of the anticipated and necessary regulatory submissions.
- **Colomac Mine Remediation Project** - Freshet monitoring of 11 newly constructed diversion ditches for two tailings lakes. Tasks included flow monitoring, surveying, sump pumping, ditch performance assessment and mitigative recommendations.
- **Snap Lake Grout Curtain** - A 700 m long grout curtain was constructed into bedrock and till along the perimeter of Snap Lake. The purpose of the curtain was to prevent the rock waste pile groundwater from entering the lake.
- **Alaska Highway Culvert Assessment** - An evaluation was carried out of the highway which included an inventory of existing culverts and their hydraulic capacity, including an assessment of highway drainage issues and slope stability concerns. The project included recommended mitigation and construction cost estimates.
- **Fish Road (40 Mile Access Road) Upgrade and Maintenance Repairs** - Recent drainage issues, melting permafrost, flooding and erosion required upgrade and maintenance repairs to a 4 km road accessing the Yukon River near Alaska. The project included assessment, design, construction, and inspection of grade and curve reductions, culvert repairs and replacements, new culverts, increases to finished elevations, and construction of drainage ditches.

jstirling@eba.ca

EMPLOYMENT HISTORY

2010 - Present	Geomorphologist EBA, A Tetra Tech Company Vancouver, BC
2004 - 2010	Geomorphologist Hay & Company Consultants A division of EBA Engineering Consultants Ltd. Vancouver, BC
1996 - 2004	Geomorphologist Hay & Company Consultants Inc. Vancouver, BC

COURSES AND AWARDS

Forest Road Deactivation Course

Advanced Road Deactivation Course

Riparian Management Area Course

Bioengineering Course

River Restoration

Geohazard Assessments

Fish Habitat Rehabilitation Workshop

Landslide Rehabilitation Assessment Procedures

APEGBC Courses and Exams

First Aid and CPR

TECHNICAL PUBLICATIONS AND PRESENTATIONS

Stirling, J.R. 1993. a) Comparison of Tree Species on NE and SW – Facing Slopes on the Wasaga Beach Sand Dunes, Ontario; b) Measurement of Glacial Depths Using Seismic Techniques. Juneau Icefield, Alaska.

Stirling, J.R. 1993-1994. B.A. Honours Thesis: Stratigraphy and Geochemistry of Soils and Palaeosols in a Holocene Chronosequence in the Tarna Glacier Area. Northern Sweden.

Stirling, J.R. 1994-1995. a) Hydrology of an Urbanized Watershed: Evaluation of the Don River Basin, b) Accuracy Analysis of the River Network within the Don River Using the Watershed Basin Program in Grass 4.1, c) Fluvial Geomorphology of the Don River: Evaluation of an Urbanized System.

Stirling, J.R. 1994-1998. M.Sc. Thesis: Channel Morphology and Riffle-Pool Sequences in “Natural” Reaches of an Urbanized Alluvial System, the East Don River. Toronto, ON.

Stirling, J.R. 1999. Conference Presentation and Publication in the Conference Proceedings – Canadian Water Resources Association: BC Branch Annual Conference: Side-Channel Habitat Development using both Ground Water and Surface Flow: The Akolkolex River. Revelstoke, BC.

Stirling, J.R. 1999. Rover Creek Hillslope Rehabilitation in Annual Compendium of Aquatic Rehabilitation Projects for the Watershed Restoration Program 1998-99. WRP Report No. 13.

RESUME James A. Stronach

JAMES A. STRONACH, Ph.D., P.Eng.
Principal and Senior Oceanographer

EDUCATION

Ph.D., Physical Oceanography, University of Waterloo, 1977
M.Sc., Nuclear Physics, University of Saskatchewan, 1972
B.Eng., Engineering Physics, University of Saskatchewan, 1970

AFFILIATIONS

Member, Association of Professional Engineers and Geoscientists of British Columbia
Member, Canadian Meteorological and Oceanographic Society
Member, American Society of Civil Engineers

Dr. Stronach is a physical oceanographer with over 33 years of experience in British Columbia. His principal technical expertise lies in the measurement and modelling of currents and water property distributions in coastal waters. A large part of his professional career has been concerned with the development of numerical modelling techniques, culminating in the development of baroclinic three-dimensional numerical models (GF8, GF9, C3, H3D) to calculate currents, salinity, pollutant and sediment transport in complex waterways. In addition to the direct development of three-dimensional dispersion models, Dr. Stronach has participated in a number of interdisciplinary studies and data analysis projects in the general field of physical oceanography, including the development of models for the continental shelf and offshore regions, and assimilation of satellite data into these models.

