

APPENDIX B

Curricula Vitae

Richard W. Browne, M.A.Sc., P.Eng.

SENIOR VICE PRESIDENT

EDUCATION

M.A.Sc., Geo-Environmental Engineering, University of Waterloo, 1988
B.Sc., Geological Engineering, Queen's University, Kingston, 1978
Deterioration and Failure of Concrete Structures, University of Toronto, 1989

PROFESSIONAL AFFILIATIONS

Professional Engineers of Ontario
Canadian Geotechnical Society
Canadian Dam Association

EXPERIENCE

1993-present — Decommissioning Consulting Services Limited

1993-2002 *General Manager, Engineering Services*
2002 – Present *Senior Vice President*

Mr. Browne is the Senior Vice President at DCS and has a background in geotechnical and environmental engineering. He is involved in a wide range of projects including subsurface contamination investigations; geotechnical site investigations; development, design and supervision of site remediation programs and in the geotechnical analyses and foundation engineering for site remediation, property redevelopment, and mine closure projects. He has been the project manager for the following projects.

Completed geotechnical engineering design, technical specifications and oversaw construction supervision of a geosynthetic clay liner waste rock and ore containment pad. Work was completed for FNX Mining Limited at a former Inco Mine site near Sudbury, Ontario.

Completed a geotechnical review of the proposed alignment of a 500 kV electrical transmission line leading from the Bruce Nuclear facility to Toronto, Ontario, as part of the overall Environmental Assessment process. The review focussed on selection of the most appropriate alignment for the crossing of an environmentally sensitive wetland area. Due to the sloping terrain, as well as potential environmental impacts of construction equipment, transmission tower locations and spacing were of particular importance.

Completed a combined geotechnical/environmental investigation for Toronto Hydro Services Inc. for the construction of a methane electrical generation facility. Up to seven electrical units are to be installed to operate on

methane gas recovered from the adjacent Ashbridges Bay Treatment Plant which is located on the City of Toronto Waterfront. Recommendations were provided for deep foundations to support the proposed building and units.

Oversaw the design and construction supervision work for the waste rock and ore containment pad for the FNX Dynatec McCreedy West Mine in Levack, Ontario. The program involved installation of a Bentofix® liner system throughout the facility and design of access ramps and an emergency spillway.

Carried out site reconnaissance and oversaw geotechnical investigation work for the Hollinger Mines historic tailings area in Timmins, Ontario. Prepared conceptual and preliminary designs for dyke and outfall structure to be constructed to control discharges from the pond during submergence of tailings and waste rock for the purposes of closure of the area.

Completed geotechnical investigation at the Hydro One Richview Transformer Station in Toronto, Ontario. Prepared geotechnical recommendations to resolve differential settlement of switchgear equipment supported by shallow foundations at locations throughout the station.

Co-ordinated the investigation of an abandoned dry stack tailings basin, 150 km northwest of Thunder Bay, Ontario. Investigated groundwater quality in the underlying overburden and bedrock in preparation for development of a tailings basin closure plan. Reviewed condition of existing earth structures and suitability of local soils for use as a partial surface cover for the tailings area. Developed detailed drawings and specifications for closure plan construction involving modifications to tailings dam and realignment of MTO tertiary Highway N^o 802.

Completed investigation into cause of periodic local subsidence of a high school football field. Developed design drawings and specifications to construct a geotextile and geogrid reinforced cap over affected area of field, which was underlain by more than 125 partially open, 90 m deep boreholes previously installed for a non-functioning geothermal building heat pump system.

Provided senior engineering review and co-ordination to the investigation of 17 Phase II ESA's of Hydro One distribution station sites throughout southern Ontario. This included review of work plans, final site investigation reports and proposed site remediation plans, specifications and risk analyses.

Completed detailed environmental investigations of University of Toronto lands surrounding a former municipal landfill site in the Scarborough area of Toronto, Ontario. Completed assessment of soil and groundwater impacts, as well as, potential concerns associated with landfill gas migration and generation. Presented environmental concerns and solutions at public meetings and to City

officials. Work was completed to obtain approvals for redevelopment of land within potential zone of influence of the landfill.

Completed the hydrogeological investigation and decommissioning design for a 29 m deep, 1.2 m diameter, hand-dug well, which had been impacted by arsenic-contaminated surficial soil associated with an adjacent electrical transformer site. The program included completion of a series of deep boreholes, development of specifications for the decommissioning of the well and on-site environmental supervision of the well closure

Carried out a review of surface water drainage and groundwater contamination concerns at four transformer sites in Ontario. Provided recommendations to improve site drainage and control potential contaminant migration.

Completed geotechnical investigation of a building lot within a historical infilled gully along the west bank of the Humber River, Toronto, Ontario. Provided geotechnical recommendations and construction supervision of a deep engineered fill foundation system, provided with underdrainage, to support estate home.

Project director for review of spill containment liner options available to Hydro One for their transformer station facilities. Provided geotechnical and environmental assistance to Hydro One on proposed drainage improvement measures to more than 10 transformer stations.

Project Manager for the geotechnical and environmental investigation of the proposed extension of Basin Street in the Port Industrial Area of Toronto for TEDCO. Evaluated anticipated settlement of proposed fill to be placed along the alignment, due to consolidation of the underlying 3 m-thick peat layer. Prepared technical specification for preloading of portions of the route and placement of engineered fill.

Project Manager for the cleanup of an industrial plant site in Etobicoke slated for residential redevelopment. Completed a geotechnical investigation of the site and provided engineering recommendations and construction supervision for a property boundary retaining wall system and deep engineered fill foundations to support 44 luxury townhouses.

Co-ordinated the geotechnical investigation of a proposed residential development site along the crest of the Humber River Valley in Bolton, Ontario. Completed stability analyses of the 20 to 30 m high valley slope and prepared an engineering report to support the proposed development at an Ontario Municipal Board hearing.

Reviewed stability analyses of natural and fill slopes along West Rainbow Creek in the City of Vaughan to support closure plan for the redevelopment of former landfill.

Project Manager for the investigation of the environmental impact of an historic landfill site located in the Rouge River Valley in Markham, Ontario. Investigated soil and groundwater contamination, landfill waste composition and reviewed the geotechnical stability of the fill and natural slopes. Prepared a closure plan for the site for submittal with an application under EPA Section 46.

1978-1993 Geocon (SNC-Lavalin), Toronto, Ontario

General Manager - Ontario - 1991-1993

Geotechnical route and structure investigations for 20 km section of proposed Highway 416 leading to Ottawa. Route evaluation for proposed expressways linking Highway 401 to proposed Highway 407 in Whitby area.

Geo-environmental investigation of heavy metal soil contamination of military rocket range stop butts at CFB Chilliwack, B.C., and CFB Valcartier, Quebec.

Geotechnical/geo-environmental investigation for major expansion of the Humber Sewage Treatment Plant.

Geotechnical investigation of a proposed oil storage tank farm on soft sediments in Hamilton Harbour. The program included detailed settlement analyses and slope indicator and pneumatic piezometer monitoring of the stability of the structure during filling of the tanks.

Senior Project Engineer - 1978-1990

Concrete gravity and earth dam stability review and remediation design, Abitibi Price, Iroquois Falls, Ontario.

High tensile steel anchor installation at above sites as well as Burt Dam in northern New York, U.S.A.

Geotechnical investigations for repair or replacement of more than 25 large diameter petroleum storage tanks at Petro-Canada Refinery, Clarkson, Ontario.

Geotechnical engineer for construction of infrastructure for the redevelopment of the Marathon Realty Limited, Southtown Railway lands in downtown Toronto.

Geotechnical investigation for new woodroom and portal crane to be founded on 20 m of compressible clays in northern Ontario paper mill site.

Environmental and geotechnical site investigation of 19 ha of downtown Toronto industrial land, within the Ataratiri site, slated for residential redevelopment.

Geotechnical investigations and construction supervision for the Sky Dome facilities, including caisson installation and spread footings on shale.

Field investigation and tailings basin location selection for an open pit graphite mine, Huntsville, Ontario.

Supervised grouting and refacing repairs to 57-year old Island Falls hydroelectric dam and powerhouse on Churchill River for Saskatchewan Power Corp.

Investigation of 60 m-high masonry irrigation dam in central Honduras including diamond drilling, packer testing and grouting trials.

Supervision of multi-stage cement grouting for low permeability grout curtain for 40 m-high tailings dam for the Noranda Hemlo gold mine site.

Project engineer for 65 borehole geotechnical investigation of proposed Hydrogen Peroxide plant to be constructed for Dupont at Maitland, Ontario.

Carried out geotechnical investigations of four proposed GO ALRT light rail transit lines in the Toronto area.

Investigation, rehabilitation, design and construction supervision to arrest uncontrolled erosion of a sand and gravel pit near Gravenhurst, Ontario, for the M.N.R.

Investigation of condition and stability of six hydroelectric dams in northern Ontario and Newfoundland including evaluation of alkali-reactive aggregate potential.

Supervised marine operations of sea floor drilling system for proposed hydroelectric transmission line crossing of Strait of Belle Isle between Newfoundland and Labrador.

Geotechnical/hydrogeological investigations for a fine coal waste tailings dam near Sydney, Nova Scotia, and a uranium mine tailings area in northern Labrador.

Supervised pile load test program and installation of 944 steel tube piles for settlement-sensitive paper machine at Abitibi Price mill in northern Ontario.

Supervised geotechnical drilling operations at proposed production well facilities on the Grand Banks, Newfoundland, 300 km offshore of St. John's.

Arctic field investigations for liquified natural gas terminal on Melville Island, N.W.T., and for artificial islands in the Mackenzie River at Norman Wells, N.W.T.

Field supervision of slope stability and piezometric monitoring of 45 m-high, 4 km-long, open pit tarsands mine in Fort McMurray, Alberta, for Syncrude Canada.

BRUCE E. HALBERT, M.Sc.

Secretary-Treasurer, Director of Aquatic Environmental Studies

EDUCATION

M.Sc., Environmental Health Engineering, 1970,
University of Texas at Austin

B.A.Sc., Civil Engineering, 1968, University of Waterloo

PROFESSIONAL AFFILIATIONS

American Water Works Association

Water Environment Federation

EXPERIENCE

1980 to date - SENES Consultants Limited

Project responsibilities include management and co-ordination of water quality monitoring and modelling investigations, environmental impact assessments, risk assessments, sanitary engineering studies and research projects.

Risk Assessment - Project manager on human health and ecological risk assessments (HHERAs) of three proposed uranium mine developments and two mine closure plans in Saskatchewan, a proposed uranium mine decommissioning project in Ontario, a contaminated site cleanup investigation at a pulp and paper mill in Ontario, and a proposed municipal non-hazardous waste landfill in Ontario.

Project director on an investigation into the risk of a transportation accident occurring and resulting in a spill of uranium ore slurry and the environmental consequences of a spill.

Technical specialist in the development of a computer model, INTAKE, used in the above assessments for estimation of human and ecological risks of exposure to natural and anthropogenic sources of numerous organic and inorganic substances.

Northern Experience – Project director on screening level HHERAs undertaken on 24 northern contaminated sites and on Tier 2 HHERA of site remediation options at the Colomac, Giant and Port Radium mines sites in the NWT. Technical specialist on site investigations and on the development of remediation options for the Port Radium mine site.

Environmental Assessment - Technical specialist on the preparation of Environmental Impact Statements for five major uranium mining projects in northern Saskatchewan. Responsible for the design and interpretation of waste leachability tests, characterization of the quality of treated mine waters, and modelling the transport of chemical and

radionuclide releases to the aquatic ecosystems.

Project specialist in the preparation of Environmental Study Reports on several municipal sewage treatment projects in Ontario. Responsible for the characterization of baseline water quality and river low flow conditions and assessment of the impact on the trophic status and chemical quality of the receiving waters resulting from anticipated future growth.

Project manager on studies of the change in trophic status of recreational lakes in northern Ontario due to shoreline development proposals. Project director on an investigation into the effects of nuclear generating station emissions on water quality and water use in the Great Lakes.

Environmental Modelling - Co-ordinator of a multi-disciplinary team in the development of the uranium tailings assessment program - UTAP, a probabilistic assessment code for predicting the long-term effects of uranium mine tailings. Project manager on a study of uncertainty analysis in probabilistic modelling and on investigations into the application and interpretation of sensitivity and uncertainty analysis techniques.

Contributing author in the development of derived release limits for uranium refinery operations in three separate studies including evaluation of process wastewater characteristics and the resultant incremental increases in receiving water concentrations.

Project director on environmental pathways modelling assessments of five proposed uranium mines in Saskatchewan and seven uranium mine decommissioning projects in Ontario and Saskatchewan. These assessments involved development and application of modified versions of the UTAP code to predict the effects of chemical and radioactive releases on aquatic, atmospheric and terrestrial environments and on human and non-human receptors.

Environmental Monitoring - Technical specialist on several environmental baseline studies including: a long-term investigation of the effects of acidic precipitation on a forested watershed; an intensive one-year study to characterize tailings and the surrounding environs at a uranium tailings disposal site; a two-phase study on the distribution of naturally-occurring radionuclides in freshwater benthos and their environment; pre-operational baseline monitoring investigations at the site of a new uranium refinery on the North Channel of Lake Huron; a beryllium and rare earth deposit on the north shore of Great Slave Lake in the NWT and several proposed large scale landfill sites in southern and northern Ontario; and several river

assimilative capacity studies of the effects of municipal sewage treatment plant discharges.

Institutional Strengthening - Environmental monitoring specialist on a project funded by the Asian Development Bank to strengthen institutions engaged in environmental protection in Uzbekistan. Responsible for assessing current environmental conditions, environmental monitoring systems and their capacity, and identifying primary environmental concerns and requirements to strengthen monitoring capabilities.

Technical specialist on aquatic ecosystem issues pertaining to monitoring the effects on the environment of mining operations in the five southern provinces of Argentina. The project, which is funded by the World Bank, is intended to establish baseline environmental conditions and to assist the Argentinean government in formulating appropriate rules and standards.

