SIO SILICA CORPORATION
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Calgary, Alberta
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ELECTRONIC MAIL

February 13, 2023

Clean Environment Commission
305-155 Carlton Street
Winnipeg MB R3C 3H8

RE: Vivian Sand Extraction Project – Witness Panel CV Submission for CEC Proceedings

Dear Clean Environment Commission Panel,

Enclosed please find CV's for Sio Silica's witnesses at the upcoming hearing. Sio will have three subject-specific panels: a Geotechnical Panel, a Hydrogeology and Geochemistry Panel and a Permitting and Business Panel designed to cover remaining topics.

Panels will be comprised of technical specialists for each topic and Sio representatives.

The anticipated witnesses as of today are listed below.

- Steve Bundrock, Stantec
- Arash Eshraghian, Stantec
- Douglas McLachlin, AECOM
- Ryan Mills, AECOM
- Miln Harvey, AECOM
- Cheibany Ould Elemine, AECOM
- Clifton Samoiloff, AECOM
- Marlene Gifford, AECOM
- Matt Kowalski, AECOM
- Tom Meuzelaar, Life Cycle Geo, LLC
- Mohsen Barkh, Recens Mine Water Consulting Services
- Feisal Somji, Sio Silica Corporation
- Brent Bullen, Sio Silica Corporation
- Laura Weeden, Sio Silica Corporation

Regards,

[redacted]

Laura Weeden P. Eng.
VP Operations

Steven Bundrock P.Eng.

Senior Principal
22 years of experience · Calgary, Alberta

Steve Bundrock provides senior mine geotechnical and integrated engineering support for the investigation, analysis, design, construction, operation, surveillance, mitigation, closure and reclamation of underground and open pit mines, mine rock and tailings storage facilities, water management structures, MSE walls and infrastructure foundations.

Steve has more than 20 years of experience in mine geotechnical engineering in resource environments which include gold, copper, silver, iron, molybdenum, potash, coal, oil sands, phosphate, sand and aggregates. Steve has a deep background in hazard assessment and management, active intervention, root cause analysis, and development of safe work procedures. He routinely leads multi-disciplinary projects in geotechnical risk assessment and mitigation, regulatory permitting, decharacterization and decommissioning, mine futures strategic planning as well as optimization to address planning, design and operational issues. He has led and participated in technical working groups with public, private and government stakeholders, mine development and mitigation regulatory hearings, negotiations with mine insurers, mine ownership transfers and mine slope failure and fatality investigations. He further directs teams to plan and execute field investigations including dam safety reviews, site inspections, construction oversight, borehole drilling, test pitting, mapping, in-situ and laboratory testing, and instrumentation installation, automation and results visualization.

Prior to joining Stantec, Steve worked in active mining operations, first as a geotechnical engineer in training at a phosphate mine, then as a geologist at an underground and open pit gold mine and later as a drill and blast engineer at an open pit copper mine.

EDUCATION

Bachelor of Science, Geological Engineering, Montana Tech, Butte, Montana, United States, 2003

Bachelor of Arts, Political Science, University of Montana, Missoula, Montana, United States, 1992

REGISTRATIONS

Professional Engineer, Engineers Geoscientists Manitoba

Professional Engineer, Association of Professional Engineers and Geoscientists of Alberta

Professional Engineer, Engineers and Geoscientists British Columbia

Professional Engineer, Engineers Yukon

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

PROFESSIONAL LEADERSHIP

Alberta Chamber of Resources Dam Integrity Advisory Committee

Montana Tech Industry Advisory Board

Engineers Yukon Council

Engineering Competency Assessor, Engineers and Geoscientists British Columbia

Mentor, Association of Professional Engineers and Geoscientists of Alberta

RELEVANT PROJECT EXPERIENCE

Underground Mine Geotechnical Assessment, Sio Silica, Manitoba | Sio Silica | Senior Geotechnical Reviewer

Senior reviewer and project sponsor for geotechnical assessments and design for underground sand mine. Site is located near Vivian, Manitoba and planned mining would be carried out using surface drilling and underground extraction techniques that includes drilling through quaternary sediments, carbonates and shale into underlying sand. After sand removal, stability of the overlying material is controlled by overlying caprock. Guided development of site investigations to collect geotechnical information (structural and lithology data), downhole survey, complete photography, sampling and follow-up laboratory strength testing. Reviewed borehole drilling, laboratory testing, side scan sonar, and surface settlement results and other background information. Guided development of overburden, caprock and sand cavity design assumptions, assessment of probable failure modes and completed senior review of FLAC and other geotechnical assessment results. Identified borehole and multi-borehole spacing design parameters to limit potential for surface settlement during sand extraction, assessment of range of most likely case and reasonable worst case, overburden, caprock and sand cavity parameters. Reported results and provided recommendations for ongoing and future monitoring, investigation, analysis and verification.

Underground Mine Geotechnical Assessment, Highvale Mine, Alberta | SunHills Mining | Project Manager and Senior Geotechnical Engineer

Completed site investigation to characterize underground conditions including borehole logging, instrumentation installation and monitoring followed by development of material properties and other design parameters. Guided Finite Element Modeling of auger underground mining method to optimize resource removal while limiting surface subsidence and maintaining stability of adjacent open pit mine slopes. Completed 2D limit equilibrium assessment of adjacent pit slopes with worst case underground openings scenarios and provided recommendations for auger mining designs and maximum surface mining limits. Prepared and presented results for regulatory permitting and provided response to regulatory supplemental information requests.

Underground Mine Structural and Lithology Logging and Mapping, Golden Sunlight Mine, Montana | Placer Dome Gold | Geotechnical Engineer

Following sublevel stoping mine advance blasting and mucking activities, completed detailed mapping of underground mine workings (ribs, roof, floor) to describe lithology, ore zones and structure orientation, infill, persistence and other characteristics. Assessed mapping results and updated mine 3D ore body and structural model to guide mine planning and support requirements. Also completed laboratory based comprehensive borehole logging of mine advance drilling results including lithologic and structural descriptors, photography, in-situ strength testing, sampling and laboratory testing for reserve estimation, confirmation of rock strength parameters and assessment of kinematic failure modes for stability analysis.

Underground Mine Assessment, State Route 45 Gilsonite Pillar Collapse and Road Subsidence, Confidential Client, Utah | Senior Geotechnical Engineer

Served as lead geotechnical engineer to assess the contributing factors to road collapse of State Route 45 in area of underground Gilsonite mine pillar. Completed background information review and carried out a site investigation to visually observe, photograph, measure and otherwise document area conditions. Met with site engineers and other stakeholders to assess geological and ore body models, mining method and history, area geotechnical, groundwater and surface water conditions, drainages, runoff pathways, and stormflow potential. Collected material samples of country rock and ore material and completed laboratory testing to characterize overburden soil and rock material (pillar) strength and structure, permeability and susceptibility to weathering and erosion. Investigated storm events and probable maximum flood and carrying capacity of area stormwater systems as well as pillar geometry relative to contributing inflows. Identified and documented contributing factors from road construction, maintenance, mining and nearby surface water management infrastructure.