Recent areas of investigation include the application of H3D to a wide range of fluid systems, ranging from fish screens, gravity separation vessels, fjords, estuaries, lakes, deep oceans, and the wetlands of south-eastern United States. Dr. Stronach has also developed a modelling system for mine tailings, and a three-dimensional geomorphological transformation model for sand-bed rivers. In addition he has been extensively involved in the oceanographic and engineering aspects of Deep Sea Tailing Placement (DSTP) studies in the last few years. Recent oceanographic projects include the development of a wave-current prediction system for the mouth of the Fraser River, and development of oil spill models for the north coast of British Columbia.

COASTAL OCEANOGRAPHY PROJECTS

- **Gulf of Mexico Shelf Model. University of Louisiana at Lafayette.** Dr. Stronach is acting as an advisor on the application of H3D to flow and sediment transport modelling in the shallow continental shelf of the Gulf of Mexico. The largest freshwater and sediment source is the Mississippi River, but there are several other major distributaries of the Mississippi, such as the Achafalaya River, that play an important role in the region as well. The goal is that this model will provide boundary condition data for several high resolution sub-models of problem areas along the Louisiana Coast.
- **Fraser River Wave-Current Interaction Study, Environment Canada and Fisheries and Oceans Canada.** The Fraser River enters the Strait of Georgia such that currents in the Fraser River plume are oriented perpendicular to the main tidal current direction, and also perpendicular to the main wind and wave directions in the Strait. Consequently, waves and currents in this region have a high degree of spatial variability, and can lead to hazardous navigation situations. Hay & Company is developing a wave prediction scheme, combining currents from H3D and waves computed by the SWAN model, to provide the marine forecast centre of Environment Canada with a 24-hour operational prediction of waves and currents in the vicinity of the river mouth, to be incorporated into the marine forecast.
- **North Coast Oil Spill Model, Enbridge Pipeline Ltd.** Hay & Company has been retained by Enbridge Pipeline Ltd. to develop an oil spill model to determine the potential impact of spills resulting from supertanker traffic carrying petroleum products into and out of Kitimat, BC. The model is based on H3D, and is driven by winds, tides and river flows. It includes a 3 km mesh grid covering the BC coast form Vancouver Island to southeast Alaska, and extending well off the continental shelf. A 400 m grid sub-model of Douglas Channel was embedded within the 3 km model. The resulting model of Douglas

Channel and Kitimat Arm has calibrated very well against historic current meter observations, and surface temperatures agree well with satellite imagery. An innovative aspect of this model was the development of a mass-conserving interpolation scheme for the wind field, so that winds conformed very closely to the configuration of the channels and their associated steep valley walls, an important consideration when advecting surface oil slicks. Oil spills were simulated using Monte Carlo techniques, included weathering aspects, and kept track of shoreline oiling.

- **Baynes Sound Carrying Capacity Study, Comox, BC, Ministry of Agriculture, Food and Fisheries.** Baynes Sound is currently an area of active oyster aquaculture. This study of shellfish carrying capacity consisted of a numerical simulation of circulation in Baynes Sound and Lambert Channel. The principal factors considered for oyster carrying capacity are the availability of food, primarily phytoplankton; the rate of utilization by oysters; and, the rate of waste production. An ecological model embedded in Hay & Company's three-dimensional hydrodynamic model H3D was used to predict the distribution of nutrients, phytoplankton and zooplankton. Another component of the study used the hydrodynamic model to investigate the extent to which tidally-driven upwelling in adjacent Lambert Channel produces an increase in primary production compared to the unmixed water.

- **Lemmens Inlet Carrying Capacity Study, BC, Ministry of Agriculture, Food and Fisheries.** Lemmens Inlet, an area of active oyster aquaculture, is located in Clayoquot Sound which is connected to the Pacific Ocean on the west coast of Vancouver Island. This study of shellfish carrying capacity consisted of a numerical simulation of circulation in Clayoquot Sound and Lemmens Inlet. An ecological model embedded in a three-dimensional hydrodynamic model was used to predict the distribution of nutrients, phytoplankton and zooplankton and to assess the carrying capacity.

- **Semiahmoo Bay Circulation Study, Surrey, BC, Environment Canada.** Shellfish harvesting had been closed within Semiahmoo Bay for many years due to bacteriological contamination. Hay & Company's proprietary three-dimensional hydrodynamic circulation model H3D was applied to the marine waters of Semiahmoo Bay and Drayton Harbour to study the temporal and spatial dispersion of contaminants, in particular fecal coliform bacteria, from identified point sources. The study identified which sources of fecal coliform had the greatest impact on shellfish growing waters.

- **Productive Capacity Study of Gorge Harbour, BC Science Council.** As part of the Fisheries Renewal BC program, Hay & Company conducted fieldwork and numerical modelling to quantify the circulation and water property distributions within Gorge Harbour, a highly-utilized shellfish aquaculture site. A small CTD and ADCP package were used to determine velocity patterns over several tidal cycles and also the spatial variability of temperature, salinity and phytoplankton. Hay & Company's numerical circulation model H3D was used to determine the time-varying current field, which was then used as part of oyster uptake studies conducted by others.