Acid Mine Drainage - Project director in the development of the reactive acid tailings assessment program - RATAP, a comprehensive model of the processes controlling acid generation in sulphidic mine tailings. Lead researcher in an assessment of the role of bacteria in the oxidation of pyritic tailings, environmental factors controlling the rate of oxidation and the applicability of tailings management technologies in limiting acid generation.

Senior investigator in the evaluation of acid generation sources from uranium mining operations in northern Ontario including laboratory and field investigations of pyrite and ammonia oxidation rates.

Mine Tailings Management - Project manager on a study to assess the applicability of underwater tailings disposal for the management of uranium mine tailings. The project included estimation of tailings seepage characteristics, evaluation of receiving water quality impacts and development of environmental monitoring and contingency response plans.

Project manager on an investigation of tailings basin closure concepts for a base metal (zinc) mine in northern Ontario. The project included design of a leach column test program to assess the effects of varying water cover depth on sulphide mineral oxidation. Also, developed a tailings basin effluent discharge control strategy to minimize variations in receiving water quality and formation of meromictic conditions in downstream lakes.

Mine Decommissioning - Project director for the development of decommissioning and closure plans for three base metal mines in northern Ontario. Technical specialist in the application of the RATAP code to assess alternative strategies for decommissioning pyritic tailings at three sites.

Environmental specialist on a feasibility study of potential concepts for decommissioning and reclamation of a uranium mine/mill facility in northern Saskatchewan. Lead investigator of post-decommissioning environmental issues at this first ever closed-out uranium mine.

Project director on two separate studies to assess alternative concepts for decommissioning open pits at uranium mining properties in northern Saskatchewan including modelling of water quality changes and incremental doses to local residents. The implications of disposing mineralized wastes in the pits were also evaluated using a pit model developed specifically for this application.

Mine Waste Rock Management - Technical specialist in the development and application of a multi-nodal geochemical model (ROCKSTAR) for assessing the dynamic behaviour of radioactive and non-radioactive contaminants in waste rock piles, coal discard dumps, open pits and underground mine workings.

Project manager on investigations into decommissioning alternatives for: waste rock piles at gold mines in Kyrgyzstan and the U.S.A.; waste rock piles at uranium mines in Germany and Saskatchewan; and coal discard piles at two coal mine operations in South Africa. In each of these investigations, the proprietary model ROCKSTAR developed by SENES was applied to assess the effects on source contaminant loadings of alternative reclamation concepts.

Landfill Leachate - Technical specialist on several investigations of surface water quality impacts of municipal landfill leachate discharges. Certain investigations included assessment of the effects of leachate on adjacent natural wetland ecosystems. Also, undertook leachate characterization and treatment investigations including the design of a Powdered Activated Carbon Treatment (PACT) system, a constructed wetland, a leachate pre-treatment system and co-treatment of landfill leachate with municipal sewage.

1970-1980 - James F. MacLaren Limited

Assistant Manager, Water Treatment and Waste Disposal Division, 1974. Manager, Municipal Treatment, 1978.

TECHNICAL PAPERS

Mr. Halbert has co-authored over 30 technical papers.



**Neil Hellas, P.Eng.
Systems Engineer**

SUMMARY OF QUALIFICATIONS

Neil Hellas holds a Master of Science in Bioresource Engineering from McGill University, where he specialised in water resources management, environmental impact assessment, environmental modeling and ecological agriculture. He also holds a Bachelor of Applied Science in Engineering Science (Electrical) from the University of Toronto and has been a registered P.Eng., with Professional Engineers Ontario, since 1998. His professional background has spanned many industries including energy, mining, manufacturing, and finance. With more than 10 years of consulting experience, Mr. Hellas has strong skills in analysis, system design, QA processes and project management.

Mr. Hellas' professional interests are focused on the relationships between land use practices and the impacts on water resources. Most recently, Mr. Hellas has been working on modeling river erosion susceptibility as part of the environmental assessment for a proposed hydroelectric dam in Northern Ontario. He also provides technical guidance and support for the Adaptive Water Management system used within the Ontario Power Generation Hydroelectric group. His recent graduate work focused methodologies to quantify the impact of land use changes on regional water quantity and quality. Other relevant academic work includes an analysis of the Jericho diamond mine Environmental Assessment process and various studies on socio-cultural relationships with water.

EXPERIENCE AND SKILLS

- Comprehensive academic background in engineering and environmental sciences, particularly water resources
- Strong data analysis skills
- Experienced in technical and non-technical communication aimed at a variety of audiences
- Familiar with Canadian environmental assessment procedures
- Experienced in the design and implementation of Quality Assurance methodologies
- Thorough knowledge of computer and information systems including software development and database design

PROJECT EXPERIENCE

Little Jackfish River Environmental Assessment (2008-Present) – Ontario Power Generation

Currently performing an analysis of river erosion susceptibility as part of the environmental impact assessment for a proposed hydroelectric generating station in Northern Ontario. A comparison of baseline terrestrial and hydrodynamic conditions to post-dam scenarios is being used to identify areas where susceptibility to erosion would change. Contributed expert knowledge to the interpretation of baseline hydrologic conditions. Documentation and mapping were produced for a variety of stakeholders.

Highway 401 Operational Review (2008-Present) – Ontario Ministry of Transport

Presently conducting an investigation into snow drifting along Highway 401 within Northumberland County. Potential for snow transport has been determined using climate data, terrestrial conditions and field observations. Additional analysis was performed for sites identified with a high potential for snow drifting and high winter accident rates. Potential mitigation measures, including their costs and benefits, are to be presented.

4DM Inc.

Adaptive Water Management System (2008) – Ontario Power Generation

Supported and enhanced a water management system used within the OPG dam operations group. Key features of the system include real-time monitoring of water flows and levels, assessment of current conditions for compliance with operating instructions and requirements, as well as an interactive mapping application to display watershed features, property rights and precipitation forecasts.

Deep Geological Repository (2007 - Present) – Ontario Power Generation

Led the Quality Assurance component of all geospatial work supporting the Environmental Assessment for the Deep Geological Repository. Developed and implemented a Quality Management System to meet the intent of the CSA N286 Quality Standard. Ongoing review of work plans and processes to provide accurate and defensible results.

Image processing library (2006-2007) – Bradley and Thornington

Designed and developed a custom image rendering software library, capable of tiling and caching large image files while allowing high concurrency and maintaining a small memory footprint. Server components were developed in C/C++ as an Apache module. Cross-browser client components were developed using Javascript and XML.

Market order routing system (2002-2004) – E*Trade Canada

Designed and enhanced software for a stock market order routing system intended for high reliability and throughput. Analysed scalability and performance characteristics, presenting results to technical and executive staff. Implemented functional and performance enhancements.

Open market electricity trading (2002) – Ontario Power Generation

Technical consultant on various projects related to launch of open market electricity trading in Ontario. Designed and developed, in consultation with users, a cross referencing system for customer identifiers across a variety of invoicing and trading systems and databases. Developed a user interface to manage customer accounts, usage information and invoices between power distributors and retail companies.

Portfolio Performance Assessment (2000) – Barclays Global Trust, Tokyo

Provided technical expertise supporting a financial data analysis system. Acquired daily market data using custom protocols. Enhanced and maintained performance assessment applications. Trained financial and technical staff on system design and operation within a multilingual office environment.

Way Forward (1999) – Barclays Global Investment, San Francisco

Enhanced and maintained a suite of portfolio management systems applications. Interviewed users to determine software interface requirements. Documented requirements, system design and testing procedures.

Advanced Process and Control System: APACS (1998-1999) – Ontario Hydro

Administered, tested and documented software used to monitor the feedwater system in a nuclear power plant. Created software demonstration presentation for industry and academic conferences.

Hot Mill Process Automation (1996-1998) – Dofasco Inc.

Designed and implemented process control improvements. Performed data analysis, presenting findings to a variety of skill levels. Provided 24 hour support for production critical automation systems.

4DM Inc.

EDUCATION

Master of Science – Bioresource Engineering

McGill University, Montreal

Thesis on the development of a watershed assessment model for a region in eastern Ontario.

Bachelor of Applied Science – Engineering Science (Electrical)

University of Toronto, Toronto

COMPUTER SKILLS

Operating Systems: Linux, Solaris, BSD, XP
GIS Applications: ArcINFO, ArcGIS, IDRISI
Databases: MySQL, Sybase, PostgreSQL, SQL Server, Access
Programming Languages: C/C++, Java, Visual Basic, FORTRAN, Perl, script languages
Internet Technologies: Apache, Tomcat, PHP, HTML, Javascript, XML, TCP

EMPLOYMENT HISTORY

Aug. 2007 - Present

4DM Inc.

Toronto

Systems Engineer

- Performed spatial analytical work using ArcGIS
- Developed QA procedures
- Assisted in business development

Feb. 2006 – Aug. 2007

Bradley and Thornington

Montreal

Software Developer

- Designed and developed custom image rendering software.

Sept. 2006 – Dec. 2006

McGill University

Montreal

Teaching Assistant

- Assisted multiple professors for an undergraduate course, Society and Environment, within the School of the Environment
- Demonstrated thorough understanding of course theories and concepts, through grading of assignments and exams in English and French
- Provided consultation to students on course material

April 1998 – July 2004

SWI Systemware Innovation

Toronto

Principal Consultant

- Systems consultant to the energy and financial sector
- Performed system design and software development using a variety of hardware and software technologies
- Documented systems and methodologies for presentation to a wide range of audiences

May 1996 - April 1998

Dofasco Inc.

Hamilton

Automation Engineer

- Designed and implemented process control improvements
- Performed data analysis, presenting findings to a variety of skill levels
- Provided 24 hour support for production critical automation systems

May 1995 – Aug. 1995

Quintette Operating Corp.

Tumbler Ridge, BC

Engineering Assistant

- Assisted engineers and electricians at an open-pit coal mine in northern British Columbia
- Maintained electrical schematics using AutoCAD

RANDALL A. KNAPP, B.A.Sc., P.Eng.

Specialist Consultant Mining Projects

EDUCATION

B.A.Sc., Chemical Engineering, 1973, University of Waterloo

PROFESSIONAL AFFILIATIONS

Professional Engineers of Ontario
Canadian Institute of Mining and Metallurgy
Prospectors and Developers Association

EXPERIENCE

1980-date - SENES Consultants Limited

Responsible for strategic planning, management, coordination and conceptual design on projects related to mining and industrial wastes in Canada and internationally. Has provided services on six continents. Specific areas of expertise include acid mine drainage assessment, mine waste management, hazardous waste management, development of monitoring and response plans, industrial effluent treatment, environmental auditing and decommissioning and reclamation assessments.

Acid Mine Drainage - Extensive work has been completed in the management of acid mine drainage (AMD). The work has included: experimental design on techniques to assess AMD; numerous manuals; modelling and evaluation of AMD control technologies; design of treatment systems to manage acid releases; and evaluation of remedial measures to mitigate AMD production. Included in this work was completion of MEND reports on Chemical treatment, ARD sampling manuals, Use of Pits for ARD waste disposal, state-of-the-art review on covers, use of elevated water tables and contribution to the overall MEND manual.

Mine Decommissioning & Closure – Development of more than 100 conceptual and detailed closure plans. Decommissioning and reclamation projects include project management of the environmental and modelling studies associated with the Beaverlodge mine decommissioning in northern Saskatchewan, the Quirke Panel, Stanleigh, Denison, Stanrock, Coldstream and the Agnew Lake mine in Ontario. Other mining projects have included conceptual closure plan development for all INCO Ontario mines; closure plans for several Falconbridge operations; assistance with closure plan development and costs for INCO Voisey's Bay; team member for the update of the Red Dog Closure Plan for Teck Cominco Alaska; member of the technical advisor team for the development of the closure plan for Giant

Mine and its arsenic chambers; the development of the conceptual closure plan for the Kam Kotia mine near Timmins; modelling of the cover benefits for the Equity Silver mine in B.C. Closure plans have been completed for mines in Ontario, British Columbia, Quebec, Nova Scotia, Newfoundland, Northwest Territories, Alaska, Chile and Portugal. Site cleanup and remediation works have been managed at 3 smelter sites and 4 tailings areas.

Mine Waste Management - Project director on numerous studies involving site selection, environmental baseline monitoring, environmental assessment, evaluation of treatment and waste disposal technologies, conceptual design of treatment systems, due diligence evaluations and environmental permitting. Specific projects have included: site selection studies for mines in Ontario, Nova Scotia, Quebec, Saskatchewan and the Northwest Territories; numerous effluent treatment plant evaluations and conceptual designs for base metal and precious metal effluents, environmental due diligence evaluations for properties in Canada, U.S.A., former Soviet Union, Africa, Australia and South America; and environmental permitting across Canada. Recent projects regarding mine effluent treatment have included: Review of treatment alternative for arsenic removal at Giant Mine; Review of alternative treatment options for long term management of Red Dog mine acid drainage; Review of ammonia removal options for the Omai Mine; Review of treatment options and laboratory testing of alternatives methods for management of Colomac tailings water; and the Evaluation of treatment options for the Goldstrike Mine, Nevada. Specific treatment reports include: Status of Chemical Treatment and Sludge Disposal Practice for MEND; State-of-the-Art review of Best Available Technology for Mine Effluents for Environment Canada and Fundamental Concepts and Technologies for Water Treatment and Disposal of residues from Uranium Mining for the German Ministry of Environment.

Hazardous Waste Management - Project manager on investigations involving the evaluation of treatment and disposal technologies, assessment of waste quantities and characteristics, waste minimization audits (3Rs) and PCB management services. Specific projects have included: evaluation and review of treatment technologies for cleanup of sites contaminated with chlorinated organics, metals, polycyclic aromatic hydrocarbons, PCBs and various hydrocarbons; expert witness on waste quantities and the need for new hazardous waste disposal facilities before the Environmental Assessment Board; review of waste production and minimization technologies for management of hazardous wastes; and direction of PCB

inspections and coordination of PCB decontamination of an industrial site.

Environmental Audits - Has performed more than 100 environmental audits and environmental due diligence reviews of mines and industrial facilities in nine provinces in Canada; seven states in the U.S.A.; South America, Australia, Mongolia, Portugal, Russia, Kazakhstan, Kurgistan, Uzbekistan, Africa, Mexico and Cuba.