Underground Mine Geotechnical Investigation, Carbon Creek Mine, British Columbia | Cardero Mining | Geotechnical Engineer

Led development of site investigation cost estimate, procurement, planning, logistics and execution to assess geotechnical conditions for developing underground mine and related surface infrastructure. Conducted site investigation including identification of target drilling locations and depths, borehole drilling, logging for overburden and rock geotechnical characteristics (lithology, structure, constituents, water etc.), sampling of representative materials, high resolution photography, standpipe and vibrating wire piezometer installation for baseline groundwater monitoring, data collection and follow-up laboratory testing to characterize ground conditions for analysis and design.

Mine Closure Cost Estimate, Smokey River Mine, Alberta | Alberta Environment and Parks | Senior Geotechnical Engineer

Completed geotechnical assessment of mine closure options for closure cost estimate for underground and surface mining facilities. The site includes numerous underground mine entries and other workings, surface pits and waste dumps, water management ponds, mine access roads, landfills and other mine infrastructure. Completed background information review and gap analysis to develop project understanding and risk profile. Assessed condition of infrastructure, history of operation, performance monitoring and mitigation to gauge current condition. Assessed critical risks associated with larger higher consequence water management ponds and dams. Provided recommendations to close gaps and guidance for stabilization, resloping, removal, cover and revegetation of existing structures to inform cost estimate.

Mine Remediation Performance Monitoring and Reporting, Bullmoose and Ruth Mines, Northwest Territories | Public Services and Procurement Canada | Senior Geotechnical Reviewer

Served as the senior reviewer for remediation, monitoring and reporting of Bullmoose and Ruth Mines closure. The project includes seven sites with both underground and surface mine infrastructure such as raise vents, shafts, landfills, tailings storage facilities, water management systems and restored stream channels. As part of the long term performance management plan compliance reporting, an annual site visit is carried out by senior engineers to assess the condition of surface and underground mine workings including surface expressions of collapsing or settling underground workings and performance of remediation capping of underground openings. An annual performance report is prepared to document observed conditions and potential non-compliances or other issues and to provide recommendations for maintenance and/or additional remediation. Completed senior review of the annual site visit and other related reports, assessed areas of non-compliance and identified action items to address observed issues. This project has been ongoing since 2019 and long term monitoring, maintenance and mitigation is occurring.

Boundary Technical Study of Impacts of SAGD Underground Extraction on Adjacent Mine Infrastructure, Mackay River/MLX-W, Alberta | Suncor/Syncrude | Senior Geotechnical Reviewer

Served as a cold eyes reviewer of the Boundary Study to determine the possible impacts of steam assist gravity drainage (injection and extraction) at the MacKay River site on the adjacent MLX-W open pit as both projects advance towards one another. Supported project goals to assess potential risks to each operation along the boundary introduced by underground and open pit mining, determining if data gaps or uncertainties are present, developing options to mitigate risks as well as monitoring plan to confirm assumptions and performance. Identified material strengths, groundwater and other modelling parameters. Detailed modelling of the most likely case and reasonable worst case scenarios for heaving, steam release, sliding and other failure modes was carried out by third party (University of Alberta) modelling experts. Completed review of modelling results, rationalized and reported results.

Underground Mine Site Investigation, Red Dog Mine, Alaska | Teck Resources | Senior Geotechnical Reviewer

Served as the senior geotechnical engineering reviewer for project to investigate underground mine workings for design. The project included borehole drilling, logging for structure, lithology, and other characteristics, photography, sampling of representative materials, axial and diametral point load testing of core samples, packer testing to identify hydraulic conductivity, downhole acoustic and optical televiewer survey and installation of vibrating wire piezometers to monitor groundwater conditions over time. Provided senior support to identify the site investigation team, to develop logging and other site investigation protocols and templates, reviewed daily drilling results to assess progress, identify developing issues and plan mitigations. Developed template and provided guidance for site investigation factual report and completed senior review for accuracy and completeness.

Stabilization, Reclamation and Closure of Rock Piles at Underground Mine, Questa Mine, New Mexico | Chevron Environmental Management Company | Senior Geotechnical Engineer

Served as the senior geotechnical engineer on multi-disciplinary project to complete phased mine rock pile design and construction for slope stabilization, regrading, capping, revegetation, water management and acid rock drainage mitigation. Completed definition of technical requirements, directions for site investigations and design processes, identification and mitigation of project risks and preparation and shepherding of design and construction packages through multi-tiered client and government stakeholder review and approval processes. Project included InSAR study to assess possible surface subsidence over time in response to settlement of extensive underground workings below the waste rock piles and other infrastructure. Assessed study results in key project areas to gauge impacts of measured settlement on past, present and future performance.

Karst Investigation and Subsidence Performance Monitoring, Muskeg River Mine, Alberta | Shell Canada Energy | Project Manager and Senior Geotechnical Engineer

Underground karst features were identified in the mine footprint of an active open pit mine which posed a hazard to personnel and infrastructure due to the potential for surface subsidence and related impacts. Reviewed background information including the results of site seismic tomography survey completed at 50 m spacing to identify locations of karst features, offsets from infrastructure, relative risk, gaps in information and other uncertainties. Conducted multiple site visits to visually observe currently impacted areas and probable surface expressions in mine advance areas. Evaluated impacts on wall stability and other short and long term risks and reported results in monthly performance monitoring reports. Provided recommendations for monitoring of retrogression and offsets and mitigations for managing short and long term risks.

Stress Strain Analysis of Mining Deformation Impacts, Muskeg River Mine, Alberta | Shell Canada Energy | Project Manager and Senior Geotechnical Engineer

Guided numerical modelling stress/strain analysis which used Sigma/W to investigate pit wall deformations adjacent to the plant site. Plant site engineers identified zero tolerance for foundation deformations which may be produced by nearby open pit mining and related stress relief or other slope movement. The team collected monitoring data from in-picket slope inclinometers installed behind the pit crest and calculated stress relief in response to mine advance, pit wall geometries, lithologies, dip angles and piezometric conditions. Material properties from performance monitoring, site investigation and laboratory testing were used to inform the Sigma/W model. Varying pit wall geometries and advance distances for most likely case and reasonable worst case conditions were modeled to identify probable deformation magnitudes in response to mining. Results were used to safely remove ore while mitigating deformation risk to the plant site infrastructure.

Mine Rock Storage Facility Numerical Modeling Back-Analysis, Confidential Client, British Columbia | Project Manager and Senior Geotechnical Engineer

Guided FLAC and 2D limit equilibrium stability spoils failure back-analysis. Deformation behavior was simulated using the Mohr-Coulomb constitutive model and assuming plastic flow in FLAC 2D modeling software. Results were used to confirm and refine limit equilibrium back-analysis to identify probable failure contributors. A combination of contributors were identified including rapid construction, surface water inflows and buildup of pore pressures, and crushing and generation of weak zones. Based upon the results, mitigation recommendations were provided and a guidance document was produced which identified placement rates and methods, surface water management, source materials, quality control and assurance and performance monitoring and mitigation good practice.

