Education

MRM, Resource and Environmental Management, Simon Fraser University, Burnaby, BC, 1996

BSc, Physical Geography, University of Victoria, Victoria, BC, 1992

Golder Associates Ltd. – Vancouver

Associate / Senior Environmental Scientist - Risk Assessment

Mr. Lawrence has 24 years of work experience in the field of ecological risk assessment, with a specific focus on water and sediment quality assessments and weight-of-evidence assessments of aquatic health. He has substantial experience with development of site-specific water quality objectives, specializes in the environmental fate and effects of persistent organic substances, and has developed mathematical models to simulate their behaviour in aquatic environments. His role on environmental quality assessments is diverse, ranging from the detailed planning and implementation of aquatic sampling and analysis programs to technical evaluation of data (e.g., statistical analysis, weight-of-evidence evaluation, risk characterization) to risk management (e.g., communication to stakeholders, peer review, technical and strategic recommendations for environmental management and/or monitoring program revisions). He has provided senior review of numerous aquatic health assessments (chronic effects benchmarks and residual effects classifications) for mining projects. As a senior Associate in Golder Associates, he is responsible for quality control of professional work products, including technical quality of written deliverables, advice/recommendations, and client liaison. Mr. Lawrence has also contributed to the development of standard methods and guidance for risk assessments, including contributions to the federal aquatic sites framework (FCSAP), risk assessment guidance and toxicity test selection guidance for the federal government, and detailed risk assessment and weight of evidence guidance in his home province of British Columbia.

Employment History

Golder Associates Ltd. – Vancouver, BC

Senior Environmental Scientist, Associate (2004 to Present)

Project Manager or Director for complex aquatic risk assessments, both local and international, specializing in sediment quality assessments and modelling of contaminants from sediment to aquatic life. Has developed site-specific water quality objectives for multiple mining projects (Oil Sands, coal, metal, diamond mines), and has participated in the design, refinement, and interpretation of environmental monitoring studies. Developed guidance for the federal and provincial governments in the fields of detailed risk assessment and risk characterization (Environment Canada / DFO), weight of evidence assessment (BC Science Advisory Board), and aquatic sites management (DFO).

EVS Environment Consultants Ltd. – North Vancouver, BC

Environmental Scientist (1997 to 2004)

Task Manager and Project Manager for numerous risk and environmental assessment projects, ranging in size and complexity. Conducted third-party reviews of ecological risk assessments. Planned and executed field programs in freshwater and marine environments. From 2001 to 2004, participated on EVS Board of Directors.

Department of Fisheries and Oceans Habitat and Enhancement Branch – Vancouver, BC
Fish Health Study Data Analyst (1995 to 1997)

Conducted field sampling and analysis of fish in the Columbia River over multiple seasons as part of an aquatic bioassessment program intended to evaluate linkages between industrial contamination of water/sediment and aquatic health. Performed quantitative analyses of the fish health and contaminants data from several sampling programs, using appropriate parametric and non-parametric statistical tests, in order to assess the spatial and temporal trends in fish health. A portion of this work (4 months) was conducted under a co-operative arrangement with Simon Fraser University; the remainder was conducted through a series of contracting arrangements with DFO

Simon Fraser University – Burnaby, BC
Research Assistant (1996 to 1997)

Provided support to Dr. Frank Gobas, School of Resource and Environmental Management, related to environmental fate modelling of hydrophobic substances in aquatic environments.

BC Hydro and Power Authority – Burnaby, BC
Student Research Assistant (1990 to 1992)

Provided data analysis assistance for a BC Hydro investigation of reservoir inflows for major drainage basins in BC.

National Hydrology Research Centre – Saskatoon, SK
Research Assistant (1989 to 1990)

As part of a Co-op position with Environment Canada, investigated precipitation patterns in Canada's Prairie Provinces.

PROJECT EXPERIENCE – ENVIRONMENTAL EFFECTS OF MINING PROJECTS

Crown-Indigenous Relations of Northern Affairs Canada (Faro Mine Closure)
Faro, YK

Senior risk assessor for the preparation of an aquatic health assessment for a decommissioned gold mine that is under active remediation. As part of the Environmental Assessment submission for the long-term remediation plan, Golder is evaluating the ecological risk of several metals released from mine tailings and waste rock to adjacent streams. Site specific water quality objectives have been developed to assess risks under multiple modelled future cases. Mr. Lawrence was senior reviewer of the aquatic health assessment component, contributed to the conceptual Aquatic Effects Monitoring Plan for the site, designed a program of site-specific toxicity testing, and has participated in multiple workshops with the stakeholders and site custodian to guide the approach for ecological risk assessment. (May 2018-October 2019)

Newmont Mining Corporation (Con Mine Effluent Assessment)
Yellowknife, Northwest Territories

Senior toxicologist for the assessment of aquatic risks associated with the effluent stream downgradient of the wastewater treatment plant, which flows through a legacy contaminated site into Yellowknife Bay. Designed a toxicology program to evaluate the toxicity of chloride in a site-specific mixture. Participated in the Water License Renewal Hearings, and assisted with design and interpretation of receiving environment monitoring data. (March 2018-November 2018)

Teck Coal Limited (Elk Valley Water Quality Plan)
Elk Valley, BC

Component lead for the evaluation of nitrate and sulphate within the Elk Valley Water Quality Plan, which was submitted to BC MOE in July 2014 (and approved in November 2014) in response to a Ministerial Order. Compliance with the Order entailed design and execution of a supplemental program of toxicity testing using Elk Valley site waters, and synthesis of existing information of sulphate and nitrate toxicity, all within a tight timeframe imposed under the Order. Evaluated the hardness-dependence of constituents. An important aspect of the regulatory compliance entailed stakeholder consultation; a series of seven Toxicity Working Group meetings were held from 2013-2014 under the Technical Advisory Committee (TAC). Mr. Lawrence participated in all of these meetings, providing technical summaries, liaison with stakeholders, and responsiveness to the advice and recommendations of the TAC. (February 2013-November 2015)