Environmental Training - Short courses have been given in Canada and internationally in several areas including environmental auditing, operational due diligence, acid mine drainage assessment, water use/ recycle, risk assessment, gold mining and the environment.

Industrial Site Cleanup and Remediation - Industrial site cleanups have included a pesticide facility, metal finishing facilities, secondary metals recovery site, gasoline stations, automotive manufacture facilities and miscellaneous industrial sites.

Industrial Wastes - Responsible for management and co-ordination of projects and specialist input related to environmental assessment, tailings management, water supply, and effluent treatment projects. Projects have included the design of effluent treatment facilities for automobile manufacturers, sulphate control for discharges to municipal sewers and design of treatment facilities for textile waste waters.

Environmental Assessment - Project manager for several environmental assessment studies for mining projects in Canada and abroad. These include EAs for 7 mine sites in Ontario and one site in Chile.

Testimony - Expert witness work has included testimony before the Provincial Court of Ontario, the Key Lake Board of Inquiry and the Ontario Environmental Assessment Board. Technical presentations have been made to numerous regulatory agencies, for public interest groups, before public meetings and numerous industry associations.

Provided expert testimony on tailings management, water utilization, and effluent treatment at environmental hearings into the Elliot Lake, Ontario uranium mining expansion and the Voisey's Bay Mine prospect in Newfoundland.

TECHNICAL PAPERS

Mr. Knapp has authored more than 50 technical papers, and has given dozens of presentations at workshops and conferences. Selected papers and presentations are

provided upon request. A selection of key papers is provide below.

Fifty Years Environmental Record At Elliot Lake, Ontario Canada, Canadian Nuclear Society Conference "Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities: Current Practices and Future Needs", 8-11 May 2005, Ottawa. (with M. Wiber, A. Coggan and R. Mansell)

The Elliot Lake Case Study, International Atomic Energy Agency, conference on Restoration of Environments with Radioactive Residues, Reference: J9-SM-379— Washington, December 2000.

Decommissioning of the Denison and Stanrock Tailings Areas. Presented at Uranium 2000-International Symposium on the Process Metallurgy of Uranium, September 2000 (with I.Ludgate, H. C. Counsell, and G. Feasby)

INCO's Copper Cliff Tailings Area, Presented at Sudbury' 95- Mining and the Environment, May 1995 (with M. Puro, W. Kipke, T. MacDonald and R. Stuparyk).

Interim Assessment of the Flooded Tailings Performance-Quirke Mine Waste management Area-Fourth International Conference on Acid Rock Drainage, June 1997 (with R. Payne, S. Kam and J. Balins)

Acid Generation Modelling - Equity Silver Waste Rock Dumps. Presented at the 16th Annual B.C. Mine Reclamation Symposium, Smithers, BC, 1992 (with C.M. Pettit, J.M. Scharer, R.V. Nicholson, R.J. Patterson).

Operational Due Diligence. Presented at Environmental Regulation Compliance and Management for Canadian Mining, Toronto, Sudbury and Vancouver 1991.

The Biogeochemistry of Acid generation in Sulphide Tailings and Waste Rock, Presented at the Acid Mine Drainage Seminar/Workshop, Halifax 1987.

Conceptual Design of Low-Level Radioactive Waste Disposal Facility. Presented at the Health Physics Society Meetings, Chicago, May 1985 (with GG. Case and D.B. Chambers).

Evaluation of Biomass for the Removal of Metals from Process Effluents. Presented at BIOMINET 2nd Annual General Meeting, Sheridan Park, ON, October 1985 (with V.I. Lakshamanan, J. Christison, J.M. Scharer and V. Sanmugasunderam).



Steven McArdle
President
Senior Geospatial Analyst

SUMMARY OF QUALIFICATIONS

Mr. McArdle main expertise has been in combining science and engineering principles with geospatial information technology. Primary focus has been to apply this knowledge in the water resources, real estate, municipal processes, demographics, emergency management and environmental areas. The experiences have been gained through consulting projects involving IT, GIS, and remote sensing tools conducting spatial analysis and application development. An integral part of these solutions has been to incorporate data management and Internet media as fundamental requirement for information exchange associated with decision support needs.

EXPERIENCE AND SKILLS

- Understanding of leveraging technology in support environmental science
- Comprehensive knowledge of measuring protocols, data management, and data integrity
- Data fusion of imagery and mapping for decision making
- Data creation, building and visualization 2D/3D for project requirements
- In depth technical knowledge in GIS software application
- Scientific consulting, project planning and proposal writing
- Marketing, Project Management, business development
- Instructing, demonstrating and evaluating for teaching and training position
- Client Liaison
- Presentations and report writing

RELEVANT PROJECT EXPERIENCE

Spatial Analysis

Dam Safety Program – Dam Break Analysis and Incremental Hazard Potential – Ontario Power Generation Inc. (OPG), Toronto, Canada - 2008

The OPG DSP initiated a pilot project to explore the application of GeoIT to assist in hydrologic/hydraulic modeling, inundation mapping, consequence analysis, and development of the Emergency Preparedness Response Plans. Responsibilities included Technical direction, analysis support and management of the project.

Highway 401 Winter Study – Ontario Ministry of Transportation – 2008

The project involves conducting collision analysis and determining the causality examining snow transport and microclimate analysis for 75 Km section of Highway 401. The role played in this study is Project Manager, Technical direction and microclimate analysis

Little Jackfish River Environmental Assessment (2008-Present) – Ontario Power Generation

Providing technical support and Project Management related to climate analysis, hydrodynamic modelling and erosion susceptibility mapping for Little Jack Fish River EA project for new hydro development

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Implementation of Adaptive Water Management System for the Ottawa River – 2008 – OPG

For meeting hydroelectric compliance requirements a decision support system is being implemented in the Ottawa River. System provides a means of monitoring water levels and flows based on compliance requirements. Incorporate into the system is hydrometric data and meteorological information related to forecast precipitation for the watershed.

Highway 7/8 Extension – Snow Drifting Analysis and Design Review – 2007 Ontario Ministry of Transport

Snowdrifting analysis is to be conducted on the redevelopment of highway 7/8 to ensure that the highway the planning and design account for and implement best practices to reduce or eliminate snow drifting. The project is currently in the planning stage and field work to identify land cover types is being conducted in December.

Feasibility of Remote Sensing Applications for Algae Monitoring in Lake Ontario – 2007 – OPG

The growth and transport of algae in Lake Ontario poses a series risk to water intakes in Lake Ontario. Identifying the location, movement and quantity is of interest to OPG. A feasibility study to investigate the application of satellite imagery from high resolution such as Quickbird to low resolution MODIS and MERIS is being conducted. The project involves tasking, processing data including atmospheric and geometric corrections and analysis

Consequence Analysis and Inundation Mapping for Dam Safety – 2007 - OPG

4DM is conducting a collaborative project with Dam Safety and Civil Engineering to conduct inundation mapping and consequence analysis for Twelve Mile Creek. Project includes hydrological and hydraulic modelling using GIS tools for dam break scenarios. Spatial analysis of inundation area will be analyzed to assess consequence analysis related to life, economic and environmental. My role is manage the project and support the analysis

Hydrometeorological Analysis of Marsh Bay – 2007 - OPG

Analysis of climatic conditions and operating water levels are required for OPG to understand the potential risk associated with properties in the Marsh Bay Areas along the Montreal. 4DM is conducting time series analysis to provide an understanding of these conditions. Analysis includes reviewing meteorological data conducting spatial interpolation for determine rainfall and temperature characteristics. Hydraulic analysis is being conducted to review historical water levels with respect to the flood limit line. Correlation analysis will also be conducted to support

Highway 115 Operational Review – 2006 – TSH Inc

MTO required the assistance of a consulting company to conduct a complete review of winter collisions on Highway 115 as related to skidding and sliding and determine mitigation treatments. GIS Analysis work by 4DM included spatial data mining, statistical analysis of collision analysis using GIS, snow transport calculations, 3D SNOWDRIFT model analysis, land cover analysis and snow fence design.

Risk Assessment Mapping for Influenza Pandemic – 2006 - 2007, Ontario Ministry of Health and Long Term Care, 4DM Inc., Toronto, Canada

Impacts of health outbreaks such as Avian Flu and SARS have detrimental impact on the province of Ontario both socially and economically. 4DM was contract to determine a spatial model to conduct "what if scenario's" to assist the MOHLTC with their pandemic planning. The process included spatial database of potential health outbreak risk indicators in Ontario utilizing multiple datasets (census and economic data, natural and built environment, facilities,

4DM Inc.

etc.) and spatial analysis (proximity, clustering, etc.). The database was then analyzed to estimate the comparative risks of disease outbreaks in various public health units across the province.

Application of SnowDrift II Modeling for Examining Treatment Solutions along Highway 6 between Highway 5 and Highway 401 – 2006 Ontario Ministry of Transportation

Highway 6 running north from Hamilton to Highway 401 is surrounded by rural agriculture lands that have a relatively flat terrain. During winter conditions, the open areas are prone to snow transport across the highway. The purpose of this project is to evaluate the effect snow treatment may have along Highway 6 using the Snowdrift II application to model selected sites. My role was to provide project management, technical direction on the project and analytical support. Including land cover characteristics, sensitivity analysis, ensure quality control is met and interpretation of model results with other staff members.

Application of Remote Sensing for Vegetation Change Detection Analysis in Support of Human Risk and Ecological Risk Assessment Project from Impacts of Smelting Emissions 2004 – 2007 Cantox Environmental/Gartner-Lee

The Sudbury basin has been home to significant mining and smelting operations from base metal deposits in the area. These operations have been ongoing for the past 100 years and have played a significant social economic role. However, mining and smelting operations have also led to environmental degradation and possible human health implications. To understand these impacts from the cumulative release of various chemicals arising from the mining activities, a detailed investigation is being conducted. 4DM, as part of larger team, is focused on providing geospatial support. Primary role has been to use satellite-based remote sensing technology to conduct change detection of the vegetation community for a sequence images that range over the past 30 years. Analysis were conducted to correlate the information and evaluate any associations with chemicals of concern. In addition a Ecological Risk Map was created to identify vegetation areas of impact over the basin areas.

Aggregate Inventory Resource Mapping of Grey County - 2003 OGS-MNDM, Grey County and Jagger Hims Ltd.

The County of Grey has recently updated its Official Plans with the exception of its aggregate resources information. With this in mind, Grey County and the Ontario Geological Survey agreed to update the Aggregate Resource Inventory mapping for the area. Jagger Hims Limited was selected as the hydrogeological consulting firm with 4DM providing spatial analytical tasks to create the Overburden, Sand & Gravel, and Bedrock Elevation maps. The process used to create the mapping information, assembled the provincial and county data sets that included water well records, geological maps and a Digital Elevation Model. Correlation analysis was used to examine the geological materials with the existing geological maps. Database analysis was conducted to derive information from water well records. ArcGIS was then used with geostatistical methods to generate bedrock elevation and overburden thickness and once completed the GIS will be used to render cartographic products for the province and the municipality. Constraints based on social-economic and environmental were then applied through spatial processing. Amendments were then made to the Official Plans.

Using Spectral Analysis for Lithology and Ore-Grade Mapping for research and development of a Core Logger Instrument - 2000-2002 Laurentian University

Applied research and development was conducted in conjunction with Laurentian University and University of Alberta to investigate using of spectral techniques for discriminating lithology. Literature review was carried out and controlled experimental measurements were conducted. The analyses of the data lead to a rigorous algorithm development demonstrating a correlation between spectral signatures and rock composition. Research was also conducted to investigate potential technology for designing an instrument to scan samples.

4DM Inc.

Canada Disaster Management Information System Simulation- 2002 NRCan – Natural Hazard Emergency Response Program

The objective of this project is to design and implement a simulation of an Internet-enabled Disaster Management System to facilitate data exchange between Federal government and Provincial/Municipal governments. The concept was illustrated by focusing on the mechanism of how information between different levels of government could be exchanged during a time of crisis. A conceptual presentation was created and presented for government officials that included realistic scenarios and data visualization using Internet mapping as a highlight of the system.

Advance Remote Sensing Technology for Foster Creek Flood Hazard Mapping - 2000-2001 Ontario Ministry of Natural Resources, and Ganaraska Regional Conservation Authority

The intent of the Project was to evaluate newer technology for improving flood hazard mapping. LIDAR technology and high resolution remote sensing were implemented in a multi-dimensional and multi-collaborative project. Digital elevation was created from the LiDAR and compared to existing elevation and survey data. GeoHec-RAS was used to create the flood hazard lines and comparison was made between existing model runs. I was responsible for providing direction, analysis and project management of the project with co-lead partners from MNR, and Ganaraska Regional Conservation Authority. Data analysis and model was conducted with the help of Greenland International Consulting and geodetic transformations with assistance of the Geodetic Survey of Canada. The resulting evaluation of elevation accuracy, model results and 3D flood hazard maps using LIDAR, RADARSAT and IKONOS imagery were presented. A project website was created to inform the community about the project.

AEMOT Groundwater Management Study - 2000-2001 Greenland International Consulting

As project lead on the spatial analysis component, the role was to coordinate digital data agreements with all levels of governments in order to acquire geospatial information in support of a holistic groundwater management plan for the study team. Information was used in support of surface water and ground water modeling encompassing environmental components. The main tasks were to conduct spatial analysis for land cover identification using remote sensing data, derive surface runoff and integrate hydrogeological data. Data management was an important part of the project as the team proposed to provide the information back to the community along with a project website relating to the study.

Atmospheric Correction of CASI Airborne Remote Sensing data for Water Quality Mapping In The Greater Miami River -1999 US Environmental Protection Agency

The project used airborne hyperspectral data for measuring water quality parameters in the Greater Miami River. The low reflectivity of water required sophisticated atmospheric corrections to examine turbidity, chlorophyll and dissolved organic matter in the water. This required onsite spectrometer and sunphotometer readings for deriving surface reflectance measurement. The collected data was processed and analyzed to apply atmospheric correction of the imagery data. The imagery was then analyzed by the team for deriving water quality parameters.