- **Malaspina Inlet - Theodosia Inlet Circulation Studies, BC Ministry of Fish, Food and Agriculture.** This study looked as two issues in Malaspina Inlet. Theodosia Inlet is a small bay connected to Malaspina Inlet. It is proposed to increase the flow in the Theodosia River by modifying a hydro-electric diversion. A small CTD and ADCP package were used to determine velocity patterns over several tidal cycles and also the spatial variability of temperature, salinity and phytoplankton. The CTD observational program extended over an eight-month period, providing a reasonable description of the annual cycle. Hay & Company's model H3D was used to determine the impact on salinity distributions and on the frequency and severity of ice-forming events, both of which were thought to have major impact on oyster aquaculture in Theodosia Inlet. Preliminary findings are that the large tidal flushing that Theodosia experiences ameliorates the impact of any potential changes in freshwater input, so that these changes will have essentially imperceptible impacts. Another component of the study was to determine current patterns and water property distributions in Trevenen Bay, in order to conduct a carrying capacity study similar to the one done previously for Gorge Harbour.

- **PacRim LNG, Kitimat, BC, Bechtel Canada Inc.** The PacRim LNG project includes a liquefied natural gas plant at Bish Creek on Kitimat Arm. Hay & Company undertook studies in aid of navigation and of construction of the port facilities. A 3-D, baroclinic model of Kitimat Arm, Douglas Channel, and the remainder of the inlet system was developed. The model determined currents under various tidal and wind conditions. In addition, storm surge and tsunami were propagated from open water into the complex network of channels and inlets using the model. Wave hindcasting was undertaken using winds from two shore-based stations. Waves were generated and statistics undertaken to develop significant wave heights/versus

jstronach@eba.ca

return period relationship. Waves were then transformed to site using a refraction program. Design wave and wave setup were then determined.

LIMNOLOGY PROJECTS

- **Okanagan Lake Limnology Study, City of Kelowna.** In 1996, the City of Kelowna experienced an outbreak of Cryptosporidium. It was hypothesized that the Cryptosporidium originated from local creeks and were carried to the domestic water intakes by lake currents including wind driven surface currents and littoral currents. Hay & Company developed a three-dimensional computer model for the entire lake, which included thermal flux at the lake surface and the development of the thermocline during the spring. The model was calibrated to existing field measured temperature profiles and verified against field profiles collected during the study.

- **Red Lake Dispersion Study, Placer Dome, Campbell Mine.** Hay & Company used a three-dimensional hydrodynamic model, H3D, to approach a problem of contaminant dispersion in Red Lake, ON. The problem involved the prediction of arsenic plume dispersion from groundwater into a small bay in the lake, and the exchange between the bay and the rest of the lake. The exchange flow was investigated for a full seasonal cycle, including winter months when ice cover is present and wind cannot induce circulation or mixing in the lake. Predictions of the contaminant concentration within the bay and greater Red Lake were made in response to wind and river forcing.

- **Lake Calcasieu/Sabine Lake Model, University of Southern Louisiana.** The Civil Engineering Department of the University of Louisiana contracted Hay & Company to provide code and support for Hay & Company's three-dimensional model H3D, for application to Lake Calcasieu and Sabine Lake, and the interconnecting wetlands. The model will be used for oil spill risk analysis, and a number of ecological studies on behalf of the State of Louisiana.

- **Comox Lake and Puntledge River Temperature Modelling Study, Comox, BC, Fisheries and Oceans Canada.** A cold lake water withdrawal from Comox Lake is an option to reduce Puntledge River temperatures in the summer months, in order to enhance fish habitat in the river. The three-dimensional hydrodynamic model H3D was used in two applications. The first investigated lake dynamics and the mixing of cold lake water with BC Hydro releases. The second predicted the subsequent attenuation of mixed water temperatures downstream in the Puntledge River. To facilitate the numerical modelling of the river, the H3D grid was made to conform to the approximate river slope, and a separate body force was applied, to emulate the downstream slope of the river.

- **Central Packwood Lake, Trans Alta Utility.** Transalta Utilities Company (TAU) operates a coal mine near Centralia, WA, will reach the end of its life in 2007. At that time, TAU will reclaim the site. The reclamation plan includes allowing the mine pit to fill with water and become a lake. Hay & Company simulated the physical characteristics of the lake as it filled over an eleven year period, as well as the post-filling operation of the lake, using the three-dimensional model H3D. The model predicted temperature and dissolved solids distributions, and was able to demonstrate that the lake would undergo an annual overturning, alleviating water quality concerns. To provide credibility to these calculations, the model was first validated by hindcasting the annual temperature cycle in Whatcom Lake, a nearby natural lake of similar depth.