Arash Eshraghian Ph.D, P.Eng., P.E.

Principal/Senior Geotechnical Engineer
22 years of experience · Calgary, Alberta

Arash is a Principal/Senior Geotechnical Engineer with 22 years of experience leading and managing civil and geotechnical engineering projects. He excels at technical leadership of engineering teams solving complex geotechnical problems for mining projects. He provides senior technical support for the analysis, design, construction, operation, surveillance, and mitigation of underground and open pit mines, mine rock and tailings storage facilities, water management structures, MSE walls, and haul roads. He has led projects for deformation and stability analysis of soil and rock slopes, slope stability risk evaluation, various water and tailings dam designs and performance reviews, waste rock pile designs, borrow source investigation and analyses, dam design section optimization, dam spillway designs, preparation of construction drawings and specifications and dam safety assessments and risk analyses. He has experience working on more than 50 projects in Canada, the United States, South America, and Australia.

Prior to joining Stantec, Arash worked in various consulting companies, progressing from a geotechnical engineer in training to a senior-level engineer. Arash has extensive education and research background in soil and rock mechanics, numerical modeling, and slope stability and seepage analyses. Dr. Eshraghian is the winner of the 2009 Thomas Roy Award from the Engineering Geology Division of the Canadian Geotechnical Society, 2009 RM Quigley Award (Honorable Mention) from the Canadian Geotechnical Society, and the 2007 Association of Environmental and Engineering Geologists (AEG) Best Publication award. Currently, he serves as the reviewer for the Bulletin of Engineering Geology and the Environment. Arash has also served as a reviewer and session moderator for the Canadian Geotechnical Society and Tailings and Mine Waste conferences.

EDUCATION

Doctor of Philosophy (Ph.D.), Geotechnical Engineering, University of Alberta, 2007

Master of Science (M.Sc.), Geotechnical Engineering, University of Tehran, 1998

Bachelor of Science, Civil Engineering, Shiraz University, 1995

REGISTRATIONS

Professional Engineer, Engineers Geoscientists Manitoba

Professional Engineer, Association of Professional Engineers and Geoscientists of Alberta

Professional Engineer, Engineers and Geoscientists British Columbia

Professional Engineer, Board of Professional Lands Surveyors Idaho

RELEVANT PROJECT EXPERIENCE

Mine Geotechnical Assessment, Sio Silica, Manitoba | Sio Silica | Senior Geotechnical Reviewer

Senior engineer for geotechnical analysis of the underground sand mine. Site is located near Vivian, Manitoba and planned mining would be carried out using surface drilling and underground extraction techniques that include drilling through quaternary sediments, carbonates and shale into underlying sand. After sand removal, stability of the overlying material is controlled by overlying caprock. Reviewed site investigation data (structural and lithology data), downhole survey, and borehole logs and laboratory data. Developed sand cavity design assumptions, assessed probable failure modes, completed senior review of FLAC 2D analysis and completed the bending failure mode analysis to define maximum allowable cavity size and support borehole and multi-borehole spacing design parameters to limit potential for surface settlement during sand extraction. Reported results and provided recommendations for ongoing and future monitoring, investigation, analysis and verification.

Designer of Record, OPTA East Tailings Dam, Forthills Operation, AB | Suncor Energy | DOR Engineer

Designer of Record for OPTA East Dyke, an approximately 70 m tall tailings dam to store approximately 300 Mm^3 of tailings and water. Led the advanced sampling and laboratory testing and advanced deformation modeling using FLAC2D to predict deformation during construction. Led updates to the dam design and supported the Engineer of Record during the dam construction/operation. Led the engineering team to update the overall design of the dam including detailed analysis and design of dam, preparation of design reports and construction drawings, establishment of quantifiable performance objectives, and assessment of performance of the dam during construction.

MTM Spoils Failure Investigation, Line Creek Operations, BC | Teck Coal | Lead Engineer/PM

Led and managed post-failure investigation of a waste rock spoil failure with pre-failure face height of 200 m. The investigation included review of construction records, weather data, material quality and quantity, failure triggering analysis, and post-failure conditions. The triggering mechanism analysis included limit equilibrium and advanced numerical modelling (FLAC 2D) to evaluate the most likely deformation and failure modes. The final report included a summary of findings of the investigation and recommendations for future design and construction considerations for the spoils in the area.

ETA Dyke – Advance Numerical Analysis, Fort McMurray, Alberta, Canada | Shell Canada – Albian Sands, Alberta | Project Engineer

Utilized an advanced numerical modelling software (FLAC 3D) and conducted a 3D deformation modeling and stability analysis to demonstrate and confirm stability of a tailings dam. Prepared presentation for reporting findings to senior team and external review board to confirm safety requirements would be met and dyke stability would improve.

Grassy Mountain Coal Project, Pit Slope Stability Analysis, Alberta | Benga Mining Limited | Lead Engineer

Optimized the Pit Slope Stability and Monitoring Design Program. Led pit wall stability analyses and preliminary stability monitoring system design for highwalls, endwalls and footwalls rock slopes of a proposed open pit mine operation in Crowsnest Pass, Alberta, as part of support for response to a Supplementary Information Request from Alberta Environment and Parks (AEP).

Beaufort Sea Steel Drill Cason (SDC) Ice Load Analysis, Canada, | Canadian Research Council | Geotechnical Engineer

Estimated the ice load on an offshore Drilling Platform in Beaufort Sea using field data and advanced numerical modeling (FLAC 3D) for deformation analysis and reported the findings to client. Co-authored a paper presenting the result in 2009 Canadian geotechnical conference.

North and Central Waste Rock Dumps Offset Assessments, Grassy Mountain Mine, AB | Riversdale | Review Engineer

Led review of stability of the Central and North Dumps, approximately 200 m high overall slope, at the vicinity of surge ponds at the toe. The assessment included evaluation of dumps stability and provide mitigation options for stability improvement and assessment of flowslide and rock rollout distances and their effect on the adjacent surge ponds. Reported the findings to Riversdale in a summary report.

Central Highwall Stability Assessment, Grassy Mountain Mine, AB | Riversdale | Review Engineer

Led review of the stability of the Central Highwall, approximately 250 m high and 3 km long pitwall in Grassy Mountain mine. The assessment included a review of joint and rock mass strength parameters, completion of a kinematic analysis of bench scale stability and completion of a global stability analysis of the pitwall design. The recommendations for pitwall stability mitigation options for various sectors of the highwall, site investigation recommendations, and instrumentation installation recommendations were provided to Riversdale.