Application of Remote Sensing Techniques for Surface Hydrology 1998 – 1999 Centre for Research In Earth and Space Technology

The project was to integrate remotely sensed images from passive and active microwave with optical data for examining precipitation, snow depth and freeze-thaw conditions for surface run-off. SSM/I, RADARSAT and AVHRR imagery was used to extract model parameters. Software code was developed and data processing routines were automated to examine the imagery for freeze-thaw conditions.

Application Development

Nuclear Safeguard Integrated Information Portal – 2006 -2008 Canadian Nuclear Safety Commission

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The ability to access information for nuclear sites is paramount for surveillance, consequence analysis and inspection process. CNSC supports the IAEA in Vienna with information and application tools to demonstrate Canadian technology expertise. My role is to develop the Use Case and Scenario planning as well as Project Management to shape the functionality of the web based mapping tools. The application is currently develop using ArcIMS and Open Source for its presentation tier. A full AJAX/ASP.NET implementation with 2D/3D visualization has been undertaken present to IAEA in October 2006. Ongoing development continues for to enable additional safeguards features.

Development of an Intranet/Internet Operational Adaptive Water Management System – 2004 –2008 Ontario Power Generation

The Ontario government is deregulating the electricity market. To ensure that operators of hydroelectric producers will address social-economic and environmental issues water management plans were required. These plans are enforceable under legislation and require producers to operate in compliance. One of the largest producers in Ontario is Ontario Power Generation, which produces 80% of the power in the province operating in 26 watersheds. OPG required a software system to support their operations and meet Water Management Plan compliance requirements. The application was based on previous applied research into adaptive water management. Spiral Model approach is being implement with enterprise technology architecture to create an intranet/internet-based solution that is community based. Development was based on integration of CGDI/OGC WMS/WFS using GML/XML/XLST with J2EE Architecture using Java plus ArcGIS with ArcHydro

Development of Spatial Analytics Tool to provide Geodemographic Analysis – 2003-2005 Strategic Solution Group – Cumis Insurance Group Ltd.

4DM has established a service agreement with SSG-Cumis Insurance Group to provide software development, data management and technical support for spatial demographic analysis. The applications would functions are to conduct geodemographic analysis and create styled reports within a GIS environment in an automated manner. The application was developed specifically for conducting census profiling, trade area analysis, examine client distribution at the postal level and integrate spatial data for reference. Integrated into the software environment was ability to geocode address and organize projects and management data into Geodatabase. Software environment was ArcGIS 9 using ArcObjects VB with Geodatabases. Reports were automated using Crystal reports within ArcGIS

Development of Ontario Ministry of Transportation Desktop Transportation Mapping Interface - Ontario Ministry of Transportation – 2004

4DM was selected to provide resources to the Ontario Ministry of Transportation to enhance and upgrade their capabilities of integrating spatial data across the province for highway information including linear referencing of facilities and points of interest, maintance and other business requirements. The upgrade was to ArcGIS 8.3 in ArcObjects using C# and included Oracle 9i and ArcSDE. Application was then rolled out all provincial locations.

Applied Research and Development Project to Create an Online Geospatial Technology Framework for Watershed Management Tool – NRC-IRAP 2002 – 2003

Spatial.View was an application development project to create a prototype Spatial Knowledge Management System using endorsed OpenGIS/Canadian Geospatial Data Infrastructure Technology. Spatial.View provides a geospatial technology framework to create customizable applications modules. The first application module was focused on water management using spatial object oriented data model. Additional modules are to focus on cadastral information and demographic. My role was overall project manager, also to create data partnership agreements with MNR and OPG, and to carry out system and data flow architecture. Key components developed include a Data Transfer Agent (J2EE), Geodatabase (Oracle8i SDO), Internet technology (XML/XSLT/GML/SVG) and map/web application server.

Spatial Data Visualization Tool for Mapping Disasters and Emergencies – Office of Critical Infrastructure Protection and Emergency Preparedness/NRCAN 2003

4DM Inc.

The purpose of the project was to provide a relative context to 2D/3D visualization for disasters and emergency situations using simulation scenarios with supporting data sets to demonstrate visualization concepts. The demonstration was coordinated during the City of Vancouver's emergency exercise to simulate an earthquake event. Scenarios were developed fusing thematic features from BC provincial TRIM data sets, NRCAN NTS, high-resolution remote sensing imagery and the City of Vancouver GIS data. Data sets were then ported to an OpenGIS web visualization tool developed by York University. An emergency exercise was conducted at the City of Vancouver. My Role was to coordinate project with collaborators, create the scenarios and present concept for the emergency exercise.

SnowDrifts II Development into ArcView 3.2 – 2000 Ontario Ministry of Transportation

Impacts of snow distribution and accumulation onto provincial highways are of concern to MTO. MTO had implemented a project to develop snow modeling tool to assist in snow treatment solution. The application was written in legacy code and inadequate user interfaces. The project involved enhancements to the original DRIFTER code and spatial enabled into ArcView 3.2. My role was to provide Fortran code support and data requirements

Hydrologix Interactive Watershed Management Tool using the Internet - 1999-2000 Ontario Ministry of Energy Science and Technology and Ontario Ministry of Natural Resources

Hydrologix was a pilot project to demonstrate the ability to use of geospatial information technology for displaying watershed information online through the Internet using ASP, Java and IDL. The project encompassed a database management system, interactive GIS mapping, satellite remote sensing to generate hydrological parameters and the ability to run a hydrological model in forecast mode in real time daily. My responsibilities included Project Management, System Architecture, programming and data building

Consulting

GIS Technical Consulting on Project Execution Plan for Dam Safety using GIS – 2007 OPG

The Dam Safety Program involved a range of decision support information from hydrotechnical modeling to emergency preparedness plans. GIS tools and data can increase capabilities and provide more comprehensive information. 4DM provided technical consultation relating to using GIS.

User Needs for Applying Geospatial Information Technology for Deep Geological Repository for Long Term Storage of Nuclear Waste – 2006 OPG

The Deep Geological Repository is a propose project that requires extensive scientific and engineering analysis to meeting regulatory requirements. The lead group requires the implementation of the system that can allow referencing of information and visualize in a collaborative manner. The scope of the project is to evaluate these needs and provide recommendation on direction to undertake

User Needs Requirements for Geospatial Information Technology for Environmental Health and Safety – 2005 Avon-Maitland District School Board

A detail business requirements analysis was conducted to evaluate how geospatial data and technology could be applied for decision support for the Environmental Health and Safety officer. Analysis included Vision statement, evaluation of current business practices and systems and Gap Analysis. Recommendations on risk assessment system and technology solution were provided

Requirements Analysis for Technical Infrastructure for Support Business Geodemographic Application – 2003 Analuein

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A financial company would like to provide trade area analysis and product penetration solutions to their customers using demographic and other spatial data. The current process is an adhoc methodology requiring extensive data manipulations due to formatting and spatial analytic requirements. The Requirements Study is developed the blueprint to a multi-phased technical infrastructure that includes Internet mapping, geodatabases and in-house applications. My role is to conduct the requirements study including interviews to identify business process and the functional requirements. In addition will be conducting the appropriate investigation to determine hardware and software environment that are scalable.

User Needs Assessment of Geospatial Technology and Data for Water Resource Division - 2001 - 2002 Ontario Power Generation

Identifying the business process and the user needs requirements for geospatial data and technology to around managing water resources, energy production and environmental applications. The process included conducting workshop on applications of the data and technology. Interviewing staff and managers. Research into latest GIS tools, Internet mapping applications and remote sensing data sources. A final report was drafted summarizing findings and providing recommendations

Geospatial Information Technology for Water Resource Engineers - 2001 Black and Vetch LLC

Determine available GIS tools for popular U.S. hydrological, hydraulic and storm water models with particular emphasis on ESRI Technology. Summaries the technology challenge for water resource engineers to migrate from ArcView to ArcGIS.

Identifying User Needs and Practices of the Conservation Authorities for Managing Water Resources in Ontario - 2001 NRCan Canada Center for Remote Sensing

Conduct user needs analysis of conservation authorities in the AEMOT Groundwater study area (SVCA, GSCA, NVCA, GRCA) to identify the business process, responsibilities data requirements and technology capabilities. Conduct interviews and create a report.

Search for Water Information Management Systems in Other Jurisdictions - 2000 Ontario Ministry of Natural Resources

A search was conduct for the Government of Ontario for water information systems in other jurisdictions. The technology used and the type of application development. Interviews were also conducted to determine details related to specific systems.

Land Information Ontario LIDS Requirements Analysis – 2000 Ontario Ministry of Natural Resources

Provided internal assistance to the lead conducting business process for Land Information Ontario to define the stakeholder requirements for a geospatial data subscription system (LIDS). The final report made recommendation on high-level functionality and architecture defined from the requirements and business analysis performed.

Data Projects

Deep Geological Repository – 2007 – OPG

4DM was awarded a 1 year contract to provide geomatics technical support to the DGR project for OPG Nuclear Waste Management Division. This includes incorporating LiDAR data, satellite imagery, incorporating orthophotos, modeling, geodetic transformation and data management.

Northern Ontario LiDAR Project – 2007 – OPG

4DM Inc.

Lidar data was acquired over northern Ontario including orthophotos. Involvement included creating terms of reference, project oversight, quality control and assurance of deliverables, generating digital terrain and visualize products and analytical support.

Geomatics Support for Real Estate Services – 2007 - OPG

4DM was awarded a 3 year contract to support RES with GIS, remote sensing, photogrammetry, and technical support for all property mapping and special projects. In this, I provide support for technical requirements and policy development. This includes data integration, data management, training on software and applications.

Lawrence Heights Urban Planning Project – 2006 Toronto Community Housing Corporation

Lawrence Heights is a large community housing site that is in the early stages of revitalization planning. To support TCHC planners, 4DM was exclusively hired to assist in data gathering, assembling and visualization of spatial data. Data sets included water/wastewater, digital terrain data, orthophotos, demographic and many others. An area calculation over the property to assess open space and infrastructure was conducted.

Aerial Surveying Flood Hazard Limited – 2005 - 2006 Ontario Power Generation

A First Nation property settlement issue required a Canadian Land Survey to determine the location of an agreed flood line contour and the need to re-establish the location of contour line. Project required assessment of existing mapping and survey data and the implementation of aerial survey using new technology such as LiDAR. Gathering and assembling of digital mapping of the area and technical requirements were conducted. Selection of aerial survey is to follow with data creation.

General Real Estate Digital Property Rights Mapping – 2004-2007 Ontario Power Generation

Digital property fabric was developed for OPG to address property rights issue. This includes Fee Simple, Water Power Leases, License of Occupation, Federal Licenses, HONI easements, easements, and Rights of Way. The layers were created using ArcGIS derived from existing surveys. Theme layers were stored within a geodatabase. Digital mapping layers were integrated from MNR NRVIS data and municipal parcel fabric. Data conversion and data standards include metadata were implemented. Example of Projects includes the following

- RFP3 for small hydro electric
- Nuclear Site Section
- Coastal Zone Engineering Study
- Plant Group data
- Property Issues Marsh Bay

Development of a Survey Image Mosaic from Digital Aerial Images and Data Fusion of Geophysical Data – 2005 - Guyana Goldfields Inc.

A geophysical magnetometer survey was conducted over a selected area of existing mining operations in Guyana. Over 7000 overlapping images were acquired for the survey area along with radar altimeter and GPS data. 4DM was contracted to develop code to correct images orientation, flight directions, and scaling. Images were georeference using onboard DCGPS in automated process.

GPS Theory and Applications- 2000 York University

Instructing on the theory and use of GPS technology for a fourth year Applied Geophysics course at York University. Included tasks were to provide assignments and teach fieldwork to provide operational exposure.

EDUCATION

Master Degree Science - Remote Sensing

Soil Organic Matter using Hyperspectral Airborne Imagery

4DM Inc.

York University, Toronto, Ontario.

Certificate Of Meteorology

York University, Toronto, Ontario 1991

Hon B.Sc. Earth Science - Geophysics and Geology

York University, Toronto, Ontario 1989

COMPUTER SKILLS

Design Tools:	Visio 2003
Database	MS Access 2003/SQL Server 2000/Oracle/PostGrep/PostGIS
GIS:	ArcView 3.2/8.3/9X, MapInfo Professional, ArcSDE/ArcIMS Vertical Mapper, ArcINFO 8.X 9.X, IDRISI, AutoCAD
Programming Languages:	VB, FORTRAN, IDL, C, .NET
Internet Languages:	HTML, XML, GML, SVG, VRML, Javascripting, JSP/ASP
Internet Tools	IIS4, Apache, FrontPage 2000, NetObjects Fusion, Visual InterDev, ION, Macromedia Flash 5, WMS/WFS
Image Processing:	ENVI/IDL, PCI Geomatica
Applications:	MS Office 2000/2003/2007, Adobe Writer, Adobe Illustrator 9, Paintshop Pro 11, MSPProject
Operating Systems	NT4.0 Windows 2003/XP (Server/workstation), Unix, Win95/98,

PRESENTATION AND PUBLICATION

McArdle, S.S., 1993. " The Radiosity Method Applied to a Closed Forest Canopy Model." internal - optical remote sensing graduate course. York University

McArdle, S.S., 1992. " The Design of the Thermal Infrared Multispectral Scanner TIMS for Lithological Mapping of the Surface". internal - optical remotes sensing graduate course. York University.

McArdle, S.S., Miller, J.R. and Freemantle, J.R. 1992. "Airborne Image Acquisition Under Cloud: Preliminary Comparisons with Clear-Sky Scene Radiance and Reflectance Imagery", *Proceedings of the Fifteenth Canadian Symposium on Remote Sensing*, Toronto, Ontario.