- **Summerland water intake feasibility study, District of Summerland.** The District of Summerland is considering the installation of a water intake in Okanagan Lake to reduce its reliance on Trout Creek source and to provide improved water quality. Currently two nearby inflows, the Summerland wastewater treatment plant and Trout Creek, present potential risk to the proposed water intake. A three-dimensional hydrodynamic numerical model is used to simulate the movement of water and tracers from each of the above noted inflows in Okanagan Lake to assist in assessing the viability of the proposed intake location. The model is constructed in a double-nested configuration consisting of a 500 m grid model of the entire Okanagan Lake and a 100 m grid model for the southern end of the lake. The 500 m grid model provides boundary conditions for the embedded fine-grid model. Both models incorporate Trout Creek, the Summerland wastewater treatment plant flow, and the proposed water intake, as well as other naturally occurring features and forcing in the lake. Simulations were carried and the 95-percentile contaminant concentration in each cell was determined and contoured to assist with the selection of the optimal depth for the water intake.

jstronach@eba.ca

FLUID MECHANICS PROJECTS

- **Primary Separation Vessel Design Optimization, Muskeg River Consultants.** Hay & Company was engaged to conduct a number simulation of the proposed primary separation vessel for the Muskeg River Oil Sands Project. Various elements of the design related to geometry and flow distribution were examined, and an optimum design determined, which should have the potential to reduce construction costs as well as reduce bitumen losses by about 50%.

- **Separation Cell 6 Investigation, Suncor Energy Ltd.** Hay & Company was engaged to review the operational characteristics of a separation vessel, which depends on both buoyancy-driven convection as well as settling of sediment to effect the extraction of bitumen. The study involved a review of plant operations and the hydraulic behaviour of the supply mechanisms, as well as a numerical model of circulation within the cell.

RIVERS PROJECTS

- **Fraser River Sedimentation Model, Fraser River Port Authority.** The Fraser River Port Authority engaged Hay & Company to develop a numerical model of sediment dynamics for the lower Fraser River. The model includes the effect of the salt wedge, and computes the changing patterns of scour and deposition through one or more freshet cycles. Model output will be used to assess the impact of structures on channel bathymetry, and to assist with the design of dredging plans. Model development has proceeded through a feasibility study, and a calibration/validation phase, and is now being used to assist with designing dredging programs.

- **North Arm Sedimentation Study, Golder & Associates.** In order to assess a number of options for capping a contaminated sediment region of the North Arm of the Fraser River, Hay & Company's three-dimensional model H3D was used to compute the scour and deposition patterns associated with alternate proposed structures.

- **Fraser River High Water Study, Fraser River Port Authority.** The Fraser River Port Authority engaged Hay & Company to review the changes in high water levels which have resulted from the inception of heavy dredging in the early 1970s and the significant reduction that has take place since the mid-1990s. Observed water levels at New Westminster and Whonnock were reviewed, and the de-tided peak water level for each year related to the magnitude of the freshet that year, and to whether or not the year was in a period of large or small dredging. A relatively strong correlation was found, and this statistical approach was confirmed using a one-dimensional model of the river, and bathymetry, which reflected either the present channel, or else the present channel after the infill which would result from a cessation of dredging. The numerical model confirmed the magnitude of effects noted in the statistical analysis.

- **Mississippi River Flow and Sediment Transport Modelling, University of Louisiana at Lafayette.** Dr. Stronach is acting as an advisor on the application of H3D to flow and sediment transport modelling in the lower Mississippi River. Flow modelling is of interest for oil spill modelling requirements. Sediment transport modelling is part of a large study being conducted by Federal and State agencies into the management of coastal erosion along the Gulf Coast. H3D has been augmented to allow for a curvilinear coordinate system and non-hydrostatic dynamics, to accommodate the multiple S-bend curves and associated secondary flows in the river. The sediment modelling has been calibrated against the fate of a temporary sill installed in the lower river as a salinity barrier, and has won acceptance by the Corps of Engineers.

MARINE TAILING PLACEMENT PROJECTS

- **Simberi Gold Mine, Papua New Guinea, Allied Gold, Australia** - EBA was retained, over several years, to develop feasibility studies and then detailed design, as the project evolved. In November 2007, the studies were completed when EBA staff conducted the site inspection of the installation of the 550 m long line, terminating at 130 m depth.

- **Goro Nickel, New Caledonia, INCO Management, Australia.** Hay & Company has been retained to develop the detailed engineering designs for a 5 km marine outfall and diffuser for the Goro Nickel plant, presently under construction. Preliminary hydraulic and engineering designs done by others are being reviewed and refined, and a detailed construction plan, detailed drawings and procurement and tender documents will be produced in early 2006.

- **Nalunaq DSTP Study, Kvaerner Engineering & Construction UK Ltd.** Hay & Company has conducted the engineering and oceanographic studies for a Bankable Feasibility Assessment of the Nalanaq gold mine DSTP system. This

jstronach@eba.ca

development proposes to discharge tails to Saqqaa Fiord in Greenland and faces the challenges of the seasonal variability in water column stratification and circulation as well as those associated with ice cover and ice bergs. Hay & Company's three-dimensional circulation model, H3D, was used to successfully simulate the three-dimensional tidal, wind–driven and density-driven circulation in Saqqaa fjord, which involved a major annual influx of water off the shelf. The model was then used to simulate the fate of liquid and fine sediment given off as part of the tailings placement process.