Eagle 4 Spoils and SRFER Pond Design, Fording River Operations, BC | Teck Coal | Supporting Senior Engineer/PM

Managed project and provided additional senior engineering support for global stability of Eagle 4 Waste Rock Spoils and Saturated Rock Fill Effluent Retention (ESRFER) Pond at the FRO site. Managed the project budget schedule and deliverables, completed the waste rock dumps settlement calculations, and reviewed deliverables for quality and consistency.

BRN Access Haul Road Geotechnical Assessment, Line Creek Operations, BC | Teck Coal | Lead Engineer

Led geotechnical assessment of lifts for Burnt Ridge North (BRN) Access Haul Road at the Line Creek Operation. The access haul road was designed to use approximately 13 Mm^3 of waste rock placed in multiple lifts. The duties included completion of the slope stability, flow slide runout and rock rollout evaluation for waste rock spoils for the haul road and preparation of the assessment report.

Phase 1 Waste Rock Spoils Redesign, Line Creek Operations, BC | Teck Coal | Lead Engineer

Led geotechnical redesign of the Phase 1 Waste Rock Spoils, approximately 60 Mm^3 Waste rock spoils, at Teck's Line Creek Operation. The duties included review of the slope stability, flow slide runout and rock rollout evaluation and preparation of a preliminary design report for the waste rock spoils.

MTM Spoils Redesign, Line Creek Operations, BC | Teck Coal | Lead Engineer

Led geotechnical engineering design for MTM Spoils, approximately 65 Mm^3 Waste rock Spoils, at Teck's Line Creek Operation. The duties included slope stability, flow slide runout and rock rollout evaluation and preparation of a preliminary design report for the spoils.

Phase 3 Access Road Geotechnical Assessment, Grassy Mountain Mine, AB | Riversdale | Lead Engineer

Led geotechnical design options for Phase 3 Mine area access haul roads at Grassy Mountain Mine in Alberta. The geotechnical assessment included evaluation of slope stability of multiple options for construction of access haul roads using waste rock spoils. The design activities included foundation and spoil material evaluation, slope stability, flow slide and rock rollout analysis and reporting.

Phase 3 Waste Rock Spoils Site Investigation and Design, Greenhills Operations, BC | Teck Coal | Lead Engineer/PM

Led and managed the site investigation and geotechnical design of Phase 3 Waste Rock Spoils at Teck's Greenhills Operations located approximately 10 km northeast of Elkford in southeastern British Columbia. The Phase 3 Spoils included placement of approximately 335 Mm^3 waste rock in seven major lifts with maximum face height of 200 m. The site investigation included boreholes and auger drilling, piezometer installation and field and laboratory testing. The design activities included foundation and spoil material evaluation, slope stability, flow slide and rock rollout analysis and reporting.

Muskeg River Mine and Jackpine Mine Pitwall Design Optimization Project, Alberta | Canadian Natural Upgrading Limited (CNUL) | Senior Engineer

Supported the design optimization for MRM and JPM pitwalls. Developed an innovative design approach for MRM and JPM pitwalls (approximately 80 km long) based on instrumentation data, previous performance, pitwalls geometry, controlling geological factors, groundwater and surface water conditions and considered data accuracy, failure characteristics and risk.

Pit Boundary Option Analysis, Aurora North Operations, Wood Buffalo, Alberta | Syncrude Canada Limited | Lead Geotechnical Engineer

Lead geotechnical engineer for Pit Boundary Option Analysis and the in-pit dykes and pit wall preliminary geotechnical designs of a common boundary between Shell Canada Muskeg River Mine Pit and Syncrude Canada Ltd. Aurora Pit in the Alberta Oil Sands area.

Pikeview Quarry Closure Geotechnical Design Review, Castle Aggregate, Colorado, USA | Lead Geotechnical Engineer

Led geotechnical stability review of the closure plan for the backfill of the Quarry to a future bike trail. The geotechnical assessment included a review of the foundation, backfill, previous landslide rubbles, and foundation clay beds properties, completed slope stability assessments and recommended acceptable mix design for the compacted backfill and mitigation options to improve stability and prepared a summary report.

Bull River Mine Tailings Storage Facility Geotechnical Design, British Columbia | Braveheart Resources Inc. | Senior Geotechnical Engineer

Senior Geotechnical Engineer for design of dry tailings stockpile at the Bull River Mine located in southeastern British Columbia. The tailings stockpile is designed for construction using compacted filtered tailings. The role included review of underdrain system, material properties of compacted filter tailings and foundation material, seepage and slope stability analyses for this 25 m high compacted filter tailings stockpile.

Eraring Ash Dam (ERAD) Liquefaction Consequence Assessment, Eraring Power Station (EPS), Queensland, Australia | Origin Energy Eraring Pty. Ltd. (OEE) | Lead Engineer

Led liquefaction consequence analysis for the cells and terraces of fly ash deposits in the ERAD basin. The project scope included evaluation of potential liquefaction failure areas, evaluation of liquefied ash tailings rheological properties, completion of tailings runout analysis, evaluation of wave generation and propagation due to tailings deposits into the pond, embankment overtopping evaluation, and estimation of flood consequence and reporting of the results.

Eraring Ash Dam (ERAD) Instrumentation Design Update, Eraring Power Station (EPS), Queensland, Australia, | Origin Energy Eraring Pty. Ltd. (OEE) | Lead Geotechnical Engineer

Senior Geotechnical Engineer for Eraring Ash Dam (ERAD) dam raise design. The project scope included updating the design basis, completing a Qualitative Failure Mode Analysis (QFMA) and developing a long-term instrumentation and monitoring strategy.

Detailed Design for SWC Tailings Storage Facility, Cell 2 Second Raise, South Walker Creek, Queensland, Australia, | BHP Billiton Mitsui Coal | Supporting Geotechnical Engineer

Senior Geotechnical Engineer for Stage 2 dyke raise of the Bidgerley Tailings Storage Facility (BTSF) Cell 2. The project included a review of background information, design and operations management philosophy, and geotechnical conditions relevant to BTSF development and lift design, complete the geotechnical analysis for the dyke raise and provide instrumentation design to support the dyke raise. The role included reviewing the final client deliverables and providing input to the design team

OTD and RWD Dams Monitoring Plan Gap Assessment, South Walker Creek, Queensland, Australia, | BHP Billiton Mitsui Coal | Lead Geotechnical Engineer

Senior Geotechnical Engineer for review of the current monitoring plan at the OTD and RWD Dams at the BHP South Walker Creek – Old Tailings Dam and Bidgerley Tailings Storage Facility. The project included review of the operational instruments at site, completion of a Potential Failure Mode Analysis (PFMA) and identification of gaps in instrumentation and providing recommendations for additional instrumentation monitoring to close the gaps.