McArdle, S.S. 1995. " A Simple Approach to Convert At-Sensor Radiance to Surface Bidirectional Reflectance", *Proceeding of 26th International Symposium on Remote Sensing of Environment / 18th Annual Symposium of the Canadian Remote Sensing Society*, Vancouver, British Columbia

McArdle, S.S., Gutelius, B., Rubinstein, I. 1998. " 3D Image Maps, Generated from Airborne CASI Imagery and ALTM 1020 Digital Terrain Data used for Subwatershed Monitoring. *Proceeding of The Fourth International Workshop on Applications of Remote Sensing in Hydrology*. Santa Fe, New Mexico

Rubinstein, I.G, McArdle S, Evangelista M, Cameron I, Schroeter H, 1998. The Use of Special Scanning Microwave Imagery and Advance Very High Resolution Radiometer Data For Watershed Monitoring. *Proceeding of The Fourth International Workshop on Applications of Remote Sensing in Hydrology*. Santa Fe, New Mexico

McArdle, S.S., Farrington G., Rubinstein. I.G, 1999. A Preliminary Comparison of Flood Risk Mapping using Integrated Remote Sensing Technology to Aerial Photography. *Fourth International Airborne Remote Sensing Conference and Exhibition and 21st Canadian Symposium on Remote Sensing*. Ottawa, Ontario, Canada

McArdle, S.S. 2000, Rubinstein, I.G., 2000. HydrologiX An Interactive Website for Displaying Watershed Information. GIS 2000, Toronto Ontario Canada, March 2000.

4DM Inc.

Gallie A. McArdle S..S, Rivard B. 2003 Spectral Analysis Techniques for Lithological Mapping of Rock Samples. Canadian Journal of Remote Sensing.

Truong, Q.S, McArdle, S.S, Yang, J 2006 Integrated Information Portal, IAEA Symposium on Nuclear Safeguards, Vienna Austria

Truong, Q.S. McArdle S.S. 2007 Integrated Information Portal and Open Source, Institute of Nuclear Materials Management, Tucson, Arizona

EMPLOYMENT HISTORY

Salinity Groundwater Contamination Mapping Using Geophysical Techniques 1999 Ontario Ministry of Transportation

Inductive EM techniques were used to map near surface saline contamination of groundwater. Temporal data set collected were integrated into a GIS environment to examine change detection of the plume. Required to collect process and analyze the data.

Generating 3D-Image maps of the Torrance Creek Subwatershed Guelph Ontario 1999-1998 CRESTech Optech Inc.

An independent initiative to compare airborne remote sensing technology to traditional methods was conducted. Hyperspectral CASI data was combined with LIDAR data from the ALTM for 3D-Image maps. The data set was evaluated for its potential applications in flood hazard mapping.

June 1994 – Dec 1997 Integrated Terrestrial System Inc. Calgary, Alberta *Managing Partner Remote Sensing Scientist/Consultant*

- Software development, data processing and digital image analysis
- Project planning, proposal writing and presentations
- Operating instrumentation for data collection
- Conducting research and development for applications of remotely sensed data

Projects Involved

- Tropical Forest mapping Using Spectral Reflectance Measurements Sarawak, Malaysia

A Malaysia forestry company was interested in using remote sensing techniques to assist in managing forestry operation and meeting environmental compliance. On site spectral measurements above and below the canopy was conducted to develop an algorithm for mapping different forest tree species. The algorithm was to be used with airborne imaging technology. Tasks include data collection, data management, analysis and interpretation of the data and generating a report.

- Vegetation mapping of the Masi Mara, Kenya

As result of concerns over vegetation impacts from tourist activities in the region and climate change the Kenya Wildlife services contracting ITC of the Netherlands to conduct a scientific investigation of number of environmental sites around and in the Masi Mara. Hyperspectral remote sensing data was acquired. Primary tasks was to coordinate scientific instruments in and out of the country, coordinate flight plans and other equipment, acquire data, process and provide quality control of the imagery. Preliminary assistance for interpreting the data was also provided.

4DM Inc.

- ❑ Coastline mapping using the CASI for Point Source Pollution, UK

The National River Authority in the UK requested that high-resolution airborne remote sensing imagery be acquired around coastal waters and rivers. Data was collected in all parts of the UK on an operational bases to identify point source pollution. Task included operating instrument, setting data parameters, communicating with government officials, and processing data.

- ❑ Atmospheric correction of CASI data for Water Quality Mapping of the Northumberland Strait Canada

Water quality base mapping was required as part of the environmental assessment for building of the Confederation Bridge across the Northumberland Strait. Remote sensing techniques were used to map water constituent using airborne hyperspectral data. To improve water quality mapping, imagery was corrected for effects of the atmosphere to improve return signals. Tasks include ground spectral measurement, algorithm development and data processing.

- ❑ Subsurface vegetation mapping, Comox Harbor, Canada

Mapping subsurface vegetation mapping was conducted using data acquired from airborne sensor. Spectral techniques were applied to extract vegetation locations.

Sept 1991 - 1995 York University Toronto, Ontario.
Research Assistant

- Research into illumination effects on remote sensing airborne imagery
- Implementing digital image processing for analysis
- Utilizing field spectrometers, GPS and other instruments for research
- Programming of applicable algorithms

Sept 1991- May 1998 York University Toronto, Ontario.
Teaching/Education Consulting

- Teaching and evaluating students
- Lecturing
- Supervising field trips

Sept 1997 - May 1998

- Applied Geophysics

Sept 1995 - May 1996

- Applied Geophysics and Remote Sensing

Sept 1994 - May 1995

- Remote Sensing and Special Course in Geomatics

Sept 1993 - May 1994

- Remote Sensing, Field School, Natural Science and Applied Geophysics

Sept 1992 - May 1993

- Geology, Field School, Applied Geophysics, and Natural Science

Sept 1991 - May 1992

- Earth Science - Geology

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Salinity Groundwater Contamination Mapping Using Geophysical Techniques 1994 - 1999 Ontario Ministry of Transportation and York University

A teaching assistant for 4th year Applied Geophysics course on geophysical methods and instrumentation specific to environmental applications relating to groundwater contamination due to road salt. Data and interpretation was conducted over a 5-year period using Inductive EM 31 techniques as well as seismic IP/resistivity, proton magnetometer, fluxgate magnetometer and Ground Penetrating Radar. GPS was also used to reference the information. Temporal data set collected were integrated into a GIS environment to examine change detection of the plume.

1989 Dighem Surveys and Processing Ltd. Mississauga, Ontario.

Field Geophysicist/Data Processing

- Determining potential anomalies from airborne magnetometer survey for base metals
- Field coordinator and liaison between survey crew, company and the client
- Ensuring data quality and coverage of survey campaign

1988 John Emery Geotechnical Engineering Ltd., Downsview, Ontario.

Geotechnical Specialist

- Field investigation of soil profiles
- Laboratory testing of soil properties
- Asphalt coring and sampling

1987 Ministry of Transportation of Ontario, Willowdale, Ontario.

Geotechnical Specialist

- Soil sampling and profile work on an auger team
- Interpretation of soil samples
- General assistance in drilling operations

1986 Ministry of Northern Development and Mines, Toronto, Ontario. Ontario Geological Survey.

Field Geologist Assistant

- Geological mapping and interpretation of gold formations in Northwestern Ontario
- Compass and traverse work
- Geological measurements and samples
- Maintenance and operation of camp facilities and motorized vehicles

SHELAGH MONTGOMERY, B.Sc., M.Sc., Ph.D.

SENES Yellowknife – Environmental Specialist

EDUCATION

B.Sc., Geology, 1990, Concordia University
M.Sc., Environmental Geochemistry, 1994, McGill University
Ph.D., Environmental Sciences, 1999, Université du Québec à Montréal, awarded with mention of Excellence and recommendation for the Dean's List

LANGUAGE CAPABILITIES

Fluent in English and French.

EXPERIENCE

March 2005 to date - SENES Consultants Limited – Yellowknife, NWT

Dr. Montgomery is based in our Yellowknife office. With a solid foundation in the environmental sciences, particularly issues related to water quality, Dr. Montgomery is responsible for leading the firm's water resources projects in northern Canada. In addition to her proven technical expertise and comprehensive knowledge of northern environmental issues, Dr. Montgomery's experience living and working in northern Aboriginal communities assists SENES in undertaking work in a way that is sensitive to the northern context.

Environmental Site Assessment - Lead on continued water quality monitoring of the former Port Radium mine site (Great Bear Lake NWT), and preliminary characterisation of the former Echo Bay mine site and vicinity. Water column, on-land water, and shoreline water samples were collected as part of a site assessment.

Cumulative Effects Assessment - Cumulative Effects advisor to Fisheries and Oceans Canada (DFO), as part of a team of professionals to develop a set of recommendations to DFO regarding the cumulative effects of the proposed Mackenzie Gas Project in the Mackenzie Valley of the NWT.

Environmental Permitting - Provided advice to and conducted regulatory research for the Water Resources Division of Indian and Northern Affairs Canada in its participation and intervention in Mackenzie Valley Land and Water Board hearings on the water licence renewal for the Diavik Diamond Mine.

Energy Inventories - As part of the federal Aboriginal and Northern Community Action Program (ANCAP), conducted an initial study of the power situation in Nunavut, with a focus on the structure of community electricity generation and delivery,

amounts of power generated, volumes of diesel fuel required, and pricing for electricity. The objective of the project was to provide baseline energy information (e.g., electricity generation, diesel consumed, pricing, trends) for Nunavut to assist ANCAP in determining how it might play a role in helping to reduce reliance on diesel fuel supply for power in Nunavut.

2002 – 2005 - Canadian Arctic Resources Committee (CARC)

Cumulative Effects Program Director for this national environmental non-governmental organisation. Based in the Yellowknife office, responsibilities included development of research programs related to cumulative effects methodology and modelling tools for evaluating development scenarios for the NWT.

Research programs involved computer-based mapping, working closely and cooperatively with other specialists in environmental and socio-economic subject areas, relating on a daily basis with Aboriginal communities, academics, government departments, regulatory boards, and industry, and communicating outcomes to scientific and non-scientific groups.

Directly involved in environmental review processes. Participated in the Technical and Public Hearings for the DeBeers Snap Lake environmental assessment. The scenario mapping presented made a contribution to recommendations about cumulative effects assessment requirements put forward by the Mackenzie Valley Environmental Impact Review Board's Snap Lake Panel. Have followed the Bathurst Inlet Port and Road proposal, and provided suggestions to the Nunavut Impact Review Board regarding project scoping and development of the Terms of Reference for the Developer's Assessment Report.

Knowledgeable of the Territorial (NWT and Nunavut) and Federal regulatory regimes and applicable legislation related to land use and environmental assessment in the north.

Approximately 20% of workload was dedicated to general organisational development activities. Responsibilities included liaising with prospective partners and funding agencies, preparation of large multi-disciplinary proposals, and strategic planning.

March 2000 – June 2002 - Déline, NWT

Science Advisor for the Déline Uranium Team, as part of the Canada-Déline Uranium Table process established by Indian and Northern Affairs Canada. As an advisor to the Déline Dene Band Council, duties included working with the community to assist in the development and implementation of environmental assessment, human health, traditional knowledge, and education projects related to the former Port Radium uranium mine on the eastern shore of Great Bear Lake.

**1999 – 2000 Université Du Québec À Montréal
Sessional Lecturer**

Co-taught a Master's level course in research methods in the Environmental Sciences program at the Université du Québec à Montréal.

RESEARCH

Research for M.Sc. thesis involved the refinement of sampling and analytical techniques for quantifying dissolved total mercury and methylmercury in the water column and interstitial waters of natural and flooded systems. Contributed to knowledge of mercury cycling in aquatic environments.

Research for Ph.D. thesis focused on the biogeochemistry of particulate matter in hydroelectric reservoirs and its contribution to the formation and transfer of methylmercury in trophic levels. An analytical technique for the quantification of lignin in geochemical samples was developed.

**PEER REVIEWED RESEARCH PAPERS AND
BOOK CHAPTERS**

Montgomery, S., Lucotte, M., and Cournoyer, L. 2000. *The use of stable carbon isotopes to evaluate the importance of fine suspended particulate matter in the transfer of methylmercury to biota in boreal flooded environments.* *Sci. Total Environ.* 261: 33-41.

Montgomery, S., Lucotte, M., and Rheault, I. 2000. *Temporal and spatial influences of flooding on dissolved mercury in boreal reservoirs.* *Sci. Total Environ.* 260: 147-157.

Montgomery, S., A. Mucci, M. Lucotte, and P. Pichet. 1995. *Total dissolved mercury in the water column of several natural and artificial aquatic systems of northern Québec (Canada).* 1995. *Can. J. Fish. Aq. Sci.* 52: 2483-2492.

Pilgrim, W., W. Schroeder, D. Porcella, C. Santos-Burgoa, S. Montgomery, A. Hamilton, and L. Trip. 2000. *Developing consensus: Mercury science and policy in the NAFTA countries (Canada, the United States and Mexico).* *The Science of the Total Environment.*

Goñi, M.A. and S. Montgomery. 2000. *Alkaline CuO oxidation with a microwave digestion system: A novel, rapid approach for lignin analyses of geochemical samples.* *Anal. Chem.*

Lucotte, M., S. Montgomery, B. Caron, and M. Kainz. 1999. *Mercury in natural lakes and unperturbed terrestrial ecosystems of northern Québec.* In: *Mercury in the Biogeochemical Cycle: Natural Environments and Hydroelectric Reservoirs of Northern Québec.* Ed. Lucotte, M., Schetagne, R., Thérien, N., Langlois, C., and Tremblay, A. Springer-Verlag, Berlin. pp. 55-87.

Lucotte, M., S. Montgomery and M. Bégin. 1999. *Mercury dynamics at the flooded soil-water interface in reservoirs of northern Québec: in situ observations.* In: *Mercury in the Biogeochemical Cycle: Natural Environments and Hydroelectric Reservoirs of Northern Québec.* Ed. Lucotte, M., Schetagne, R., Thérien, N., Langlois, C., and Tremblay, A. Springer-Verlag, Berlin. pp. 165-189.

Montgomery, S., A. Mucci and M. Lucotte. 1995. *The application of in situ dialysis samplers for close interval investigations of total dissolved mercury in interstitial waters.* *Water, Air, and Soil Pollution.* 87: 219-229.