Teck Coal Limited (Chronic Toxicity Permit Implementation)
Elk Valley, BC

Senior technical lead for the implementation and evaluation of a chronic toxicity monitoring program to evaluate nitrate, sulphate, and mixture-based toxicity in the Fording and Elk rivers in response to Ministry Permit requirements. Provided interpretation of quarterly and semi-annual test results, designed and interpreted supplemental studies for amphibian toxicity and individual constituents. Liaised with the Ministry and Technical Advisory Committee. Provided technical advice and recommendations for program refinements in both water-based and sediment-based testing. (February 2016-October 2019)

Mount Polley Mining Corporation (Polley Mine Embankment Breach)
Cariboo Region, BC

Senior scientist responsible for aggregating the weight-of-evidence for ecological responses in the aquatic environments (Polley Lake, Quesnel Lake, Hazeltine Creek, Quesnel River) influenced by debris from a Tailings Storage Failing failure in 2014. Integrated information on risks to plankton, invertebrates, fish, and other biota from a wealth of field studies and monitoring tools, culminating in a risk assessment deliverable prepared for the Ministry of Environment. (October 2016-June 2017)

Public Works and Government Services Canada (Giant Mine Baker Creek Sediments)
Yellowknife, Northwest Territories

Sediment quality specialist for an assessment of arsenic contamination associated with the remediation of Giant Mine. Part of this work entailed an assessment of sediments in Upper Baker Creek and Lower Martin Lake, with primary objectives being to investigate the distribution and potential sources of arsenic in sediments within the study area. Helped design the sediment sampling program and provided interpretation of data including visual and microscopic observations, analysis of water and sediment chemistry, and chemometric methods to determine the form of arsenic (speciation) in sediment. (September 2014-May 2015)

Royal Nickel Corporation (Dumont Project)
Northern, Quebec

Royal Nickel evaluated the potential environmental effects associated with leachate from waste rock pile and the overburden pile associated with their Dumont Project. A specific issue arose concerning the potential categorization of the waste rock, low-grade ore, and/or overburden material as deleterious material for the purposes of Schedule II of the Metal Mining Effluent Regulations (MMER). Mr. Lawrence participated in the regulatory compliance oversight for this project, partly through directing the development technically defensible site-specific water quality objectives (SSWQOs), and partly through consultation with Environment Canada with respect to the potential for designation as deleterious material. (June 2013-December 2014)

Confidential Client
North Slave Region, Northwest Territories

Senior technical advisor to an assessment of sediment quality in an enclosed inlet adjacent to a diamond mine operation. The purpose of the ongoing investigations is to determine whether, at mine closure, a dike separating the inlet adjacent to mine operations could be opened (i.e., removed) to return to fish habitat. Helped design and interpret a sediment quality assessment program from 2010 to 2011 that entailed various chemistry sediment and sludge chemistry analyses, benthic community evaluation, and toxicity studies. Assisted with follow-up monitoring including development of a benchmark for heavy fraction petroleum hydrocarbons, and mass-balance assessment of hydrocarbons entering the Inlet. (April 2015-October 2019)

BHP Billiton (Ekati Mine) Kennedy Lake, Northwest Territories	Was lead technical investigator for a study conducted to summarize and synthesize biological monitoring data for the Ekati diamond mine receiving environment downstream of mine operations. The study entailed review and synthesis of a large quantity of environmental monitoring data from 1995-2006, for the mine and surrounding environment, much of which was available in Aquatic Effects Monitoring Program (AEMP) documentation. In addition to distilling pertinent technical findings from the AEMP reports, Mr. Lawrence incorporated additional data analyses, emphasizing biological data including plankton, sediment benthic community measures, and fish health indices. At the same site, he separately provided senior oversight of a wildlife ecological risk assessment component in support of an Environmental Impact Statement for a kimberlite diamond mine. This role entailed developing toxicity reference values for acute and chronic exposures of wildlife to metals associated with mine development and provision of guidance for screening of contaminants and risk characterization. (December 2007-March 2008)
Luscar Coal & Elk River Basin Coal Producers Southeast BC	Conducted two human health-risk assessments for selenium-contaminated fish intake in the vicinity of coal mining operations in British Columbia and Alberta. The risk assessments considered both the essentiality and toxicity of selenium, and used a weight-of-evidence approach to assess the potential for harm (or benefit) for recreational anglers that may consume moderate to high quantities of local fish. HHRA deliverables were provided to Luscar Coal and the Elk River Basin Coal Producers in March and July. (March 2000)
Cortez Gold Mines Ltd. (Cortez South Pipeline Site), Nevada	Assisted in conducting a risk assessment supporting an Environmental Impact Statement for the development of a proposed open pit gold mine (South Pipeline Terrestrial ERA). The ERA focused on estimating the ecological risks associated with post-closure conditions, since the formation of a pit lake after mine closure is expected to result in elevated concentrations of metals in the water. The major concern was whether the predicted water quality would affect birds and mammals potentially utilising the area. A major component of the study was an extensive review of avian and mammalian toxicity to metals. (August 1997-May 1998)

PROJECT EXPERIENCE – RISK ASSESSMENT (ECOLOGICAL & HUMAN HEALTH)

Public Services and Procurement Canada (Whitby Harbour Sediment)
Whitby, ON

Project director for the evaluation of risks in a working harbour, where a legacy of dioxin- and furan-contaminated contaminated sediment remains. Planned and supervised investigations to fill key information gaps, characterize environmental risks, and provide the base for a remedial design to strike a compromise between chemical risk reduction, environmental disturbance, and practical and financial achievability, recognizing the need to maintain the recreational use of the marina and incorporate knowledge of sediment transport dynamics. The field program results were combined with historical Site data to complete a preliminary quantitative and detailed quantitative risk assessment, in accordance with the Canada-Ontario Decision Making Framework for Assessment of Great Lakes Contaminated Sediment. Contributed to and directed a conceptual remedial options evaluation for management of dioxin/furan sediment contamination at the Site. Project director for stakeholder engagement and remedial strategy refinements. (October 2016-October 2019)