South Expansion Tailings Area Dyke Detailed Design, Fort McMurray, Alberta, Canada | Shell Canada – Albian Sands | Shell Canada – Albian Sands | Project Engineer

Applied theoretical, analytical, and team leadership skills to resolve issues of a time and schedule sensitive project and delivered quality design reports and drawings and presented the results to an external review board to support construction and operation of an external tailings dyke for Shell Canada

West ETA Dyke Numerical Analysis, Kearl Oil Sands Operation, Fort McMurray, Alberta, Canada | Imperial Oil | Lead Engineer

Led numerical deformation, seepage, and stability analyses and back calculated material properties to match the observed field data and estimated the future deformation, seepage, and stability of a large tailings dyke for Imperial Oil's Kearl Oil sands operation and co-authored a paper presented the result to Canadian Geotechnical Society conference.

Kearl East ETA Tailings Dyke Design, Fort McMurray, Alberta, Canada | Imperial Oil, Kearl Oil Sands Operation | Lead Design Engineer

Led design for East External Tailings Area (East ETA), a large 90 m high tailings dyke with stability controlling soft Holocene clay in the foundation, at the Kearl Oil Sands site, northern Alberta, including detailed design of dyke geometry, internal zoning, and instrumentation; dyke raise design updates based on site observation and instrumentation data. Deliverables included construction drawings and specifications and design report.

Suncor Pond 1 2019 Soft Cap Performance Update | Fort McMurray, AB | | Suncor Energy Inc | Project Manager, Lead Engineer

Led and managed performance review of the soft cap area within Pond 1, located at Suncor's operations north of Fort McMurray, Alberta. The assessment included evaluation of pond progress toward a ready to reclaim status based on instrumentation, field, laboratory, and survey data and site inspection information. The final report identified gaps in information and recommended actions to close the information gaps and plans for moving the pond toward final reclamation.

OPTA East Dyke 2020 Annual Construction and Performance Report, Fort McMurray, Alberta | Suncor Energy Inc. | Lead Geotechnical Engineer

Led preparation of Annual Construction and Performance Report (ACPR) for OPTA East Dyke construction in 2020. The project included construction record data analysis and preparation of a summary report for regulatory submission. The reporting included presentation of construction records, QA/QC records, and comparison of as-built with design requirements.

Basal Water Storage Pond 1 Stability CNRL, Horizon Mining Operation, Alberta | CNRL | Design Engineer

Led the stability analysis for a water retention dyke within an External Tailings Dyke with maximum height of 22 m for Canadian Natural Resources Limited, including the stability analysis and setting operational requirements to achieve adequate dyke stability during dewatering and refilling of the impoundment with tailings

SELECTED PUBLICATIONS

Journal Papers

Eshraghian, A., Martin, C.D., and Morgenstern, N.R. 2008. "Movement triggers and mechanisms of two earth slides in the Thompson River valley, British Columbia", Canadian Geotechnical Journal. Vol. 45(9): 1189-1209.

Eshraghian, A., Martin, C.D., and Morgenstern, N.R. 2008. "Hazard Analysis of an active earth slide in the Thompson River valley, Ashcroft, British Columbia, Canada". Canadian Geotechnical Journal, Vol. 45(3): 297-313.

Eshraghian, A., Martin, C.D., and Cruden, D.M. "Complex earth slides in the Thompson River Valley, Ashcroft, British Columbia", Environmental and Engineering Geoscience, Vol. 9: 161-181.

Douglas (Doug) McLachlin, M.Sc., P.Eng. (MB, ON)

Senior Geotechnical Engineer

Education

M.Sc. Earth Sciences, University of Waterloo, Ontario, Canada, 1985

B.Sc. (Hons) Geological Engineering, Queen's University at Kingston, Ontario, 1982

Years of Experience

With AECOM: 8
With Other Firms: 30

Professional Affiliations

Association of Professional Engineers Ontario

Engineers and Geoscientists Manitoba

American Society of Civil Engineers

Past Member: Hong Kong Institution of Engineers

Conferences and Presentations

A Case Study for Ground Improvement Using Surcharge and Wick Drains for the Canadian Port of Entry Building Foundations of Gordie Howe International Bridge. Co-author, Geo-Calgary, October, 2022.

Trenchless Technology Selected for High Voltage Cable Installations in Hong Kong. Co-author, Proceedings of the Trenchless Asia 2002 Conference, November, 2002

Design and Assessment of the Proposed Adams Mine Landfill, Ontario, Canada. Co-author, proceedings of the 6th Environmental and Canadian Geotechnical Society Specialty Conference, London, Ontario, June 2000.

Summary

Doug McLachlin, P.Eng. is a professional engineer with more than 38 years of experience providing technical leadership for geotechnical engineering, mining, environmental assessment, waste management and renewable energy projects. He has been the technical lead for large scale infrastructure projects that include geotechnical and hydrogeological site investigations, mine tailings management, site selection and assessment studies, the design of waste management facilities and renewable energy projects. As AECOM's Geotechnical Practice Lead in Ontario, he is responsible for a team of geotechnical specialists with extensive experience in the geotechnical design of mining, road and rail, bridge / building and tunneling projects. Doug was previously a Technical Director with Scott Wilson Ltd (a heritage AECOM company) based in Hong Kong and Shanghai, China where he was a technical director responsible for the Project Management, Environmental Assessment, and Waste Management businesses.

Relevant Project Experience

Mining, Waste Management, Environmental Assessment and Infrastructure

Vale North Creighton Seepage FEL3 Services, Sudbury, Ontario. Geotechnical lead providing geotechnical recommendations for the design of the proposed infrastructure including: 1) Retention Pond Upgrade, 2) Phase 1 and Phase 2 Interceptor Trench, and 3) Pump Station 1 and 2 Force-main Alignment. The field work included advancing boreholes through the overburden and coring bedrock at selected locations. Monitoring wells were installed to measure the hydraulic conditions, monitor groundwater levels and support the application for a permit required to manage dewatering during construction.

Whiteshell Reactor-1 Disposal Facility, Canadian Nuclear Laboratories (CNL), Pinawa, Manitoba. Geotechnical lead for the detailed design of a concrete cap and earthen barrier for the decommissioned Whiteshell Reactor 1.

Nuclear Power Demonstration (NPD) Facility Engineered Barrier, CNL, Deep River, Ontario. Geotechnical lead for the design of an engineered barrier for the NPD project, including a geomembrane barrier and drainage blanket above the reinforced concrete cap.

Near Surface Disposal Facility, CNL, Chalk River, Ontario. Geotechnical lead for the design of the Engineered Containment Mound (ECM), including an assessment of the design seismic event. The presence of liquefiable soils beneath the ECM required a design to mitigate the potential for liquefaction under the seismic design loading. The engineered barrier includes a double composite base liner and leak detection system, and a geosynthetic capping system.

Port Granby Long Term Waste Management Facility, CNL, Port Granby, Ontario. Geotechnical lead providing clarification responses to tenderers for a long-term waste management facility for low-level radioactive waste and marginally contaminated soil in the Municipalities of Port Hope and Clarington. The design includes a low permeability geosynethetic capping system.