Mucci, A., M. Lucotte, S. Montgomery, Y. Plourde, and H. Van Tra. 1995. *Mercury remobilization from flooded soils in a hydroelectric reservoir of northern Québec, LG-2: Results of a soil resuspension experiment.* *Can. J. Fish. Aq. Sci.* 52: 2507-2517.



Aleskey Naumov

Spatial Modeller/Geospatial Analyst

SUMMARY OF QUALIFICATIONS

Mr. Naumov's primary focus has been on environmental applications of geoinformatics. He has expertise in environmental modelling, particularly hydrologic modelling with geographic information systems, water resource analysis, design of spatial databases for environmental applications, digital elevation models, TINs, remote sensing, aerial and ortho photographs, spatial analysis, GIS application development and programming.

EXPERIENCE AND SKILLS

- Geographic Information Systems (GIS): database design and development, spatial analysis, design and programming of custom applications, data conversion, cartography
- Hydrologic and environmental modelling with GIS
- Databases for environmental and social applications, spatial databases
- Geocomputation
- Remote sensing, digital image processing
- Visualization, statistical analysis
- Spatial statistics, geostatistics
- Project planning, report writing, making presentations

RELEVANT PROJECT EXPERIENCE

Analysis

Dam Safety Program – Dam Break Modelling and Incremental Hazard Potential – Ontario Power Generation Inc. (OPG), Toronto, Canada - 2008

The OPG DSP initiated a pilot project to explore the application of GeoIT to assist in hydrologic/hydraulic modeling, inundation mapping, consequence analysis, and development of the Emergency Preparedness Response Plans. Performed hydrological modelling and analysis utilizing HEC-HMS, HEC-GeoHMS, Arc GIS 9.2.

Little Jackfish River Environmental Assessment (2008-Present) – Ontario Power Generation

Currently performing hydrological analysis as part of the environmental impact assessment for a proposed hydroelectric generating station in Northern Ontario. Modeling for this phase is focused on establishing baseline characteristics to assess impacts of the proposed structure.

Hydrometeorological analysis of Marsh Bay area to estimate potential for flooding events – 2007, Ontario Power Generation Inc. (OPG), Toronto, Canada

Analyzed hydrological and weather observation data to estimate potential for flooding events in the Marsh Bay area due to a combination of high water levels and extreme weather events. Analyzed historical pattern of operating water levels at the Hound Chute Generating Station and in the Marsh Bay area. Collected, processed and analyzed meteorological data from several available weather stations to identify potential and timing of large rainstorm events. Performed simple risk analysis to identify seasonal periods of the highest risk of flooding in the Marsh Bay area.

Nuclear Waste Management Organization (NWMO) Geographic Information System – 2007, Nuclear Waste Management Organization, Toronto, Canada

4DM Inc.

Provided geospatial support for creation of the NWMO Geographic Information System: identification of data sources, data compilation, and data quality issues.

GIS Technical Consulting on Project Execution Plan for Dam Safety using GIS – 2007 OPG

Prepared project execution plan for the hydrological analysis and related phases of the Dam Safety GIS project.

Real estate property database creation and mapping – 2005-2007, Ontario Power Generation Inc. (OPG), 4DM Inc., Toronto, Canada

Provided geospatial support for OPG Real Estate Group (RES): building geospatial databases of OPG property rights (Lower Mattagami, Small Hydro, Saunders, Pickering, Darlington, etc.), map production, airphoto georeferencing and mosaicking (Mattagami First Nation area, Saunders), compilation of spatial datasets in preparation for LIDAR data collection, compilation of base datasets (Ontario Base Mapping), spatial data conversion, quality control and documentation.

Health outbreak impact risk assessment – 2006-2007, Ontario Ministry of Health and Long Term Care, Toronto, Canada

Created a spatial database of potential health outbreak risk indicators in Ontario utilizing multiple datasets (census and economic data, natural and built environment, facilities, etc.) and spatial analysis (proximity, clustering, etc.). The database was then analyzed to estimate the comparative risks of disease outbreaks in various public health units across the province.

Highway 115 operational review – 2006, Ontario Ministry of Transportation

Performed statistical and spatial analysis of collision data on Highway 115 between Highway 35 and Highway 7 to determine possible causes of winter collisions. Utilized the SNOWDRIFT (version 2) model to estimate the accumulation and drifting of snow on portions of Highway 115 and to evaluate possible snow drifting mitigation measures.

Application of SnowDrift II Modeling for Examining Treatment Solutions along Highway 6 between Highway 5 and Highway 401 – 2006 Ontario Ministry of Transportation

Used the SNOWDRIFT (version 2) model to assess the accumulation and drifting of snow on portions of Highway 6 between Highway 401 and Hwy 5. Performed landuse/landcover characterization to derive values for the model surface roughness parameter. Carried out quality control of model inputs. Performed model sensitivity analysis of SNOWDRIFT to variations in the digital elevation model and landuse/landcover data.

Creation of spatial database for a school board – 2006, Avon Maitland District School Board, 4DM Inc., Toronto, Canada

Planned and carried out creation of a spatial database for environmental health/safety and property management for a school board. Designed a strategy for database creation, wrote ArcGIS geoprocessing scripts to automate database compilation tasks, performed database creation activities: conversion from CAD data, digitizing and editing, attribute input, spatial adjustment, geodatabase design.

Lawrence Heights urban planning project – 2006 Toronto Community Housing Corporation

Lawrence Heights is a large community housing site that is in the early stages of revitalization planning. To support TCHC planners, 4DM was exclusively hired to assist in data gathering, assembling and visualization of spatial data. Data sets included water/wastewater, digital terrain data, orthophotos, demographic and many others. An area calculation over the property to assess open space and infrastructure was conducted.

Spatial database support for management of cable networks – 2005, Plantec Inc, Toronto, Canada

4DM Inc.

Performed data building and automation of work flow for a spatial database support system designed for management of cable networks. Programmed custom ArcGIS geoprocessing tools to automate repetitive tasks and streamline spatial analysis and data building procedures.

Environmental Health and Safety GIS user needs assessment – 2005, Avon Maitland District School Board, 4DM Inc., Toronto, Canada

Participated in a user needs assessment for a GIS and data integration system for the Environmental Health and Safety department of the Avon Maitland District School Board, Ontario: conducting user interview, managing communication with client and 3rd party companies and organizations, understanding client's work and data flow, evaluating system design options, technical report writing.

Georeferencing and mosaicking of aerial photos and creation of an aerial photo map for geological exploration in Guyana – 2005, 4DM Inc., Toronto, Canada

Created software programs to process a large number of aerial images: extract and plot flight line coordinates, georeference images using GCP information, mosaic images and create a spatial index, perform image conversion.

Development of an intranet/internet operational Adaptive Water Management System – 2004–2005 Ontario Power Generation, 4DM Inc, Toronto, Canada

Provided support: GIS database development with ArcGIS/ArcHydro, software development.

Multi-objective calibration and validation of a distributed process-based hydrological model – 2004, Great Lakes Center for Environmental Research and Education, Buffalo State College, Buffalo, NY, U.S.A.

Performed multi-objective calibration and validation of the SWAT (Soil and Water Assessment Tool) hydrological model using several independent data sources, such as river discharge and groundwater well records. Utilized automated evolution-based calibration algorithm for robust multi-objective optimization. Unlike traditional hydrological calibration techniques, multi-objective calibration results in many acceptable parameter sets, thus allowing to estimate the degree of uncertainty inherent in model predictions. Information on uncertainty associated with hydrological predictions, in turn has direct implications for practical water management, e.g. flood protection or water quality issues. In this project, the relative value of various data sources in reducing model uncertainty was also assessed.

Hydrological modelling of the Buffalo River watershed – 2002-2003, Great Lakes Center for Environmental Research and Education, Buffalo State College, Buffalo, NY, U.S.A.

Performed hydrological modelling of the Buffalo River watershed with the SWAT (Soil and Water Assessment Tool) model: estimation of input precipitation from multiple weather stations, water and sediment budgets, model calibration and validation, effect of management scenarios, Monte Carlo sensitivity analysis of the SWAT model. Created software tools for automating SWAT related tasks: SwatInput (programmatic reading, editing and writing of SWAT input files), and SwatGrass (an interface for generating SWAT files from GRASS layers).

Database of Social and Economic Risk Indicators of Erie County – 2003, Center for Health and Social Research, Buffalo State College, Buffalo, NY, U.S.A.

Compiled a database of social and economic indicators for the Erie County, NY, U.S.A. The database contains geographically distributed – at census tract and zip code area levels – indicators of social risk and protective factors for the Erie County. It brings together data from many diverse sources, such as Census tables, county public health and voter data, municipal police records, school district reports. The Erie County Social and Economic Risk Indicator Database is one of very few examples of utilizing multiple archival sources of information to provide a set of integrated measures of social and economic well-being of population at a fine geographic scale. The primary goal of the database is to improve the planning and provision of local services through a data driven decision making approach. Implemented the database using geospatial technology, relational databases, statistical analysis and programming.

4DM Inc.

Spatial analysis for the Erie County Health Outcomes (ECHO) study – 2001-2002, Center for Health and Social Research, Buffalo State College, Buffalo, NY, U.S.A.

Provided GIS, database, programming and statistical support for the analysis of health related data for the ECHO project. Performed spatial clustering to identify “hot spots” of high occurrence rates of specific health problems.

Remote sensing of coastal Kamchatka, Russia for geological applications – 1997, State University of New York at Buffalo, NY, U.S.A.

Conducted analysis of aerial and satellite images of coastal Kamchatka, Russia to assist in identification of linear geological features, such as tectonic fault lines. Performed image enhancement, rectification, fusion and analysis in ERDAS IMAGINE remote sensing package.

Creation of GIS database to support environmental modelling – 1995-1996, State University of New York at Buffalo, NY, U.S.A.

Developed GIS database for water resource and other environmental modelling for a regional-scale watershed in Kansas, U.S.A. Performed watershed delineation, digitizing, quality control, edge matching and attribute editing using ArcInfo GIS. Created watershed, digital elevation model (DEM) and river network GIS layers to be used in water resource modelling studies.

GIS transportation modelling and database development – 1994-1995, Geographic Information System Division, City of Johnson City, TN, U.S.A.

Conducted urban transportation network analysis and modelling with ArcInfo: geocoding, planning and optimization of routes (school buses, public transit, special transit), creation of route features and stop tables, enhancement of street network coverage, map production. Developed AML programs and GUI interface to automate address matching and data entry.

Geoinformational support for decision making on rehabilitation of Chernobyl-affected areas in western Russia – 1992-1993, Geoinformatics Department, Russian Scientific and Expert Center, State Chernobyl Committee of the Russian Federation, Moscow, Russia

GIS database creation, mapping, and ecological modelling of radionuclide contaminated areas, cartographic and statistical analysis, field survey and sampling.

Natural resource and ecological assessment of the Moneron Island, northwestern Pacific, Russia – 1991, Moscow State University, Moscow; Russia Sakhalin State Ecological Committee and Marine Ecology Center Vitas, Uzhno-Sakhalinsk, Russia

Field landscape surveying and mapping, natural resource assessment and evaluation of possible land use strategies, development of preliminary functional zoning plan for the proposed Moneron Marine National Park.

Application Development

- Geoprocessing scripts and tools in ArcGIS for data building, spatial analysis and automation of work flow
- Developed two extensions for ArcView GIS, many AML programs and menu-driven interfaces in ArcInfo
- Software for supporting hydrologic modelling with the Soil and Water Assessment Tool (SWAT) model: automated reading and writing of SWAT input files, reading of SWAT output files in the R statistical and data analysis environment, interface to GRASS GIS
- Object-oriented programming with Python, C++
- Software for automated analysis of health data: designed and programmed automated procedures for analyzing large volumes of medical data (breast cancer) in interactive and batch modes (data preprocessing, statistical analysis, presentation of results online); implemented software tool for data visualization using VTK (Visualization Toolkit), Python/PyQt

4DM Inc.

EDUCATION

Ph.D. Geography

Multi-Criteria Validation of the SWAT Hydrologic Model
University at Buffalo, The State University of New York, Buffalo, NY, U.S.A.

M.A., Geography, 1995

East Tennessee State University, Johnson City, TN, U.S.A.

Diploma (B.Sc./M.Sc.), Geography and Geoecology, 1993

Moscow State University, Moscow, Russian Federation

COMPUTER SKILLS

GIS:	ArcView 3.2/8.3/9, ArcINFO 7.X \8, ArcGIS, GRASS, IDRISI, GDAL
Database	PostgreSQL/PostGIS, MS Access 97/2000
Programming Languages:	Python, C/C++, VB
Design Tools:	Eclipse, Kdevelop, Emacs
GUI design:	Qt/PyQt
Data Analysis:	R, S-Plus
Visualization:	Visualization Toolkit (VTK)
Other Languages:	HTML, LaTeX
Internet Tools:	Apache, Quanta Plus, MapServer, FrontPage
Image Processing:	ERDAS Imagine, GRASS
Applications:	OpenOffice, MS Office 2000/2003, GIMP
Operating Systems:	NT, XP, Linux, Unix

PRESENTATION AND PUBLICATION

Naumov, A. and Inamdar, S., 2004. "Use of STATSGO versus SSURGO soils on SWAT predictions of discharge and sediment yields". International Association for Great Lakes Research Conference, University of Waterloo, Waterloo, Ontario, May 24-28, 2004.

EMPLOYMENT HISTORY

4DM, Inc., Toronto, ON, Canada

GIS Analyst, December 2005 – present

- Spatial data building for the Avon Maitland District School Board and Ontario Power Generation Inc.: design and creation of database, conversion and editing tasks
- Geoprocessing scripts to automate database compilation in ArcGIS
- Remote sensing: image conversion, mosaicing
- Business development, research on spatial and temporal databases
- Mapping

Plantec Inc., Toronto, Canada

GIS Analyst, October – November 2005

- Data building and automation of work flow for a spatial database support system (management of cable networks)
- ArcGIS geoprocessing tools to automate and streamline spatial analysis and data building procedures

4DM Inc.