Public Services and Procurement Canada (DFO Small Craft Harbours Sediment Evaluations)
Ontario and Newfoundland

Project director for the evaluation of risks in numerous working harbours (e.g., Silver Islet [Thunder Bay], Confederation Basin [Kingston], Lakefront Promenade [Mississauga], Fitzroy Harbour [Ottawa], Five Mile Wharf [Fort Frances], and Red Bay [Labrador] with the objective of characterizing risks and environmental liabilities following the Canada-Ontario Decision Making Framework for Assessment of Great Lakes Contaminated Sediment. Planned and supervised investigations to fill key information gaps, including supplemental toxicity testing, and conducted weight-of-evidence assessments of historical and current risk assessment information. (July 2017-October 2019)

Public Services and Procurement Canada (Rideau Walls Sediment)
Ottawa, ON

Senior technical lead for investigation of sediment quality in the Rideau Canal, which is designated a National Historic Site of Canada and is operated by Parks Canada and administered by Public Works. Supervised the development a sampling and analysis plan to complete sediment and surface water sampling (Spring 2017). The program results were used to develop and Environmental Management Plan that articulates mitigation measures and best management practices to avoid and/or minimize environmental and human health adverse impacts during wall repairs. (March 2017-June 2017)

Public Works and Government Services Canada (Couchiching First Nation)
Fort Frances, ON

Sediment specialist for the investigation of sediments in Rainy Lake, located offshore from former industrial lands leased on a First Nations reserve. Liaised with Fisheries and Oceans Canada and Aboriginal Affairs and Northern Development Canada to design a work plan for assessment of sediments that were historically influenced by sawmill activities and other nearshore contaminant sources. The project was a Phase II-III ESA that is collecting all the necessary data required to complete a risk assessment and/or remediation. The presence of wood debris necessitated application of methods different from standard sediment quality triad tools. (May 2015-April 2016))

Transport Canada/ Public Works (Kingston Inner Harbour Sediment Assessment)

Acted as Principal Investigator for a sediment quality assessment of a contaminated federal waterlot adjacent to downtown Kingston. The study entailed synthesis of historical sediment quality data, and completion of a detailed risk assessment following the Canada-Ontario Decision-Making Framework. Work was conducted in a tiered manner (i.e., Problem Formulation, Preliminary Quantitative Assessment, Detailed Quantitative Assessment), and Mr. Lawrence designed and provided technical direction throughout these studies. Follow-up activities have included provision of technical advice to the custodians of the sediment water lots, source characterization, assessment of deformities in bottom fish, revision of wildlife toxicity reference values, and data gap assessments. Acted as Project Director for a risk refinement deliverable, intended to synthesize all information related to sediment quality and risk assessment, and intended for use in risk management by the site custodians. Also directed a Conceptual Remedial Options Evaluation, communicating risks and progressing toward stakeholder consultation and remedy selection. (December 2010-October 2019)

Public Works and Government Services (Esquimalt Graving Dock)
Esquimalt, BC

PWGSC owns and operates the Esquimalt Graving Dock (EGD), a major ship construction and maintenance facility within Esquimalt Harbour. Mr. Lawrence participated in the Phase II environmental site assessment and detailed site investigations undertaken to characterize sediment quality in the waterlot adjacent to the EGD facility, focussing on the evaluation of tributyltin in a sediment risk assessment. As a part of the project remedial design, an intertidal marsh in Esquimalt Harbour (Dunn's Nook) was constructed to offset disturbance to aquatic habitat at the facility. To support planning for construction of the marsh, an evaluation of potential risks associated with the sediment contamination to the constructed habitat was undertaken, and remedial action objectives (RAOs) were developed to determine the extent of remediation needed. (June 2010-August 2013)

Rio-Tinto Alcan (RTA)
Kitimat Arm, BC

Planned, supervised, and interpreted results from a broad-scale Sediment Quality Triad investigation of contaminated sediment adjacent to a large smelter operation. A surface sediment and shallow coring study was conducted in Fall 2012 and culminated in a sediment quality assessment report that was submitted to the BC Ministry of Environment in 2013. The project role included conceptual design, project direction, technical lead for weight of evidence interpretation, senior report review, and liaison with the client team and regulatory stakeholders (BC MOE, Environment Canada, Haisla Nation). In addition to the sediment quality component, the project included an assessment of upgradient contaminant sources (including spent pot liner materials in groundwater) to the estuarine environment through foreshore seeps. Tools applied on the project included: bulk sediment chemistry; laboratory toxicity testing of a battery of species in sediment, groundwater, porewater, and seep water; toxicity identification evaluation; and benthic community structure. A quantitative weight of evidence framework was developed for the project and vetted with stakeholders prior to implementation. (August 2012-June 2013)

Department of Fisheries and Oceans (FCSAP Aquatic Sites Professional Development Course)

Department of Fisheries and Oceans - Was either lead presenter or co-presenter for eight workshops held across Canada to instruct and communicate the application of the Framework for Addressing and Managing Aquatic Contaminated Sites under the Federal Contaminated Sites Action Plan (FCSAP) (the Framework). Developed case studies and instructional materials, and facilitated workshops in Victoria BC, Vancouver BC, Edmonton AB, Toronto ON, Moncton NB, Québec City PQ, and Yellowknife, NT. The course emphasized the practical side of implementing the Framework and was designed for Expert Support, Site custodians, and their consultants. (2012)