- **Moa Nickel S.A., Cuba, Sherritt International Corporation/MOA Nickel S.A.** Hay & Company is currently conducting a study of the environmental and engineering feasibility of using deep-sea disposal to manage tailings from Sherritt's nickel mine at Cayo Moa, Cuba. The project would involve transporting mine tailings to the coast as slurry, which would then be carried by a pipe installed on the seafloor to a depth of about 150 m. This project has extended over several years, and has a detailed bathymetric survey using multi-beam technology, a year-long field program of CTD, wind and ADCP (current) measurements, bottom sediment chemistry and fisheries surveys. Hay & Company's three-dimensional circulation model, H3D, has been used to investigate the fate of deep sea placement of tailings and waste water, as well as to demonstrate the impact of continuing the present operation, involving discharge of acidic waste water into the Moa River, and the potential improvements obtained by an engineered discharge into the Moa Lagoon.

- **Moneo Nickel and Cobalt Project, New Caledonia, Moneo Metals Ltd.** Hay & Company was engaged to assess the feasibility of Deep Sea Tailing Placement (DSTP) for a proposed nickel laterite project in New Caledonia. A significant factor in the design is that the tailing pipeline must cross 13 km of lagoon before it exits to deep water through a pass in the fringing reef. In addition to the engineering analysis of the pipeline system, Hay & Company developed wave and current models to determine design criteria with respect to the passage of hurricanes over the lagoon, which is in a strong hurricane belt on the tropical Pacific Ocean. H3D was used to compute hurricane-driven current in the lagoon and reef passes in response to a 200-year synthetic hurricane event, and the SWAN model was use to generate the corresponding wave field. The output from these models was used to provide design criteria for the concrete weighting required to keep the pipeline stationary in the event of a 200-year hurricane.

- **Ramu Nickel Marine Tailings Disposal Feasibility Study, Papua, New Guinea, Flour Daniel - H.A. Simons Joint Venture.** Hay & Company was retained by Flour Daniel - H.A. Simons Joint Venture to undertake the feasibility study for deep marine tailing disposal for the Ramu Nickel Mine in Papua, New Guinea. Hay & Company directed laboratory work on the tailings, hydraulic design of the tailings outfall system including the on-land pipeline from the plant to tidewater, carried out oceanographic studies and modelled the descending effluent plume using a detailed three-dimensional model, driven on its boundary by data from the US Navy's operational global oceanographic model.

- **Asia Pacific Nickel Project, Gag Island, Indonesia, H.A. Simons.** Hay & Company was engaged to assess the feasibility of submarine tailings disposal for a proposed nickel laterite project in Indonesia. Of particular interest is the fate of tailings disposal in the marine environment, given that land constraints precluded the use of on-land disposal. An extensive bathymetric survey found the basis of a three-dimensional hydrodynamic model of the oceans surrounding the island, driven on its boundary by data from the US Navy's operational global oceanographic model. A number of proposed alignments for the pipeline and outfall were assessed in terms of the tailings footprint when modelled as a density current.

- **Marcopper Tailings Discharge, Marinduque Island, Philippines, Placer Dome Inc.** A detailed river and estuary hydraulics study was undertaken to assess options for remediating the tailing spill at Marcopper. A dredge cut in the river was proposed to act as a sediment trap. Detailed plans for the dredge cut were prepared, along with specifications and preliminary environmental impacts. Of particular interest was the implementation of a three-dimensional model to assess the fate of the fine tailings fraction once it discharged into Tablas Strait.

MISCELLANEOUS APPLICATIONS

- **Cable Oil Leaks, BC, BC Hydro.** An evaluation of the fate of oil leaking from BC Hydro submarine lines was conducted out, using standard engineering principles of two-phase flow to model the rise of escaping oil bubbles through the water column, and H3D to model the fate of the resulting surface slick.