4DM, Inc., Toronto, ON, Canada GIS Analyst, July – September 2005

GIS User Needs Assessment for a school board client: analysis of client requirements, review and comparison of GIS, spatial database and web technology options, recommendations on technology options and system design scenarios

4DM, Inc., Toronto, ON, Canada Volunteer, December 2004 – February 2005

GIS analysis, remote sensing, spatial databases (PostGIS), programming (Avenue, Python), preparation of business proposals for GIS related services

Great Lakes Center for Environmental Research and Education, Buffalo State College, Buffalo, NY, U.S.A.

Research Assistant, May 2003 – February 2004

Buffalo River Modelling project:

- Performed hydrologic modelling of the Buffalo River watershed with SWAT (Soil and Water Assessment Tool): water and sediment budgets, model calibration and validation, effect of management scenarios, Monte Carlo sensitivity analysis of the SWAT model
- Created software tools for automating SWAT related tasks: SwatInput (programmatic reading, editing and writing of SWAT input files), and SwatGrass (an interface for generating SWAT files from GRASS layers)

Center for Health and Social Research, Buffalo State College, Buffalo, NY, U.S.A.

GIS Analyst and Data Manager, November 2000 – February 2004, November 1997 – August 1998

Databases:

- Managed, enhanced, converted and documented a large geospatial database
- Completed several database projects using relational databases (PostgreSQL) and custom programming (Python, R); experience in handling large Census datasets

Spatial analysis, programming:

- Performed spatial statistics, clustering analysis (SaTScan), geocoding, mapping
- Authored two ArcView extensions, miscellaneous scripts and tools (Avenue, Python/PyQt, R, SQL)

Department of Physiology and Biophysics, University at Buffalo, Buffalo, NY, U.S.A.

Research Assistant, June 1999 – December 2000

Automated analysis of health data:

- Designed and programmed automated procedures for analyzing large volumes of medical data (breast cancer) in interactive and batch modes: data preprocessing, statistical analysis, presentation of results online
- Implemented software tool for data visualization using VTK (Visualization Toolkit), Python/PyQt

Department of Geography, University at Buffalo, Buffalo, NY, U.S.A.

Research and Teaching Assistant, September 1995 – May 1999

GIS and remote sensing for environmental research:

- Digital elevation models, watershed delineation and digitizing
- Analysis of aerial and satellite images of coastal Kamchatka (Russia): identification of linear features, image enhancement

Teaching:

- Developed and taught lecture course "Physical Environmental Geography" and laboratory exercise sections of "Introduction to GIS" and "Remote Sensing" courses

Environmental Systems Research Institute, Redlands, CA, U.S.A.

Intern, May – August 1996

Testing of ArcInfo 7.1 and ArcView 3.0: localization and national language support

Geographic Information System Division, City of Johnson City, TN, U.S.A.

4DM Inc.

Intern, September 1994 – May 1995

GIS transportation modelling and database development:

- Urban transportation network analysis and modelling with ArcInfo: geocoding, planning and optimization of routes (school buses, public transit, special transit), creation of route features and stop tables, enhancement of street network coverage, map production
- Developed AML programs and GUI interface to automate address matching and data entry

Department of Geography, East Tennessee State University, Johnson City, TN, U.S.A. Teaching Assistant, September 1993 – May 1994

Supervised laboratory exercises and exams in the “Cartography” and “Introduction to GIS” courses

Geoinformatics Department, Russian Scientific and Expert Center, State Chernobyl Committee of the Russian Federation, Moscow, Russia Intern, March 1992 – May 1993

Geoinformational support for decision making on rehabilitation of Chernobyl-affected areas in western Russia:

- GIS database creation, mapping, and ecological modelling of radionuclide contaminated areas, cartographic and statistical analysis, field survey and sampling

Moscow State University, Moscow, Russia Sakhalin State Ecological Committee and Marine Ecology Center “Vitas”, Uzhno-Sakhalinsk, Russia Landscape Surveyor/Researcher, July – December 1991

Natural resource and ecological assessment of the Moneron Island, northwestern Pacific, Russia:

- Field landscape surveying and mapping, natural resource assessment and evaluation of possible land use strategies, development of preliminary functional zoning plan for the proposed Moneron Marine National Park

PAUL H. PATRICK, M.Sc., Ph.D.

Aquatic Scientist

EDUCATION

Ph.D., 1985, University of Manitoba
M.Sc., 1974, Durham University (England)
B.Sc., 1972, University of Windsor
Dipl. Electronics, 1998, DeVry Institute of Technology

AWARDS

1972, President's Scholar (University of Windsor)
1987, Director's Award (Ontario Hydro)
1994, Director's Award (Ontario Hydro Technologies)
1995, Sustainable Development Award (Merit)

EXPERTISE

- Environmental Project Management
- US 316 (b) Legislation- Clean Water Act- Best Technology Assessments (BTA)
- Experimental Design for Baseline Studies and Statistical Approaches
- Water Intake Systems and Design- US and Canada (CCW and discharge systems)
- Lab based studies on BTA and field evaluations
- Fish Behavior and Fish Management Mitigation Strategies
- Water Pollution Control Strategies and Mitigation Approaches
- Environmental Assessments and Pathways (EA)
- Chemical and Physical Monitoring- Valued Ecosystem Components (using conventional sampling and remote sampling techniques)
- Animal Behavior and Mitigative Measures
- Advanced Sonar Systems
- Laboratory Assessments and Procedures for Analysis of Water, Sediment and Biota
- Aquaculture and Fish Holding Facilities (Aquariums)

SUMMARY OF QUALIFICATIONS

Highly skilled professional with over 29 years experience dealing with environmental issues associated with industrial plants in US, Canada and Sri Lanka. Expert in Best Technology Assessments for intake and discharge designs, experimental design for EA monitoring, US316b studies (entrainment and

impingement, Comprehensive Demonstration Studies), assessing both chemical and radionuclide assessments on valued ecosystem components (water, sediment, biota). Internationally recognized in water intake design and general aquatic field especially related to cost-effective fish protection systems. Strengths/weaknesses in mitigation control strategies for aquatic systems.

CURRENT AREAS OF WORK

Environmental Project Management, Water Intake and Discharge Systems, Pathway Analysis, Experimental Design and Statistical Analysis:

- CCW water intake and discharges at power plants- NPDES Permitting Issues (US and Canada).
- Best Technology Available (BTA) for water intake systems to protect aquatic life in US and Canada.
- Comprehensive Demonstration Studies.
- Lab and Field evaluations of cost-effective technologies for 316b mitigation.
- Experimental design for EIA monitoring incorporating hypothesis testing and control sampling.
- Statistical analysis of data using parametric and non-parametric statistics and power analysis.
- Unique in-situ system for pathway analysis of radionuclides/contaminants in aquatic biota.
- Unique monitoring system for monitoring terrestrial animals which vocalize (AIMS).
- Monitoring chemicals and radionuclides in specific endpoints such as water, soil, sediment, vegetation and fish, and interpretation (pathway).
- Transit Canal Project- Sri Lanka- Project Management and Environmental Assessment.

Environmental Assessment of Fish Populations and Aquatic Impacts at Generating Stations, and Other Industry:

- US 316 (b) legislation on Clean Water Act in reference to best available technology (BAT) for station intake design and discharge effects.
- Fish diversion using attraction and repulsion systems for application at different generating stations.
- Enhanced aquaculture in fish using unique technology.
- Fish monitoring in the vicinity of utilities using advanced sonar and radiotelemetry.

Environmental Assessment of Mammal Populations and Control at Transmission Stations:

- Animal behavior experiments in response to different exclusion systems including electric fences, non-electric fences, acoustic devices, strobe light, and other technology.
- Specially designed research facility at the Metro Toronto Zoo.

Zebra Mussel Assessments and Water Pollution Control (Biofouling):

- Unique monitoring system of zebra mussels which allows more efficient use of chlorine for mussel control. This sampling program is currently being used at Darlington Nuclear, Pickering Nuclear, and Bruce Nuclear.
- Evaluation of different technologies for zebra mussel as alternatives to chlorination. A unique test rig has been set up where different technologies can be tested.
- Expertise in consulting on innovative approaches for controlling biofouling and algal growth in ponds, rivers and lakes using unique plastic polymers.

EXPERIENCE (EXAMPLES)

Kinectrics Inc.

1979-1984 – Ontario Power Generation Environmental Assessments Pre and Post Operational Station Impacts

- Experimental designs for assessing environmental impacts
- Fish habitat studies
- Sampling of water, sediment and aquatic biota
- Statistical analysis and data, interpretation and report preparation.

OPG Zebra Mussel Program- Nuclear Facilities

- Designed zebra mussel program for monitoring and sampling veliger and adult zebra mussels.
- Designed bioboxes and chlorination statistical comparisons.

OPG Radionuclide Sampling Program- Nuclear Facilities

- Development of sampling program including different environmental components, and rigorous sampling methodology
- Develop procedures for routine monitoring yet maintaining statistical integrity.

BUFDSF EA:

- Team leader and responsible for designing pre-construction EA for BUFDSF which included soil sampling, water, sediment, terrestrial and aquatic

vegetation. Efficient sampling program, analytical analysis, statistical treatment of data and interpretation.

Algae (Cladophora) Influx at Power Plants

- Project Manager of methodologies to assess algae distribution and abundance, and risk to power plants.
- As team leader, development of short and long term engineering solutions to minimize to power plants.
- Interaction with regulators for approvals (DFO, MNR, MOE, TRCA, Transport Canada).

Intake Design/Discharge Effects:

- Project Manager and technical responsibility for design of modified porous dike for WE Power's port Washington's Plant. Involved multi-disciplinary team of hydraulic engineers, civil engineers, and environmental staff.
- Internationally recognized on USEPA 316b guidelines for recommending and testing technologies to manage fish entry, biofouling and intake designs.
- Habitat assessment in discharges and thermal impacts.
- As part of multidisciplinary team designed and evaluated intake systems for both Darlington (porous veneer), Bruce Nuclear (barrier net system), and Saunders (eel return system).
- Fish behavior in response to behavioral and physical systems.
- Developed and patented innovative technologies for 316b applications such as pipe based dike systems, reversed louvers, light attraction systems, acoustical control systems.
- Interaction with USEPA regulators.

PATENTS AND PUBLICATIONS

Acoustic Fish Control Device (1987)-US
Hydroacoustic Sonar Development (1990)-US
Sound Conditioning System (1994)-US
Integration Radiotelemetry/Sonar (1995)-US
Automated Intelligent Monitoring System (1997)-US
Photovoltaic Powered Fish Light Attraction System (1999)-US
Behavioural Fence for Animal Exclusion (1999)-US
Modified Porous Dike Intake System (2004-submitted)
Reversed Louvers (2005- submitted)

Publications (peer reviewed):

Over 20 publications in peer reviewed publications

Reports:

Over 100 reports dealing with fish diversion technologies, radionuclide/chemical assessments, environmental monitoring, entrainment and impingement studies, etc.

D. BRUCE STEWART

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WINNIPEG, MANITOBA, R3V 1X2
TEL+FAX (204) 269-0102
stewart4@mts.net

DATE OF BIRTH: December 22, 1955

CITIZENSHIP: Canadian

EDUCATION:

- Master of Science, Zoology, University of Manitoba, 1980. Thesis Supervisor: Dr. J.H. Gee.
- Bachelor of Science (Hons.), Zoology, University of Manitoba, 1977.

PROFESSIONAL AFFILIATIONS:

- Canadian Society of Zoologists 1979-current.
- Arctic Institute of North America 1983-current.

SPECIAL APPOINTMENT:

Panelist and Alternate Chairperson, Canada-Manitoba Environmental Assessment Review Panel for the Conawapa Hydroelectric Project, 1991-93. Appointed jointly by the Ministers of the Environment for Canada and Manitoba to a six-member panel charged with conducting a public review of the potential environmental effects of the \$5.7 billion Conawapa hydroelectric development proposed by Manitoba Hydro.

EXPERIENCE:

Since 1976, I have studied aquatic systems throughout northern Canada. This has involved the planning, performance, and management of large-scale aquatic resource assessment programs designed to facilitate land use planning, resource management, and development; environmental impact evaluations; and strategic planning for park and resource developments. Governments, industries, and native organizations have employed my professional services.

1983 to present

As Senior Aquatic Biologist and Head of Arctic Biological Consultants, I am responsible for the design and completion of major aquatic study programs in northern Canada, and for providing expert advice on aquatic resources and resource developments. Examples of my work include:

Fishery Development: (Fisheries Joint Management Committee)

- Prepared a comprehensive assessment of the commercial harvest potential of the Canadian Beaufort Sea-Amundsen Gulf area, and considered options for fishery development by the Inuvialuit. Biological, social, and economic factors were evaluated through reviews of the literature on area fishery resources and Arctic commercial fisheries, economic analyses, and consultations with the Inuit communities and others. A general approach to fishery development, and specific research projects were recommended.

Environmental Impact Assessment: (Environment Canada; Manitoba Environment; Delcan Corp. for DND; Fisheries and Oceans Canada; Yellowknives Dene First Nation; Fisheries Joint Management Committee; SENES Cons. Ltd; Indian and Northern Affairs Canada)

- Wrote guidelines for the Environmental Impact Statement to be prepared by Manitoba Hydro for the Conawapa hydroelectric project. This project included a 1390 mega watt generating station on the lower Nelson River and a 500 kilo Volt transmission line connecting it with southern Manitoba. Panelist at public hearings that were undertaken at communities throughout Manitoba.
- Assessed: 1) the potential effects of a proposed military training facility, and closure of the Nanisivik Mine, on the aquatic environments and resource harvesting of Baffin and Melville islands, and 2) the potential impacts on overwintering fish of trucking granular materials over lake and river

ice in the Mackenzie Delta area. An assessment of possible impacts of the Mountain Winds Wind Farm project on aquatic environments in the Pembina Hills of Manitoba is ongoing.