Capital Regional District (Greater Victoria Outfalls)
Victoria, BC

Acted as Project Manager for a series of environmental investigations related to the two deep-sea wastewater outfalls in Greater Victoria (Clover Point and Macaulay Point outfalls). The first task consisted of a comprehensive review of all CRD environmental monitoring data associated with the outfalls since 1992, and production of the synthesis document that used a risk assessment format to integrate the numerous lines of evidence. The results were presented to the Marine Monitoring Advisory Group. Subsequently, numerous projects were conducted related to the monitoring and assessment of wastewater discharges. Acted as either Principal Investigator or Project Director for all of these projects. These projects included: (1) annual evaluations of benthic community and sediment quality results for the Macaulay Point outfall; (2) annual evaluations of mussel biology and chemistry results for Clover Point; (3) assessment and ranking of wastewater constituents relative to biology indicators; (4) development of a quality assurance and quality control (QA/QC) framework for CRD monitoring data; (5) evaluation of high-resolution data from special studies of trace contaminants in wastewater, sediment, and tissue; (6) assessment of trends in wastewater discharges and sediment quality. Continuing support to CRD includes guidance for the updated design of the Wastewater and Marine Environment Program (WMEP) monitoring, and linkage to the proposed secondary treatment facilities. (May 2005-June 2012)

Environment Canada and Fisheries and Oceans Canada (Risk Characterization Guidance)
Vancouver, BC

Was principal investigator for the development of the 2012 risk characterization guidance for ecological risk assessment, in support of the Federal Contaminated Sites programme (FCSAP). Mr. Lawrence worked with regulators and other practitioners to harmonize the guidance with other components of the emerging guidance. Was principal investigator for specific guidance for the selection and interpretation of toxicity tests; this provided a systematic process for identifying candidate tests, and then provided a summary of evaluation criteria for choosing among candidate test protocols and endpoints. In 2019, he participated in the development of a revised FCSAP guidance document, building from the previous documents but updating with new materials and streamlining the process. (October 2009-February 2012; February 2019-October 2019)

Weston Solutions & U.S. EPA (Housatonic River Site)
Pittsfield, MA

In conjunction with the ecological risk assessment, provided assistance to Weston and EPA in the areas of risk management and remediation. Provided technical support related to the definition of environmental thresholds considered to be protective of aquatic and terrestrial wildlife receptors. Provided review and input to project deliverables under the Consent Decree, including responses to the General Electric Interim Media Protection Goals (IMPG) Proposal, General Electric Corrective Measures Study (CMS) Proposal, and the final IMPG and CMS documents. Assisted EPA with risk evaluation under multiple remediation alternatives, including combinations of floodplain and main channel remediation scenarios. This task entailed simulation of PCB exposures to species that are exposed via a combination of aquatic and terrestrial pathways (e.g., mink, wood duck). (January 2005-October 2010)

Transport Canada/ Public Works (Ontario Sediment Assessments)
Great Lakes, Ontario

Acted as Coordination Consultant for sediment risk assessment of five of Transport Canada's Harbour Projects in Ontario, conducted as part of the Sediment Management Strategy. The sites included contaminated sediments in Kingston (Inner and Outer Harbour), Cornwall, Sarnia, and Sault Ste. Marie. The role entailed development of project-specific Terms of Reference (TORs), preparing Requests for Proposals (RFPs), reviewing of proposals, and the overall coordination of the client projects, including the review of draft and final reports. Technical issues governing the effectiveness of the study approaches and proposed work plans were identified and resolved through collaboration with the project managers and client group. (May 2009-March 2011)

Confidential Client (RCRA Site)
Holland, MI, USA

Conducted a review of site investigation data (sediment, groundwater, tissue, toxicity, benthos) in conjunction with a foreshore contaminated site investigation in Michigan. A risk assessment framework was applied to evaluate potential ecological and human health risks associated with semivolatile organics, PCBs, and other contaminants in a freshwater system influenced by multiple anthropogenic physical and chemical stressors. Findings were presented to the client and the Michigan Department of Environmental Quality (MDEQ) and are being used to frame needs for future site investigations. (May 2009-July 2009)

Science Advisory Board (WOE Workgroup)
Vancouver, BC

In 2009, the Science Advisory Board for Contaminated Sites in British Columbia (SAB) formed a working group of regulators and risk assessment practitioners to continue the development of weight-of-evidence (WOE) guidance, in support of BC's regime for evaluation of ecological risk assessment and contaminated sites management. Mr. Lawrence served as "champion" for the working group, which entailed: (1) facilitating the group to frame key issues and identify areas of consensus; (2) presentation of group findings to SAB focus groups and at the Annual Ministry Risk Symposium, and (3) coordinate and contribute to the development of a Terms of Reference for continued research on WOE in BC. Mr. Lawrence has been selected by SAB as the chairperson for the Task Force to assist in furthering these WOE concepts. (February 2009-July 2010)

Capital Regional District (Saanich Peninsula WWTP)
Victoria, BC

Conducted an investigation of the monitoring program for the Saanich Peninsula wastewater treatment facility. The assessment entailed screening and ranking of wastewater constituents (influent and effluent) to identify priorities for environmental monitoring. The criteria included evaluations of concentrations relative to screening benchmarks, temporal trends, detection limit considerations, frequency of detection, magnitude of chemical hazard, and other factors. A systematic analyte ranking procedure was applied, and results were used to assign each analyte into a category of monitoring frequency. Recommendations were also made with respect to detection limits and sampling methods. (April 2007-August 2007)

Science Advisory Board (Detailed ERA Guidance)
Victoria, BC

Beginning in 2006, contributed material to the Detailed Ecological Risk Assessment (DERA) guidance document, prepared for the BC Ministry of Environment (MOE) Science Advisory Board (SAB). The material related to the overall framework of detailed ERA in BC and several detailed technical aspects of the methodology. The first phase of work culminated in a March 2006 deliverable to SAB. Beginning in late 2007, contributed supporting material related to: (1) field sampling methodologies within DERA; (2) supplemental ERA process guidance; and (3) additional guidance and document revisions from SAB and MOE. The process included treatment of policy issues in the context of a technical guidance document, and required liaison with the SAB DERA Task Group. (January 2006-October 2008)

Greater Vancouver Regional District (Lions Gate WWTP)
Vancouver, BC

Used an ecological assessment approach to evaluate potential effects associated with the Greater Vancouver Regional District (now Metro Vancouver) Lions Gate discharges. The study entailed compiling available environmental effects information for the outfall and associated receiving environment, including sediment chemistry, wastewater chemistry, seafloor biology, effluent toxicity, and toxicity identification evaluations. A weight-of-evidence process was used to harmonise the multiple lines of evidence. (October-November 2006)