- **Chemical Spill Hazard Analysis, Tilbury Terminal, Fraser River, CP Rail.** Hay & Company developed a one-dimensional tidal model for the lower Fraser River, integrated with a Monte Carlo contaminant transport/diffusion model to develop scenarios of the extent of contamination resulting from a spill at CP Rail's truck and rail-car loading facility on Tilbury Island.
- **CANSARP Software Upgrade, Ottawa, ON, ASA Consulting Limited.** Specialist subconsulting services for the CANSARP and SAR operations systems were provided.
- **3-D Kinematic Model of Forebay, Chelan County, Washington State, Chelan County Public Utility District.** Chelan County PUD has constructed a surface fish bypass system consisting of a surface flow withdrawal augmented by internal structures to locally modify the flow field. The system makes use of the preference of migrating salon and steelhead trout for the upper 50 feet of the water column. The design of the flow modification structures has relied in the past on physical modelling. A numerical technique was developed to produce a fully 3-D flow field from a sparse grid of velocity measurements in the physical model. Using this model, the impact of various structural modifications on the flow field can be readily calculated and presented using a number of flow visualization techniques.
- **Gold River Plume Delineation, Gold River, BC, Avenor Inc.** Hay & Company were engaged to design and implement a rhodamine dye study to determine the 1% and 5% dilution limits for Avenor's Gold River effluent diffuser.
- **Cleveland Dam East Abutment EIA, Vancouver, BC, Hatfield Consultants Ltd./Greater Vancouver Regional District.** As part of a multi-disciplinary team, Hay & Company provided assessments of the impacts of proposed remedial options for repair of the East Abutment (on reservoir turbidity, sedimentation, sediment production and fish hatchery water supply).

PROJECTS UNDERTAKEN AT SEACONSULT, 1988 TO 1996

- Tasmania Department of Environment. Implementation of a three-dimensional numerical model (C3) for Macquarrie harbour in Tasmania to compute the fate of mine tailings and acid mine drainage discharge to the King River.
- Capital Regional District, Victoria, BC. Development of a high-resolution (200 m grid) 3-D contaminant fate model based on GF8 for municipal discharges from the Capital Regional District's main outfalls on the south coast of Vancouver Island.
- Capital Regional District, Victoria, BC. Development of a high-resolution (167 m grid) 3-D containment fate model based on GF8 for municipal discharges into Ganges Harbour.
- Canadian Navy, METOC Esquimalt. Review of numerical models and assimilation schemes appropriate to a regional high-resolution numerical model.
- Canadian Navy, METOC Esquimalt. Preliminary implementation of an interface between the US Navy's global ocean model and the Princeton Ocean Model to be applied to the west coast of North America.
- Department of Fisheries and Oceans. Development of 2 km and 5 km grid baroclinic models (GF8) for the Gulf of St. Lawrence and St. Lawrence Estuary. These are now the fundamental modelling tools used at Institute Maurice Lamontagne, Rimouski.
- Canadian Coast Guard/Department of Fisheries and Oceans. Application of GF8 to the Gulf of St. Lawrence in support of predictive search and rescue planning.
- Canadian Coast Guard. Technical advisor for the initial development of CANSARP V3; project manager and technical adviser for the implementation of CANSARP V3.2, the latest upgrade.
- Canadian Coast Guard. Project manager for the design and implementation of the CANSARP/ECDIS interface and demonstration using an Offshore Systems Limited ECPINS System.
- Canadian Coast Guard. Project manager and principal investigator for an examination of the impact of real-time drifter buoy data on CANSARP drift predictions.
- Canadian Coast Guard. Demonstration of the accuracy of GF9 current forecasts in the Strait of Georgia through a hindcast of Bob Lord's drift path after falling from a BC ferry on July 25, 1993.

jstronach@eba.ca

- Trans-Mountain Pipe Lines/Dames & Moore. Application of the GF8 Strait of Juan de Fuca - Georgia Strait - Puget Sound modelling system to provide currents for oil spill predictions for the proposed Low Point loading terminal.
- Beak Consultants/Department of Fisheries and Oceans. Development of a high resolution hydrodynamic model of Howe Sound, and a sediment transport model to predict deposition rates for the Squamish River.
- MacMillan Bloedel Ltd., Powell River, BC. Development of a three-dimensional transport-diffusion model to predict the long-term fate of effluent from a submerged outfall.
- Department of Fisheries and Oceans, Nanaimo Biological Station, BC. Development of an ecological model to simulate primary and secondary production throughout the Georgia-Fuca system over a multi-year period.
- Department of Fisheries and Oceans. Development of a temperature prediction model, to accompany the three-dimensional hydrodynamic model GF9.
- Department of Fisheries and Oceans. Development of numerical models to predict surface currents in Barkley Sound in support of salmon migration studies.
- Department of Fisheries & Oceans. Statistical analysis of the relationship between plant and zooplankton communities and submergence at disturbed, compensation and natural beaches along the Lower Fraser River.
- Department of Fisheries and Oceans. Upgrading existing and developing new three-dimensional numerical models of circulation in the Straits of Georgia and Juan de Fuca. This was a major project funded under the Unsolicited Proposals Program, and resulted in the development of GF8 and GF9.
- U.S. Navy. Numerical modelling of surface currents in the southern Strait of Georgia in support of torpedo tracking studies.