- Reviewed aquatic studies related to Nanisivik Mine closure, the Diavik and Jericho diamond mines, and the proposed Meadowbank Gold Project.
- Prepared the marine ecosystem section of the 2005 NWT Environmental Audit.
- Advised Parks Canada on marine environmental monitoring programs for their Arctic Parks, the Municipality of Sanikiluaq on setting up a longterm marine environmental monitoring program, and DFO on establishing a northern aquatic monitoring program.
- Prepared detailed reviews of habitat use by and diet of Arctic grayling, brook stickleback, bull trout, and round whitefish for DFO related to pipeline development in the Mackenzie Valley. Similar reviews are ongoing for Dolly Varden, northern pike, and walleye.
- Described the Hudson Bay complex LME and assessed its vulnerability to hydrocarbon development for the Arctic Monitoring and Assessment Program (AMAP) (ongoing).

Aquatic Resource Assessment: (Indian and Northern Affairs Canada; Environment Canada; Fisheries and Oceans Canada)

- Planned and conducted baseline research on the aquatic resources of Baffin Island, Melville Peninsula and Southampton Island, NWT, for the Northern Land Use Information Series (NLUIS) Mapping Program. Remote areas were accessed by aircraft or boat to collect data on the distribution, growth, reproduction, movements, diets, parasites, and use of fish species; on zooplankton, phytoplankton, and water chemistry; and on the use of coastal waters by marine mammals. The results of these and my earlier surveys were published on 222 resource maps (1:250,000 scale) and in 9 reports to aid in the planning and management of northern land use activities.
- Studied the biology, harvest potential and utilization of anadromous Arctic charr stocks in rivers on Victoria Island (Kuuk, Kagluk), the Mackenzie Delta (Rat, Big Fish), and in the Kivalliq (Brown, Hayes, Diana). These remote field programs were completed with the help of Inuvialuit and Inuit workers who were trained on site.

Fishery Management: (Fisheries and Oceans Canada)

- Reviewed information on fish stocks and harvests in the Nunavut, Sahtu Dene and Metis, Gwich'in, North Slave, South Slave and Deh Cho settlement areas.
- Reported the results of experimental fisheries studies in the Mackenzie Basin from the Fort Resolution area of Great Slave Lake, Mackenzie mainstem and tributaries, and lakes in the Sahtu Dene and Metis and Deh Cho settlement areas, and of sport fishery studies in the East Arm of Great Slave Lake.
- Compiled Inuit traditional knowledge of the distribution and biology of narwhals and belugas in the Canadian eastern Arctic.
- Prepared: 1) aquatic habitat sensitivity maps for the District of Keewatin, Hudson Bay, Foxe Basin, and Hudson Strait; 2) a colour booklet on parasites and diseases affecting freshwater fish harvested in the NWT and Nunavut, and 3) descriptions of fish habitat usage in the NWT (ongoing).
- Coordinated workshops in Winnipeg and Hay River, NWT, to consider the potential effects of a change in gillnet mesh size by the Great Slave Lake commercial fishery.
- DFO term contract (1988) in Rankin Inlet, NWT, as Fishery Management Biologist for the District of Keewatin.

Species at Risk: (Environment Canada, Fisheries and Oceans Canada)

- Prepared the COSEWIC updates on the status of narwhal, Atlantic walrus, bearded seal, darktail lamprey, and carmine shiner in Canada.

- Compiled historical harvest data for the southeast Baffin beluga population stock recovery plan; similar work on narwhal in Canada is ongoing.
- Secretariat for the carmine shiner, shortjaw cisco, western silvery minnow, and east slope sculpin recovery committees (DFO). Work to support preparation of a national recovery strategy for the lake sturgeon is ongoing.

Ocean Management: (Fisheries and Oceans Canada)

- Prepared computerized bibliographies to assist coastal zone management in the Cumberland Sound (>600 refs.), Yukon North Slope (>1800 refs) and Hudson/James Bay areas (>2800 refs.).
- Prepared detailed overviews of the Hudson Bay marine ecosystem and of Cumberland Sound.

Park Planning: (Environment Canada)

- Assessed the physical, biological, and cultural features of the Hudson Bay and James Bay marine regions and recommended areas for consideration as new National Marine Parks.
- Advised on the locations of a new National Land Park in Natural Region 28, Southampton Plains, Nunavut.
- Wrote the chapter on Limnology and Marine Biology for the Resource Description and Analysis (RDA) of Ellesmere Island National Park Reserve, now Quttinirpaaq National Park.
- Prepared an annotated computerized bibliography (>1600 refs.) of information on the natural and cultural resources of the proposed North Baffin National Park.

During this period, I also studied tundra swans; the use of bone strontium and parasitism in the identification and management of anadromous Arctic charr populations; and the feasibility of ecotoxicological research on Arctic aquatic biota at a southern laboratory. I have employed the services of other scientists and technicians to perform a wide variety of biological and chemical studies; reviewed and edited the work of other scientists; taught fish biology at Arctic College; lectured to the Chemical Institute of Canada, Manitoba Naturalists Society and other groups on my work; and been an invited participant at the Rawson Academy's Hudson Bay Program Workshop (1993) and Parks Canada's Arctic Marine Workshop (1994), DFO's Great Slave Lake Gillnet Mesh Selectivity Workshop (1997), Western Hudson Bay Workshop (2000), Marine Environmental Quality Workshop (2000) and Hudson Bay Working Group Meeting (2004), Parks Canada's Northern Bioregion Marine Monitoring Meeting (2006) and the Sanikiluaq Environmental Monitoring Workshop (2007).

1976 to 1983

As a Consulting Biologist to the NLUIS mapping program (see above) and its predecessor, the Arctic Land Use Research Program, I planned, conducted and reported on synoptic surveys of aquatic resources in the Districts of Mackenzie and Keewatin and in the Arctic islands bordering the Northwest Passage. In 1976, as a Reservoir Fisheries Technician for DFO, I studied the environmental impact of the Churchill River Diversion on fish in Northern and Southern Indian lakes, Manitoba.

PUBLICATIONS:

- Stewart, D.B., Carmichael, T.J., Sawatzky, C.D., Mochnacz, N.J., and Reist, J.D. 2007. Fish life history and habitat use in the Northwest Territories: round whitefish (*Prosopium cylindraceum*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2795: vi + 36 p. (in review)
- Stewart, D.B., Carmichael, T.J., Sawatzky, C.D., Reist, J.D., and Mochnacz, N.J. 2007. Fish diets and food webs in the Northwest Territories: round whitefish (*Prosopium cylindraceum*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2794: iv + 20 p. (in review)
- Hnytka, F.N. (Chair), and Stewart, D.B. (ed.). 2007. Proceedings of the lake sturgeon recovery planning workshop, 28 February to 1 March 2006, Winnipeg, MB. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/030: xiv + 169 p.
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- Stewart, D.B., Carmichael, T.J., Sawatzky, C.D., Mochnacz, N.J., and Reist, J.D. 2007. Fish diets and food webs in the Northwest Territories: brook stickleback (*Culaea inconstans*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2798: iv + 17 p.
- Stewart, D.B., Mochnacz, N.J., Sawatzky, C.D., Carmichael, T.J., and Reist, J.D. 2007. Fish life history and habitat use in the Northwest Territories: bull trout (*Salvelinus confluentus*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2801: vi + 46 p.
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- Dick, T.A., Jarvis, S.R., Sawatzky, C.D., and Stewart, D.B. 2006. The lake sturgeon *Acipenser fulvescens* (Chondrostei: Acipenseridae): an annotated bibliography. Can. Tech. Rep. Fish. Aquat. Sci. 2671: iv + 251 p. + CD ROM. [<http://dsp-psd.pwgsc.gc.ca/Collection/Fs97-6-2671E.pdf>]
- Stewart, D.B., and Lockhart, W.L. 2005. An overview of the Hudson Bay marine ecosystem. Can. Tech. Rep. Fish. Aquat. Sci. 2586: vi + 487 p. [<http://www.dfo-mpo.gc.ca/Library/314704.htm>]
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- Stewart, D.B., and Bernier, L.M.J. 1999. Common parasites, diseases and injuries of freshwater fishes in the Northwest Territories and Nunavut. Prepared by Arctic Biological Consultants, Winnipeg for Department of Fisheries and Oceans, Winnipeg, MB. 41 p. [colour booklet available in English, French and Inuktitut]
http://wildlife1.usask.ca/Publications/Parasites_and_Diseases_of_Northern_Fish_DFO_En_20051108.pdf
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- Low, G., Stewart, D.B., Day, A.C., and Taptuna, W.E.F. 1999. Comparison of fish harvests from the east arm of Great Slave Lake, N.W.T., by itinerant sport anglers in 1986 and 1994. Can. Tech. Rep. Fish. Aquat. Sci. 2263: iv + 32 p. [<http://www.dfo-mpo.gc.ca/Library/235976.pdf>]
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- Guinn, B., and Stewart, D.B. 1988. Marine mammals of central Baffin Island, Northwest Territories. Lands Directorate of Environment Canada and Department of Fisheries and Oceans, Background Report 6: 65 p. + map.
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- MacDonald, G., and Stewart, D.B. 1980. Arctic land use research program 1979: a survey of the aquatic resources of the central Keewatin region of the Northwest Territories. Department of Indian and Northern Affairs, Environmental Study 17: 111 p.
- Stewart, D.B. 1979. Our spectacular waterfalls in the Arctic. *Can. Geogr. J.* 98(3): 36-39.
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- Fisheries comments on 222 of the 1:250,000 scale Northern Land Use Information Series resource maps of the NWT, published by DIAND and DOE, were prepared by me and either G. MacDonald or L.M.J. Bernier between 1977 and 1986. In 1985, B. Guinn and I prepared marine mammal comments on 24 of the maps.

REPORTS AND DOCUMENTS:

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[http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr%5Fatlantic%5Fwalrus%5Fe%2Epdf\]](http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr%5Fatlantic%5Fwalrus%5Fe%2Epdf)

- Stewart, D.B. 2004. Commercial and subsistence harvests of beluga whales (*Delphinapterus leucas*) from Cumberland Sound, Nunavut 1840-2002. Arctic Biological Consultants, Winnipeg, MB for Canada Department of Fisheries and Oceans, Winnipeg, MB. iii + 36 p.
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- Stewart, D.B. 2003. Protected areas and sensitive habitats in the Hudson Bay marine ecosystem. Arctic Biological Consultants, Winnipeg, MB for Canada Department of Fisheries and Oceans, Winnipeg. iv + 16 p. (preliminary draft 5 Sept. 2003).
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- Stewart, D.B., Dunbar, M.J., and Bernier, L.M.J. 1993. Marine natural areas of Canadian significance in the James Bay marine region. Arctic Biological Consultants for Parks Canada, Ottawa. ix + 294 p.
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CONAWAPA ENVIRONMENTAL REVIEW PANEL DOCUMENTS:

As a member of the Conawapa Environmental Review Panel, I co-authored the following documents:

Conawapa Environmental Review Panel. 1992. A summary of the November 1992, final guidelines for the preparation of an environmental impact statement for the proposed Conawapa Project draft for review and comment. Joint Review Secretariat, Winnipeg. 8 p.

Conawapa Environmental Review Panel. 1992. Final guidelines for the preparation of an environmental impact statement on the proposed Conawapa Project (Draft for comment and review). Joint Review Secretariat, Winnipeg. ii + 62 p. + appendices.

Conawapa Environmental Review Panel. 1992. Stage 1 review procedures. Joint Review Secretariat, Winnipeg. 10 p.

Conawapa Environmental Review Panel. 1991. Operational procedures. Joint Review Secretariat, Winnipeg. 8 p.

ARCTIC STATION/NORTHERN TRAINING CENTRE REPORTS:

As one of a multi-disciplinary team assembled by Delcan Corporation, I described the aquatic environments in the area of the proposed training centre, evaluated potential effects of the project upon them, and made related mitigation and monitoring recommendations in the following reports:

Delcan Corporation. 1990. Northern Training Centre environmental screening: Rea Point, Melville Island, Northwest Territories. Environmental Systems Group, Delcan Corporation, Ottawa for Director of Military Engineering Operations, Department of National Defence, Ottawa. 105 p. + 2 maps.

Delcan Corporation. 1990. Northern Training Centre initial environmental evaluation, final report: Nanisivik, Baffin Island, Northwest Territories. Environmental Systems Group, Delcan Corporation, Ottawa for Director of Military Engineering Operations, Department of National Defence, Ottawa. 333 p.+ 2 maps.

SPECIES AT RISK RECOVERY STRATEGY REPORTS:

As a member of these teams and/or their Secretariat, I wrote or co-wrote the following reports:

Milk River Fish Species at Risk Recovery Team. 2007. Recovery strategy for the eastslope sculpin (*Cottus* sp.) in Canada. *Species at Risk Act* Recovery Strategy Series, Fisheries and Oceans Canada, Ottawa. xi + 48 p. (Draft October 2007)

Milk River Fish Species at Risk Recovery Team. 2007. Recovery strategy for the western silvery minnow (*Hybognathus argyritis*) in Canada [Proposed]. *In* Species at Risk Act Recovery Strategy Series. Ottawa: Fisheries and Oceans Canada. x + 49 p. (Draft March 2007)

Carmine Shiner Recovery Team. 2006. Recovery strategy for the carmine shiner (*Notropis percobromus*) in Canada [Proposed]. *In* Species at Risk Act Recovery Strategy Series. Ottawa: Fisheries and Oceans Canada. x + 34 pp.

Shortjaw Cisco Recovery Team. 2006. Recovery strategy for the shortjaw cisco (*Coregonus zenithicus*) in Canada. June 2005 Draft. 80 p. [Available from Canada Department of Fisheries and Oceans, Central and Arctic Region, Winnipeg, MB, R3T 2N6]

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**FRESHWATER SITES
IN THE NWT AND NUNAVUT
SAMPLED BY D.B. STEWART**

- during the NLUIS mapping program.
- ▲ during other aquatic research programs.

NORTHERN CANADA NORD

Bathymetric contours shown in metres. Courbes bathymétriques indiquées en mètres.
Scale Échelle
kilometres 100 0 100 200 300 400 500 600 kilometres
Lambert Conformal Conic Projection, Standard Parallels 49°N and 77°N.
Modified Polyconic Projection, North of Latitude 80°.
Projection conique conforme de Lambert, parallèles standard 49°N et 77°N.
Au nord de 80° de latitude, projection polyconique modifiée.