BFI Green Prairie Waste Management Facility, R.M. of Rosser, Manitoba. Geotechnical lead for the design of a 48 ha municipal solid waste landfill, including providing technical support during the environmental assessment process. The design considered the high piezometric groundwater levels in the aquifer, and the potential for basal heave in the cell excavation. Responsible for preparation of construction drawings and specifications for the single composite liner system.

Atomic Energy of Canada Limited, Atikokan, Ontario. Responsible for delineation of regional Pleistocene deposits, bedrock joint and fracture mapping, and hydrogeological classification of the Eye River Basin including installation of piezometers to characterize groundwater recharge/discharge areas.

Notre Development Corp., Adams Mine Landfill, Kirkland Lake, Ontario. Project manager for the design of a proposed 20-million tonne municipal solid waste landfill in a 200-metre-deep open pit mine. The design included a landfill gas extraction and utilisation system; a granular drainage blanket to collect leachate and groundwater; and a shaft and adit to convey leachate/groundwater to the surface for treatment. Expert witness at environmental assessment (EA) hearing to present evidence before an EA board for the Province of Ontario.

Falconbridge Strathcona Mine, Sudbury, Ontario. Design and preparation of tailings basin deposition plans including dams and retaining structures.

Ministry of Northern Development and Mines, Unattended Tailings Deposits, Ontario. Project manager responsible for inspection and preliminary evaluation of the physical and geo-chemical stability of 70 unattended tailings deposits in northeastern Ontario.

Ontario Hydro, Lakeview Coal Ash Disposal, Ontario. Design engineer responsible for concept design for disposal of two million cubic metres of coal ash at five alternative quarry sites in southern Ontario. The designs included the "pervious surround" concept and full submergence of the waste, as well as concepts involving use of hydraulic barriers (base liners and covers) and leachate collection systems.

City of Toronto, Keele Valley Landfill Expansion, Maple, Ontario. Engineer for the modelling of long-term performance of the proposed final cover for the 99-hectare landfill including hydrologic evaluation of landfill performance (HELP) modelling and research on soil cover infiltration rates. Prepared the annual environmental monitoring reports for the site.

Sudbury Region Landfills, Sudbury, Ontario. Responsible for the environmental assessment and restoration of three landfill sites located in close proximity to natural wetlands. Use of natural and constructed wetlands for attenuation of landfill contaminants was included in the designs.

Ste-Gertrude Landfill, Trois Riviere, Quebec. Design and preparation of technical specifications and construction drawings for the 40 mil HDPE geomembrane capping system at an 8ha municipal landfill including infiltration performance evaluation and stability assessment.

Cameco Cigar Lake Mine, Saskatchewan. Design and preparation of deposition plans for a proposed below-ground basin for radioactive tailings.

Sham Tseng/Ma Wan/Lantau Cable Crossings by Horizontal Directional Drilling, Hong Kong, China. Project Manager for contract management and site supervision for a HK$350 million (CDN$60 million) project to install 132kV and 11kV cable crossings beneath Ma Wan and Kap Shui Mun Channels using horizontal directional drilling. The geological conditions included complex lithology and fault/shear zones, and geometry constraints required curves in plan and section along the 1,300 m and 800 m long drillpaths beneath Ma Wan and Kap Shui Mun Channels, respectively.

Study on the Long-term Arrangements to Accommodate Inert Construction and Demolition Materials and Dredged Mud, Hong Kong, China. Project Manager for a study to identify potential sites to accommodate inert Construction and Demolition (C&D) materials and uncontaminated dredged mud until 2030. The study considered interim accommodation arrangements; materials recycling re-use and export options and the long-term option included the design of a 1,400ha artificial island situated on soft marine clays. A territory-wide site search was carried out using constraints mapping and site selection criteria that considered social, environmental, engineering, and planning issues.

Study for Restoration of the East Lamma Channel Marine Borrow Area, Hong Kong: Project Manager for a study to rehabilitate and restore the East Lamma Channel Marine Borrow Area, including re-establishment of the original ecosystem and restoring the ship anchorages.

Extension of Existing Landfills and Identification of Potential New Waste Disposal Sites, Hong Kong. Technical lead for a study to evaluate methods for extending the landfill capacity at WENT, NENT and SENT strategic landfills including a site selection study to identify potential new disposal sites to meet Hong Kong's waste management needs until 2050. Study

included a territory-wide site search to identify potential new waste disposal sites and the conceptual design of a new artificial island within Hong Kong waters.

Hong Kong – Pearl River West Link Preliminary Environmental Review: Technical lead of a preliminary environmental assessment for a 30km long bridge to connect Hong Kong to Macau and Zhuhai on the western side of the Pearl River Delta. The study focuses on landing points and associated infrastructure on the Hong Kong side. A total of eleven possible landings were reviewed with alternative road link options to identify the routes having the least environmental impacts.

Hong Kong Port – Masterplan 2020. Technical director for a strategic environmental assessment of potential sites for the development of new port facilities in Hong Kong including initial coarse screening to reduce four options to two, qualitative assessment of impacts to air, noise, water, waste management, ecology, fisheries, cultural heritage and landscape and visual impacts, and territory-wide air quality, noise and water quality modelling.

Xingfeng Landfill, Guangzhou, Guangdong, China. Project manager for the tender design of a 2,500 tonne per day landfill to meet the long-term waste management needs of Guangzhou. The design included a landfill gas extraction and utilisation system, a geosynthetic liner and a low permeability capping system to minimize leachate generation. The proximity of a drinking water reservoir for more than 80,000 people located 1km downstream of the site was carefully considered in the development of the leachate management and treatment plant design.

Study on the Future of Solid Waste Management in Macau, China. Project director for this strategic study on the long-term management of solid and hazardous waste in Macau to 2025 including review of options for expanding the existing waste-to-energy facility, site selection for development of new landfills, proposed measures for waste avoidance, reduction, reuse and recycling and targets for material recovery. Also assessed the existing collection and transfer system, proposed alternative institutional measures for encouraging reduction, reuse and recycling of waste including "polluter pays", "user pays" incentives and proposed a public education programme on the benefits of sustainable waste management.

Proposed Landfill Extension, Initial Engineering Assessment, China. Project manager for an engineering review of a proposed extension over an existing landfill with an estimated capacity of 26Mm3, landfill life of 25 years and a maximum depth of waste of 140m. Assessment included a review of liner design, geotechnical and slope stability assessments, optimisation of the landfill profile to maximise the landfill capacity, investigation of options to provide material for on-site uses and additional landfill capacity, hydrologic evaluation of landfill performance (HELP) modelling and estimation of leachate generation rates.

Wind Farm Projects, GE Energy and Vestas, China. Responsible for the foundation design and construction supervision services for more than ten wind farms and over 400 turbines. Services included establishment of site investigation and laboratory testing programmes, review of ground investigation reports, conceptual and detailed foundation designs meeting both international and local Chinese standards.