PROJECTS UNDERTAKEN AT PACIFIC OCEAN SCIENCES, 1984 TO 1988

- Canadian Coast Guard. Development of a PC-based interactive search and rescue planning system (DRIFTCALC) for the Straits of Georgia and Juan de Fuca.
- Department of Fisheries and Oceans. Study of the numerical prediction of wind generated waves in the coastal sea between the Queen Charlotte Islands and the mainland of British Columbia, with particular emphasis on wave-current interactions.
- Canadian Hydrographic Service. Development of a microcomputer based tidal current display system for the Straits of Georgia and Juan de Fuca.
- Department of Fisheries and Oceans. Graphical presentation and analysis of oceanographic data, Strait of Georgia, based on unpublished archival material.
- Department of Fisheries and Oceans. Analysis of tidal elevations and currents in the Northwest Passage, based on all data collected between 1977 and 1985.
- Egyptian General Petroleum Corporation. Participation in the development of an oil spill contingency plan. Provided current models for oil spill scenario development, including a sensitivity mapping system.
- Thailand National Environmental Board. Participated in the development of a hazard wastes contingency plan. Provided current models for hazardous spill scenario development. Provided a sensitivity mapping system.
- Université du Québec à Rimouski. Supervisory assistance for numerical modelling students.

PROJECTS UNDERTAKEN WHILE WITH BEAK CONSULTANTS, 1979 TO 1984

- Department of Fisheries and Oceans. Project management and oceanographic components for a study of the feasibility of enhancing pink salmon production by applying fertilizer to the Yakoun Estuary.
- Department of Fisheries and Oceans. Analysis of residual and tidal currents derived from numerical models of the Juan de Fuca - Georgia system and the development of predictive numerical tidal models of successively finer spatial resolution.

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- Department of Fisheries and Oceans. Development of a predictive numerical model of the upper layer of the Strait of Georgia, involving an extensive drogue tracking program as well as calibration and verification of the numerical model.
- Public Works Canada. Member of a group which provided an assessment of the impact of channel modifications (training walls) on the dynamics of the lower Fraser River, in terms of flows, water levels and sedimentation.
- BC Hydro. Member of a team assessing the impact of flow regulation on the Stikine delta and flood plain. Responsible for addressing concerns with respect to altered salinity penetration, altered temperature regime, reduced sediment supply (and hence potential erosion), and altered regimes of water level on the flood plain.
- Petroleos de Venezuela. Participated in developing an oil spill contingency plan for coastal Venezuela, including installation of current meters and subsequent interpretation of data; CTD survey of Lake Maracaibo; assessment of short term fate of spilled oil.

EMPLOYMENT HISTORY

2004 - Present	Principal/Senior Oceanographer Hay & Company Consultants, a Division of EBA Engineering Consultants Ltd. Vancouver, BC
1997 - 2004	Principal/Senior Oceanographer Hay & Company Consultants Inc. Vancouver, BC
1988 - 1996	Senior Oceanographer Seaconsult Marine Research Ltd. Vancouver, BC
1984 - 1988	Principal Pacific Ocean Sciences Ltd. Burnaby, BC
1979 - 1984	Oceanographer Beak Consultants Vancouver, BC

AWARDS

CMOS	Canadian Meteorological and Oceanographic Society, CMOS prize in applied oceanography for 2005 for outstanding contribution to the application of oceanography in Canada.

TECHNICAL PUBLICATIONS AND PRESENTATIONS

Stronach, J.A. 1977. Observational and modelling studies of the Fraser River plume. Ph.D. thesis. Univ. of BC. Vancouver, BC.

Stronach, J.A. 1981. The Fraser River plume, Strait of Georgia. Ocean Management. V. 6. pp 201-221.

Crean, P.B., J.A. Stronach and T.S. Murty. 1988. Salt and fresh water exchange on Roberts Bank, British Columbia. Water Poll. Res. J. Can. V. 23. pp 160-178.

Stronach, J.A., P.B. Crean and T.S. Murty. 1988. Mathematical modelling of the Fraser River plume. Water Poll. Res. J. Can. V. 23. pp 179-212.

Crean, P.B., T.S. Murty and J.A. Stronach. 1988. Numerical simulation of oceanographic processes in the waters between Vancouver Island and the mainland. Oceanogr. Mar. Biol. Annu. Rev. V. 26. pp 11-142.

Crean, P.B., T.S. Murty and J.A. Stronach. 1988. Mathematical Modelling of Tides and Estuarine Circulation. The Coastal Seas of Southern British Columbia and Washington State. Springer-Verlag. 471 pp.

Stronach, J.A. and T.S. Murty. 1989. Importance of the L2 tide in the Straits of Georgia and Juan de Fuca. Marine Geodesy. V 13, pp 61-66.

Murty, T.S. and J.A. Stronach. 1989. State of tide and tsunami threat to the Pacific coast of Canada. Int. J. Nat. Hazards. V. 2. pp 83-86.

Stronach, J.A., C.R. Murthy and T.S. Murty. 1991. Pollutant transport modelling in large river plumes. Proc. 2nd Estuarine and Coastal Modelling Conference. Tampa Ed. M.L. Spaulding, K. Bedford, A. Blumberg, R. Cheng and C. Swanson. ASCE. pp 759-770.