Weston Solutions & U.S. EPA (Housatonic River Site)
Pittsfield, MA

Acted as Project Manager for three components of a large ecological risk assessment (Housatonic River Freshwater Aquatic ERA) led by the United States Environmental Protection Agency and subject to Consent Decree lodged in U.S. District Court. The site was contaminated by PCBs from former industrial activities associated with a manufacturing facility. Directed, conducted, and reviewed assessments of risks to fish, benthic invertebrates, and amphibians, and helped to integrate the ERA findings into the overall deliverable. Liaised with USEPA, study team leaders (principal investigators), and subconsultants, and provided peer review and guidance support to the project. Was also Principal Technical Investigator for the benthic invertebrate portion of the ERA document, and conducted a weight-of-evidence evaluation of biological endpoints, including benthic community structure, in situ and laboratory toxicity testing, toxicity identification evaluation data, and chemistry data. Guided the application of multivariate statistical methods, habitat quality index methods, and probabilistic methods. Participated in Peer Review process, including formal Responsiveness Summary and report revisions. (January 2000-November 2004)

Seaspan International Ltd. & Domtar Inc.
North Vancouver, BC

Acted as Project Manager and Principal Investigator in the investigation of sediment quality issues at the largest shipyard in Western Canada (Vancouver Shipyards). The major concern was whether present (i.e., ship mooring and repair) and historical (i.e., creosoting and sawmill operations) site activities have resulted in adverse ecological impacts to boat basin sediments. Historical sediment quality data were synthesised and site management issues (e.g., need for maintenance dredging) were considered. The resulting sampling plan was tailored to be applicable to both post-dredge and in-place management of sediments. Designed, coordinated, and executed a sediment-coring program to delineate the extent of chemical contamination. Acted as Principal Investigator for a large, surface sediment ecological risk assessment (Fall 2001), including toxicity testing, bioaccumulation testing, and site-specific customisation of analytical methods. Provided technical guidance to the client to help unite sediment risk management and upland remediation. (April 1998-June 2004)

Transport Canada (Victoria Harbour)
Victoria, BC

In 2000, assisted in designing, coordinating, and executing marine ecological risk assessment of multiple water lots, owned by Transport Canada, in Victoria Harbour that were being evaluated as part of the divestiture process (Belleville and Fisherman's Wharf sites). Sediment quality triads are being employed to evaluate the liability associated with contaminants in the water lots. Background harbour-wide contamination is an important issue in the ERAs and was explicitly incorporated into the sampling designs for these sites. Acted as Field Manager for sediment sampling at these sites during March 2000. Related to the above, also served as Field Manager for the Transport Canada basin-wide ERA sampling effort in March 2001. (October 2000-June 2001)

Akzo-Nobel Inc. (Courtaulds Site)
Cornwall, ON

Conducted ERA support and liaison for a riverfront site (Courtaulds site, St. Lawrence River, Ontario). The site was formerly occupied by an industrial plant and contaminated by metals, including mercury. Conducted a review of sediment quality data (toxicity, chemistry, benthos). Responsibilities included application of a weight-of-evidence assessment of sediment quality triad data, liaison with local regulators and interest groups, and consultation and guidance for a mercury bioaccumulation study. Provided analysis and input on several site-specific risk issues, including benthic community health, mercury risks to fish, and mercury risks to higher trophic receptors (birds, mammals). (October 2000-May 2001)

URS Australia Pty Ltd. (ORICA Site)
Sydney, Australia

Project Manager for a large, detailed assessment of sediment risks at a former industrial site in Sydney Harbour (ORICA site). The project entailed identification of biological effects that could be linked to upland historical land uses. A weight-of-evidence evaluation of sediment quality triad components, including multivariate statistical evaluation, was conducted to identify whether phthalates, PAHs, and/or metals pose risks to sediment in fauna. (October 2000-April 2001)

Metro Vancouver (Clark Drive CSO) Vancouver, BC	Conducted an ecological assessment of potential effects associated with the Greater Vancouver Regional District (now Metro Vancouver) Clark Drive Combined Sewer Overflow (CSO), integrating historical and recent exposure and effects information, and updating the biological assessment to incorporate ecotoxicological knowledge accumulated since the original program (e.g., improved understanding of confounding effects of ammonia, sulphides, and fine particulate matter in sediment toxicity tests). Deliverables included an ERA report and presentation of findings to Metro Vancouver and regulators in a workshop format. (May 2000-August 2000)
Transport Canada, BC Hydro, & Hemmera Inc. (Rock Bay Site) Victoria, BC	Acted as a Principal Investigator in the assessment of a high-profile, coal tar-contaminated sediment site in Victoria Harbour (Rock Bay Marine Sediment ERA). The primary contaminants of concern at the site were PAHs, PCBs, and metals. The key issue at the site was to determine whether upland contamination at the site has resulted in adverse effects in the adjacent marine environment, or if the observed impacts are related to external sources, such as nearby stormwater discharges. Tools used in the project include sediment profile imaging, toxicity testing, toxicity identification evaluations (TIE), and chemical fingerprinting. The TIE component of the project represented a critical extension of the sediment quality triad method. (January 2000-May 2000)
EA Engineering Science and Technology (Barrow Site) Barrow, AK	In 2000, finalised two screening-level ecological risk assessments for former naval arctic research laboratory (NARL) facilities located near Barrow, Alaska, following the Alaska Department of Conservation ERA protocol. Food-web models were applied to predict the fate of bioaccumulative substances, and non-bioaccumulative chemicals were compared against toxicity benchmarks derived from numerous jurisdictions. A final ERA deliverable was submitted in June 2000 to the US Department of the Navy. (February 2000-April 2000)
Domtar Inc. (Liverpool Site) Surrey, BC	Completed an ecological risk assessment for a former creosote storage facility located immediately adjacent to the Fraser River in Surrey (Liverpool site). Issues included whether dissolved creosote compounds (PAHs) were causing adverse effects to river organisms, and whether soil contamination posed risks to terrestrial receptors. A combination of site-specific evaluation (chemistry and toxicity testing) and literature-based methods were used to assess risk. The results were incorporated into a management plan for the site that considered remediation and monitoring activities. (2000)
Office of Marine Administration & Sinclair Knight Merz Pty. Sydney, Australia	Planned and coordinated a site-specific ecological toxicity investigation for sediments in Homebush Bay, Australia, to support an ecological risk assessment. A sediment quality triad design, in conjunction with historical biota surveys, was used to assess whether residual contaminant concentrations following a proposed human health-based remediation would result in unacceptable impacts to site biota. Duties included study design, coordination of field sampling efforts, synthesis and interpretation of data, and management recommendations. Also provided technical review and guidance for adjacent sediment quality triad assessments within Homebush Bay. (July 1999-April 2000)