Gordie Howe International Bridge, Windsor, Bridging North America, Windsor, Ontario. Geotechnical lead for the design of the building and structure foundations, responsible for managing a team of specialists providing geotechnical analyses and design for the Canadian and US Ports Of Entry, Main Span, and Michigan Interchange including bridge, roadways, buildings and underground structures. With a main span of 850m, the structure will be the longest cable stayed bridge in North America.

Scarborough Centre Station and Sheppard East Station for proposed Scarborough Subway Extension Project with TTC, Toronto, Ontario. To extend the existing Bloor-Danforth subway from Kennedy Station to Scarborough Town Centre, and to replace the aging Scarborough Rapid Transit with a rapid transit network, two new stations were proposed. Responsible for a preliminary review of subsurface conditions based on available geotechnical information. A design report was prepared summarizing the geotechnical factual information, considerations for support of excavation, a discussion on basal stability against buoyancy pressure, tie-down micro-piles, jet grouting of sensitive surrounding structures, zone of influence due to dewatering, mitigation of ground movements, instrumentation and monitoring.

Metrolinx Finch West Light Rail Transit (LRT), Toronto, Ontario. Responsible for the geotechnical, geo-environmental and hydrogeological investigations, and baseline assessments for the main lines and maintenance and storage facilities.

Ottawa Light Rail Transit (LRT), City of Ottawa, Ottawa, Ontario: As part of Capital Transit Partners consortium, AECOM is serving as Owners Engineer for the Stage 2 expansion project for Ottawa LRT. Stage 2 consists of 44 km of new rail resulting from three extensions: Confederation West, Confederation East, and Trillium South, for 24 new and renovated LRT stations. Lead for the geotechnical and hydrogeological assessments and Owner's Engineer services for the Confederation East, Confederation West, Trillium, and Airport extensions, and maintenance and storage facilities.

Hurontario Light Rail Transit (LRT), Metrolinx, Mississauga, Ontario. The Hurontario LRT is a new 18-km LRT that will extend from its southern terminus at the Port Credit GO Station in the City of Mississauga to the northern terminus at Steeles Avenue, adjacent to the Brampton Gateway Terminal in the City of Brampton. Lead for the geotechnical assessment for the main line and maintenance and storage facilities.

Hamilton Light Rail Transit (LRT), Metrolinx, Hamilton, Ontario: The Hamilton LRT is 14 km long, running from a terminus stops at McMaster University in the west to Eastgate Square in the east with 17 at-grade stops. Lead for the geotechnical assessment for the main line and maintenance and storage facilities.

GO Rail Service Expansion – Lakeshore East Rail Corridor, Metrolinx, Toronto, Ontario: Geotechnical lead responsible for preparing Terms of Reference for the geotechnical and hydrogeological assessment for new track construction, including site investigation, laboratory testing, and reporting requirements.

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Ryan Mills, M.Sc., P.Geo. (MB, BC, AB)

Senior Hydrogeologist

Education
M.Sc., Hydrogeology
B.Sc., Earth and Environmental Science

Years of Experience
With AECOM: 19
With Other Firms: 2

Training and Certifications
Well Design and Rehabilitation
Improving Hydrogeologic Analysis of Fractured Bedrock Systems
Interpretation of Pumping Tests in Complex Settings
Groundwater Modelling
GoldSim Water Balance and Water Quality Modelling
PSMJ Project Management

Professional Affiliations
Engineers and Geoscientists Manitoba (EGM)
Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Engineers and Geoscientists of British Columbia (EGBC)
British Columbia Ground Water Association
International Mine Water Association

Summary

Ryan Mills is a Senior Hydrogeologist with 21 years of experience collecting, analyzing and presenting hydrogeological and environmental data in Manitoba, British Columbia, Alberta, Saskatchewan, Northern Canada and internationally. Ryan has significant experience in the following areas:

- Integrated Hydrogeological and Hydrological Characterization
- Fractured Bedrock Characterization
- Conceptual Model Development
- Water Resources Management
- Environmental Assessment and Permitting
- Mine Closure and Reclamation

Mr. Mills is an experienced project manager that has managed all aspects of project execution including program design, implementation, data analysis, report writing and liaison with regulatory agencies. He has coordinated and implemented numerous integrated hydrogeological investigations involving drilling, well installation, aquifer testing, monitoring, evaluation and permitting. He has managed multidisciplinary teams to successfully resolve complex problems at sites located in remote, lowland, alpine, arid and high precipitation environments. He has served as an external hydrogeology technical reviewer for the BC Ministry of Environment and BC Ministry of Energy, Mines and Low Carbon Innovation since 2013 and has contributed to provincial guidance documents pertaining to hydrogeology and groundwater modelling.

Project Experience

Mining

Sio Silica Corp., Vivian Sand Extraction Project Environmental Impact Assessment, Vivian, MB. Technical Lead for design and implementation of comprehensive field investigation to characterize hydrostratigraphy involving mud rotary, air dual-rotary, and diamond tip drilling; borehole logging and RQD analysis; installation of several piezometers, wells, and vibrating-wire transducers; and hydraulic testing of the aquifers. Directed development of 3D hydrogeological conceptual model and numerical groundwater model to support a feasibility study for silica sand extraction project. Geological model was developed from a combination of publicly available databases (the Manitoba Groundwater Information Network), private wells, and AECOM installed wells. Used model to assess impacts of an extraction and injection well field designed for sand extraction using a room and pillar method to support an Environmental Assessment application and permitting. Development of monitoring and management plans for waste streams, groundwater quantity and groundwater quality. (2020-Ongoing)

Hudbay Minerals Inc., Water Balance and Water Quality Modelling of Anderson Tailings Impoundment Area. Snow Lake, MB. Technical Lead for integrated hydrology, hydrogeology and geochemical evaluation of tailings facility in response to mineral process changes including addition of cyanide leach circuit for gold ore. Developed hydrological and geochemical inputs to GoldSim water balance and water quality model to evaluate impacts on effluent quality. (04/2017 – Ongoing)

Rockcliff Metals Corporation, Hydrogeological and Geotechnical Investigations and Development of 3D Conceptual Site Model for Tower/Rail AEP Projects, Manitoba. Technical Lead for integrated hydrogeological, geotechnical, geochemical and geophysical investigation of proposed underground mines and tailings facility. Designed and implemented drilling program to characterize geology, hydrogeology, geotechnical and geochemical properties of bedrock. Involved geomechanical logging of boreholes, packer testing, water quality evaluation, mine inflow estimation and development of a water balance and water quality model for the Bucko Lake Mine tailings impoundment. Integrated borehole geology and RQD data with oriented ATV/OTV borehole geophysical surveys in Leapfrog to characterize geological structures such as rock foliation and faulting for use in mine planning study. Developed preliminary 3D bedrock structural model in Leapfrog for input into geotechnical model of underground mine design. (07/2020 – 6/2021).