Stronach, J.A., T.S. Murty. 1989. Non-linear river-tidal interaction in the Fraser River, Canada. Marine Geodesy. V. 13. pp 313-339.

Stronach, J.A., J.O. Backhaus and T.S. Murty. 1993. An update on the numerical simulation of oceanographic processes in the waters between Vancouver Island and the mainland: the GF8 model. Oceanogr. Mar. Biol. Ann. Rev. V. 31. pp 1-87.

Stronach, J.A., A.J. Webb. T.S. Murty and W.J. Cretney. 1993. A three-dimensional numerical model of suspended sediment transport in Howe Sound, British Columbia. Atmos. Ocean. V. 31. pp 73-97.

St. John, M.A., S.G. Marinone, J. Stronach P.J. Harrison, J. Fyfe and R.J. Beamish. 1993. A horizontally resolving physical-biological model of nitrate concentration and primary productivity in the Strait of Georgia. Can. J. Fish. Aquat. Sci. V. 50 pp 1456-1466.

Stronach, J.A., S.R.M. Gardiner, Y. Zhang and W.S. Schriek. 1999. Submarine Mine Tailings Fate. Can. J. Chem. Eng. V. 78. pp 770-779.

Stronach, J.A., Y. Zhang, S.R.M. Gardiner and W.S. Schriek. 1999. Numerical simulation of submarine density currents. Proc. of 1999 Canadian Coastal Conference. Victoria, BC. pp 809-821.

Stronach, J.A., S.R.M. Gardiner, R.P. Mulligan, R.E. Draho. 2001. Limnology of Lake Okanagan. Proc. of 15th Hydrotechnical Conference. Can. Soc. Civ. Eng. Victoria, BC.

jstronach@eba.ca

RESUME Shawneen Walker

Shawneen Walker, B.Sc., EP, BIT

Biologist, Environmental Scientist

- **12 YEARS OF EXPERIENCE**

Ms. Walker is a Biologist & Environmental Scientist with the Environment Practice in EBA, a Tetra Tech Company. She has seven years of consulting experience in both biology and contaminated sites, as well as five years of experience as a naturalist/environmental educator.

Ms. Walker has worked in BC, Alberta, Saskatchewan, Yukon, NWT, Minnesota and Georgia. Her projects have involved oil and gas, forestry, mining and property development industries as well as all levels of government.

RELEVANT EXPERIENCE

Some highlights of Ms. Walker's relevant natural science experience includes the following:

- Environmental Assessments and Biological Inventories in a variety of habitats in Coastal and north eastern BC, Alberta, NWT and Yukon.
- Canadian Environmental Assessment Act (CEAA) Screenings, including background research, field reconnaissance, Responsible Authority liaison and report submission
- Riparian Area Regulation (RAR) Assessments
- Wildlife management and surveys, including: aerial ungulate surveys, black bear management planning, bird banding for migration studies, breeding bird surveys and nocturnal raptor surveys
- Wildlife inventories and habitat assessments, including identification of sensitive habitats and significant habitat features such as mineral licks
- Ecological mapping and identification of flora and fauna in a variety of environments, including species at risk
- Environmental and Socio-Economic Impact Assessment for a National Energy Board application for inter-provincial pipeline
- Fish Habitat and Stream assessments, including fish sampling (electrofishing, beach seining, gill netting and minnow trapping), benthic invertebrate sampling, stream classification, channel mapping and stream flow measurements
- Surface water sampling for water quality assessments
- Erosion and sediment control planning and monitoring
- Recreational planning for trail systems and public use areas within a Saskatchewan Provincial Park and a Nature Preserve in Georgia
- Environmental monitoring for various projects, including property development, infrastructure installation, watercourse crossings and construction
- Special Use Permit deletion for forestry sites
- Sediment sampling, including planning and communication for Environment Canada's "Disposal At Sea" program
- Experience coordinating and conducting projects in remote locations (ATV, boat, float plane and helicopter access)

EDUCATION

B.Sc., Environmental Studies and Biology, Augustana University College, Camrose, AB

Diploma, Biological Sciences and Renewable Resources, Northern Alberta Institute of Technology, Edmonton, AB

SUMMARY OF EXPERIENCE

Environmental Assessments and Biological Inventories

CEAA Screenings

Environmental Monitoring

Erosion and Sediment Control Plans and Monitoring

AFFILIATIONS

Member in Training, Association of Professional Biologists of British Columbia (APBBC)

Member in Training, Canadian Environmental Certification Approvals Board (CECAB)

Member, Building Environmental Aboriginal Human Resources (BEHAR) Canada

Member, Society for Conservation Biology

Member, The Canadian Society of Environmental Biologists

TRAINING/CERTIFICATION

Fish Habitat Restoration

Electrofishing Supervisor

Erosion & Sediment Control Techniques

Construction Monitoring

CEAA Screening & RAR Assessment