Vancouver Wharves Ltd. North Vancouver, BC	Participated in the development of a sediment assessment and management plan for a large-scale Canadian port facility. The major objective was to assess potential ecological effects from site contaminants in relation to a proposed major berth redevelopment. Duties included project coordination, client and regulatory agency interaction, field sampling, data analysis and interpretation, and reporting. (October 1999-October 2000)
Hemmera Inc. (Versatile Shipyards Site) North Vancouver, BC	Participated in a large sediment assessment project for a former shipyard facility in Burrard Inlet (Versatile Shipyards Marine Sediment ERA). Contaminants of concern included metals, organic contaminants, and tributyltin related to past industrial activities. Involvement included field sediment sampling (grab and core samples), effects assessments, and development of recommendations for site management. A sediment quality triad (sediment chemistry, sediment toxicity, benthic community structure) formed the basis for the sediment evaluation; the project also required assessment of potential groundwater effects. (1999)
Washington Department of Natural Resources Washington State	Participated in a risk assessment for the herring stocks (Cherry Point stocks) adjacent to three major industrial facilities in northwestern Washington State. As part of a larger ERA that investigated all potential stressors to herring (e.g., climatic, biological, physical), evaluated contaminant risks to herring stocks, including contaminated sediments and industrial discharges. (March 1999-May 1999)
Teck Coal Limited (Elk Valley Water Quality Plan) Elk Valley, BC	Senior technical lead for the implementation and evaluation of a chronic toxicity monitoring program to evaluate nitrate, sulphate, and mixture-based toxicity in the Fording and Elk rivers in response to Ministry Permit requirements. Provided interpretation of quarterly and semi-annual test results, designed and interpreted supplemental studies for amphibian toxicity and individual constituents. Liaised with the Ministry and Technical Advisory Committee. Provided technical advice and recommendations for program refinements in both water-based and sediment-based testing. (2016-2017)
Mount Polley Mining Corporation (Polley Mine Embankment Breach) Cariboo region, BC	Senior scientist responsible for aggregating the weight-of-evidence for ecological responses in the aquatic environments (Polley Lake, Quesnel Lake, Hazeltine Creek, Quesnel River) influenced by debris from a Tailings Storage Failing failure in 2014. Integrated information on risks to plankton, invertebrates, fish, and other biota from a wealth of field studies and monitoring tools, culminating in a risk assessment deliverable prepared for the Ministry of Environment. (2016-2017)
Public Works and Government Services Canada (Giant Mine Baker Creek Sediments) Yellowknife, Northwest Territories	Sediment quality specialist for an assessment of arsenic contamination associated with the remediation of Giant Mine. Part of this work entailed an assessment of sediments in Upper Baker Creek and Lower Martin Lake, with primary objectives being to investigate the distribution and potential sources of arsenic in sediments within the study area. Helped design the sediment sampling program and provided interpretation of data including visual and microscopic observations, analysis of water and sediment chemistry, and chemometric methods to determine the form of arsenic (speciation) in sediment. The results of this program will provide key data for possible future risk assessment which will inform future discussion regarding end land use, and also provide data to update calculations of metal loading to lower Baker Creek. (2015)

Royal Nickel Corporation (Dumont Project) Northern Québec	Royal Nickel evaluated the potential environmental effects associated with leachate from waste rock pile and the overburden pile associated with their Dumont Project. A specific issue arose concerning the potential categorization of the waste rock, low-grade ore, and/or overburden material as deleterious material for the purposes of Schedule II of the Metal Mining Effluent Regulations (MMER). Mr. Lawrence participated in the regulatory compliance oversight for this project, partly through directing the development technically defensible site-specific water quality objectives (SSWQOs), and partly through consultation with Environment Canada with respect to the potential for designation as deleterious material. (2013-2014)
Confidential Client (Commercial Site) Prince Rupert, BC	Mr. Lawrence was contracted by a company operating a fish processing plant in Prince Rupert, in order to identify information gaps and provide recommendations for the risk management of site-related contaminants. The intended use of the review was to provide a starting point for discussions with the Prince Rupert Port Authority, their consultants, and federal regulators. Recommendations were made concerning: rescreening of existing environment site assessment data; obtaining supplemental site characterization data (contaminant profiling); and additional risk assessment recommendations. (2012)
Confidential Client North Slave Region, Northwest Territories	Senior technical advisor to an assessment of sediment quality in an enclosed inlet adjacent to a diamond mine operation. The purpose of the ongoing investigations is to determine whether, at mine closure, a dike separating the inlet adjacent to mine operations could be opened (i.e., removed) in order to return to fish habitat. Helped design and interpret a sediment quality assessment program from 2010 to 2011 that entailed various chemistry sediment and sludge chemistry analyses, benthic community evaluation, and toxicity studies. (2011-2012)
Azimuth Consulting/ Environment Canada (Risk Characterization Guidance) Vancouver, BC	Was principal investigator for the development of risk characterization guidance for ecological risk assessment, in support of the Federal Contaminated Sites programme (FCSAP). The guidance was constructed as a chapter within the supplemental guidance currently being finalized by Environment Canada. Mr. Lawrence worked with regulators and other practitioners to harmonize the guidance with other components of the emerging guidance. Cenovus FCCL Ltd. (2011-2012)
Cenovus FCCL Ltd. Christina Lake, Alberta	Provided review and technical oversight of the Supplemental Information Request stage of the Christina Lake Thermal Expansion Project (Phases 1E, 1F and 1G). The work entailed provision of responses to regulatory feedback on an Environmental Impact Assessment submission for a proposed Oil Sands development project, specifically for issues pertaining to environmental health and contaminant fate. (2010)

Minera Panamá S.A. (Petaquilla Baseline HHERA)
Petaquilla, Panama

Provided senior review and ecological risk assessment contributions to the baseline Human Health and Ecological Risk Assessment (HHERA) report for the Minera Panamá S.A. Copper Project. A baseline study was conducted to allow an appropriate assessment of the project's potential impacts. The HHERA integrated data from multiple studies and investigations (including those conducted by other study disciplines) and interpreted these data in the context of potential human and ecological health risks. Conducted a review of toxicity reference values to support an evaluation of site contaminants (principally metals/metalloids and PCBs) to evaluate risks to mammals and birds. (2009)

Azimuth Consulting/Environment Canada (Toxicity Guidance)
Vancouver, BC

Was principal investigator for the development of risk assessment guidance for the selection and interpretation of toxicity tests. The guidance was prepared to supplement existing federal guidance for ecological risk assessment. The project provided a systematic process for identifying candidate tests, and then provided a summary of evaluation criteria for choosing among candidate test protocols and endpoints. Existing protocols were summarized in a preliminary manner using the evaluation criteria, and the selection process was linked to other federal guidance developed by Azimuth Consulting Group. (2009)

BHP Billiton (Ekati Mine)
Kennady Lake, Northwest Territories

Was lead technical investigator for a study conducted to summarize and synthesize biological monitoring data for the Ekati diamond mine receiving environment downstream of mine operations. The report provided scientific information to assist BHP Billiton with environmental management and permitting of mine activities. The study entailed review and synthesis of a large quantity of environmental monitoring data from 1995-2006, for the mine and surrounding environment, much of which was available in Aquatic Effects Monitoring Program (AEMP) documentation. In addition to distilling pertinent technical findings from the AEMP reports, Mr. Lawrence incorporated additional data analyses, emphasizing biological data including plankton, sediment benthic community measures, and fish health indices. At the same site, he separately provided senior oversight of a wildlife ecological risk assessment component in support of an Environmental Impact Statement for a kimberlite diamond mine. This role entailed developing toxicity reference values for acute and chronic exposures of wildlife to metals associated with mine development and provision of guidance for screening of contaminants and risk characterization. (2008)

Capital Regional District (Hartland Landfill Leachate)
Victoria, BC

Conducted assessments of leachate chemistry from the Hartland landfill. The work entailed analysis of high-resolution data and comparison to environmental quality thresholds. Using a fingerprinting approach, leachate compositions were compared against CRD wastewater chemistry and literature studies to provide information on likely sources. Temporal trend assessments and comparisons to other jurisdictions were also completed. (2006-2007)

New Skeena Forest Products Inc.
Prince Rupert, BC

Acted as Task Manager for environmental investigations related to closure of lagoon areas associated with a former mill site located on Watson Island, near Prince Rupert. The first stage of evaluation included gathering information required to evaluate the feasibility and relative merits of various options, including natural recovery. Tasks included: (1) identification of candidate remedial options for site; (2) delineation of dioxin-like substances in lagoon sediment and biota tissue; (3) evaluation of wildlife risk for biomagnifying substances; (3) evaluation of risks to the benthic invertebrate community using a sediment quality triad approach, incorporating toxicity identification evaluation; and (4) oversight of a water circulation assessment. In the future, the project will entail finalisation of remedial objectives and preparation of a risk-based remediation plan, and post-closure monitoring and reporting. (2005-2006)

BHP Billiton (BHP Steelworks Site)
New South Wales, Australia

Provided risk assessment review and guidance for an estuarine industrial facility in New South Wales (BHP decommissioned steelworks site). Liaised with local consulting firms to design a tiered groundwater and sediment ERA that incorporated knowledge of background sediment chemistry and substrate conditions. (2000)

Luscar Coal & Elk River Basin Coal Producers
Southeast BC

Conducted two human health-risk assessments for selenium-contaminated fish intake in the vicinity of coal mining operations in British Columbia and Alberta. The risk assessments considered both the essentiality and toxicity of selenium, and used a weight-of-evidence approach to assess the potential for harm (or benefit) for recreational anglers that may consume moderate to high quantities of local fish. HHRA deliverables were provided to Luscar Coal and the Elk River Basin Coal Producers in March and July. (2000)

Cortez Gold Mines Ltd. (Cortez South Pipeline Site)
Nevada

Assisted in conducting a risk assessment supporting an Environmental Impact Statement for the development of a proposed open pit gold mine (South Pipeline Terrestrial ERA). The ERA focused on estimating the ecological risks associated with post-closure conditions, since the formation of a pit lake after mine closure is expected to result in elevated concentrations of metals in the water. The major concern was whether the predicted water quality would affect birds and mammals potentially utilising the area. A major component of the study was an extensive review of avian and mammalian toxicity to metals. (1998)

PROJECT EXPERIENCE – BIOACCUMULATION MODELLING

Weston Solutions & U.S. Environmental Protection Agency
Pittsfield, MA

Provided a technical oversight role on behalf of the USEPA for application of a food web bioaccumulation model (AQUATOX) to modelling of PCBs in the Housatonic River, Massachusetts. Duties included scoping of biological fate and partitioning processes, and development of a Model Framework document to guide the implementation and parameterisation of the model. Also contributed to the “Responsiveness Summary” as part of the formal Consent Decree process. (January 2000-December 2001)

Weston Solutions & U.S. Environmental Protection Agency
Pittsfield, MA

Applied a separate food web model (QEAFDCHN) and managed a team of biological modellers studying the bioaccumulation of PCBs in the freshwater aquatic food web (Housatonic River, MA). The project required application and customisation of a bioenergetics-based time-dependent food web model. Successfully applied the model to a Test Reach of the Housatonic River. The model was then calibrated within the Primary Study Area, and validated using a broader model domain and an independent data set. The model entailed simulation of multiple trophic levels, PCB congeners (including both dioxin-like and dominant congeners), and ecosystem types (flowing and impounded environments). The model was implemented using both a deterministic and distribution-based framework, and was formally evaluated for goodness-of-fit. The model was presented to the public, stakeholders, and the formal Peer Review under the Consent Decree for the site. The project work also entailed liaison with client group, other study team members, and hydrodynamic modelers as part of a collaborative effort. (January 2001-December 2004)

Weston Solutions & U.S. Environmental Protection Agency
Pittsfield, MA

Extended the application of the food web model (QEAFDCHN) to the development and testing of Interim Media Protection Goals (IMPGs). The model was applied in back-calculation mode to assess scenarios associated with General Electric's Corrective Measures Study (CMS). The model was applied to forecast changes in the environmental concentrations of PCBs associated with various remedial options. The project entailed provision of expert advice to U.S. EPA regarding model assumptions and linkage to the human and ecological risk assessments for the Site. A continuing role on the project entails re-running the model for various remedial alternatives identified under the Corrective Measures Study. (January 2005-November 2008)

Office of Marine Administration & Sinclair Knight Merz Pty.
Sydney, Australia

Participated in the preparation of a detailed human health risk assessment of sediments near the 2000 Olympics site in Sydney, Australia (Homebush Bay). A specific objective was to define a dioxins/furans concentrations in fish tissue, and thereby sediments, that will not result in unacceptable human health risks. A food-chain bioaccumulation model was used to describe the mathematical relationship between bay sediments and fish tissue concentrations. The model findings were compared to field biota-sediment accumulation factors (BSAFs), and were considered in the back-calculation of a sediment remediation objective. (May 1998-April 1999)

National Oceanic and Atmospheric Administration (Sheboygan Site)
Wisconsin

Participated in an ecological risk assessment for a USEPA Superfund site in Wisconsin, USA (Sheboygan River). A time-dependent food chain bioaccumulation model was used to describe congener-specific PCB accumulation in resident river fish species. The model accounted for fish growth, changes in dietary composition, and environmental parameters over time, as the fish age and over different seasons. The model was validated by comparing predicted fish tissue concentrations to observed (i.e., sampled) fish. A rationale was proposed for using the model to establish sediment concentrations that are protective of fish and piscivorous avian and mammalian receptors. (September 1998-October 1999)

Department of Navy and EA Engineering, Science, and Technology
Barrow, AK

Applied a terrestrial fugacity-based environmental fate model at two Alaskan sites (Airstrip Site and Powerhouse Site) to predict the uptake of hydrophobic contaminants (e.g., PCBs, phthalate esters) from soil, sediment, and water into plant and animal tissues. Concentrations in foodstuffs were incorporated into a simple terrestrial food web model to determine whether ingestion rates of these chemicals by arctic fauna exceed safe toxicity threshold levels. (February 2000-April 2000)

PROJECT EXPERIENCE – STATISTICAL DATA ANALYSIS

Capital Regional District – Scientific Programs
Victoria, BC

Acted as Project Director for multiple reports related to a technical review of the quality assurance and quality control (QA/QC) program associated with environmental monitoring of the Capital Regional District (CRD) wastewater treatment facilities and surrounding receiving environment. The primary objective of these studies was to assess and, as appropriate, make recommendations for modifications to the QA/QC program. These reports included development of rigorous data quality objectives and data flagging (sediment, tissue, and wastewater chemistry data) and specification of control ranges for the identification of anomalous data. Follow-up actions in terms of data analysis and storage (i.e., use of appropriate statistical analyses to describe data, how to deal with outliers and non-detected values, etc.) were also considered. (June 2007)

Capital Regional District – Source Control/Scientific Programs
Saanich, BC

Acted as Project Manager for a critical review of the Saanich Peninsula Wastewater Treatment Plant (SPWWTP) monitoring program. The overall objectives of this study were to: (1) review the monitoring parameter lists and make recommendations on parameters and monitoring frequency; (2) to assess the respective value of grab samples versus composites for meeting overall program objectives; and (3) to assess if the current method detection limits for each parameter are suitable for future trend analyses. The outcome of the study was a set of specific recommendations regarding the type, frequency, and timing of influent and effluent sampling in order to maximise the effectiveness of the monitoring program. (June 2006-April 2007)

Department of Fisheries and Oceans
Kootenay Region, BC

Provided data management expertise to Department of Fisheries and Oceans (DFO) fish health studies in the Columbia River. Performed quantitative analyses of the fish health and contaminants data from several sampling programs, using appropriate statistical tests including analysis of variance, analysis of covariance, linear regression, contingency analysis, and nonparametric methods, in order to assess the spatial and temporal trends in fish health. Results for fish meristics, muscle metals, liver metals and metallothioneins, polychlorinated organic contaminants, mixed function oxidase activities, stomach contents, disease, and histology were documented in DFO reports. (February 1995-February 1997)

BC Hydro and Power Authority
Burnaby, BC

Provided data analysis assistance for a BC Hydro investigation of reservoir inflows for major drainage basins in BC. Employed techniques such as linear regression using indicator streamflow data, Fourier smoothing, and manual adjustments in order to quality control and correct (noise removal) reservoir inflow data. (September 1990-April 1992)

PROFESSIONAL AFFILIATIONS

Registered Professional Biologist (RPBio), BC College of Applied Biology, 2005 to present

Association of Professional Biologists (BC), 2005 to present

Society of Risk Analysis, 2009