Hudbay Minerals Inc., Environmental Consequence Classification of Hudbay Facilities in Manitoba and Saskatchewan. Technical Lead for Intrinsic Hazard of Contents Dam Consequence Classifications (DCC). Ryan was responsible for coordination of geochemical and water quality evaluation for presentation and discussion at a series of workshops. Involved chemical, geochemical and toxicological data review, analysis, and evaluation of potential impact within inundation areas and downstream environment for 7 facilities in the Flin Flon and Snow Lake region. (06/2021 – Ongoing)

Canadian Premium Sand Ltd., Hydrogeological, Geochemical and Water Supply Assessment to Support Feasibility Study of Sandstone Quarry, Seymourville, MB. Technical Lead for hydrogeological and geochemical assessment of overburden and weakly consolidated bedrock at a proposed sandstone quarry. The project involved a desktop review and development of a 3D conceptual geological model to evaluate aquifer thickness and guide water supply well drilling efforts. Installed several water supply wells and monitoring wells to facilitate water level measurements and conducted 24-hour pumping tests to characterize aquifer transmissivity and storativity. Developed and calibrated a 3D numerical groundwater model using FEFLOW to simulate development of the open pit mine over a 30+ year mine life to evaluate mine inflows and assess impacts on nearby water wells and surface water features. Made recommendations for water supply well locations. (2019-Ongoing)

Goldcorp, Hydrogeology Baseline Investigations and Permitting, Borden Lake Mine, Chapleau, ON. Technical Lead for baseline hydrogeological investigation EIA of a proposed underground gold mine beneath Borden Lake to support PFS mine design, advanced exploration permitting and environmental impact assessment. Summer and winter (on-ice) drilling programs were conducted to support development of a conceptual model, determine groundwater quality and estimate groundwater inflows to the mine. Evaluated seepage through crown pillar below lake. (03/2012 – 11/2014)

Gunnar Mine, Abandoned Mine Closure Planning and Environmental Assessment, Saskatchewan Research Council, Uranium City, SK. Hydrogeologist for characterization and modelling for a comprehensive Environmental Impact Statement for rehabilitation of the Gunnar Abandoned Uranium Mine and Mill Site consistent. Installed instrumentation to characterize pit lake hydrology and interaction working closely with geotechnical engineering team. (3/2010 – 11/2013)

BC Ministry of Energy and Mines, Copper Mountain Mine, Princeton, BC. Peer Reviewer of report for Copper Mountain Mine root cause investigation of an accidental tailings. Report provided recommendations for addressing tailings, geotechnical design, quality assurance and water management issues to the permitting agency and First Nations. (03/2015 – 05/2016)

BC Ministry of Energy, Mines and Petroleum Resources, BC Ministry of Environment, Hydrogeology Review, Various Mine Sites, BC. Hydrogeology Discipline Reviewer for BC Ministry of Energy and Mines and BC Ministry of Environment. Recommended permit conditions in support of Mines Act permitting and Environmental Assessment Certificate Applications and approvals at multiple coal and metal mines including: Quinsam, Brule, Sukunka, Silvertip, Bul River, Red Chris, Dome Mountain and Gibraltar. (06/2014 – Ongoing)

BC MFLNRO CLORB, Britannia Mine Remedial Option Assessment, Britannia Beach, BC. Managed and directed characterization of soil, waste rock, surface water and groundwater contamination at the abandoned Britannia Mine underground copper mine in support of remedial planning, implementation, and monitoring. The project involved a Multiple Accounts Analysis to determine the best approach to remediating hazardous materials, soil, waste rock and groundwater to reduce copper loadings to Britannia Creek. Conducted geochemical assessment of ARD/ML and developed water balance and water quality model to aid in selecting the optimal remedial design involving a combination of physical remediation of mine waste, and diversion of clean surface water and groundwater around the mine waste. (09/2019 – Ongoing)

BC MFLNRO CLORB, Abandoned Mine Closure Planning and Remediation, Atlin Ruffner Mine, Atlin, BC. Managed and directed characterization of soil, sediment, waste rock, tailings, surface water and groundwater contamination at the abandoned Atlin Ruffner underground lead-silver mine site in support of reclamation planning, implementation, and monitoring. The project involved a dam safety review and design/implementation of passive water diversion structures at a remote alpine site in discontinuous permafrost terrain to minimize loading of lead, zinc, arsenic, cadmium, fluoride and sulphate to nearby wetlands and streams. Prepared water balance and water quality model. Managed the design and costing of water management structures and covers for two tailings ponds including a passive automatic siphon, several interceptor trenches and bituminous geomembrane covers. Project won the BC TRCR award for outstanding Reclamation Achievement in 2012 and 2019 for innovative permitting of an abandoned mine with multiple regulatory constraints. (03/2009 – Ongoing)

BC MFLNRO CLORB, Brynnor Mine/ Toquaht Bay Marina and Campground, Abandoned Mine Tailings/ Sediment Investigations and Reclamation Planning, Ucluelet, BC. Technical Lead for sediment characterization, tailings characterization and design and implementation of a detailed groundwater flow and geochemistry evaluation for the historic Brynnor iron mine tailings deposit in the marine foreshore to guide remedial planning. Involved use of both land based and water based sediment characterization approaches including sub-bottom profiling, grab sampling, sediment coring and drilling investigations to delineate and characterize tailings and sediment over a 4km^2 area surrounding the tailings deposit. The investigation revealed complex geochemical processes at the freshwater/saline interface were controlling trace metal dissolution and mobility. Remedial option development and consultation process is underway. (05/2013 – Ongoing)

BC MFLNRO CLORB, Emerald Glacier Mill and Tailings Site, Mine Closure and Reclamation, Houston, BC. Project Co-ordinator for site investigation and remedial options assessment at Abandoned Emerald Glacier Mine - Mill and Tailings Site under the BC Crown Contaminated Sites Program. Assisted with development of preferred option analysis and costing for risk- based Remedial Plan to cap tailings and contaminated soil and decommission a water supply dam. Dam stability was also assessed. Project included liaison with MFLNRO and MOE regarding dam decommissioning and Water Act permit. (5/2012 – 11/2014)

First Coal Corp., Central South Mine, Baseline Investigations and Mine Permitting, Chetwynd, BC. Project Manager for baseline hydrogeological characterization and impact assessment to support bulk sample collection and *Mines Act* permitting for the Central South project. Conducted grass roots groundwater exploration for groundwater supply and installed and tested a water supply well for dust control at the proposed coal loadout facility. (05/2007 – 12/2009)

Peace River Coal Limited Partnership, Belcourt Coal Mine, Baseline Investigations and Feasibility Study, Tumbler Ridge, BC. Technical Lead for determination of baseline groundwater quality and anticipated mine inflows for the proposed Belcourt open pit coal mine to support EIA and development of a water balance. (7/2005 – 11/2009)

Orica / Teck, Fording River Operations, Remedial Investigations of Explosives Manufacturing Facility, Elkford, BC. Technical Lead for investigation of an historic petroleum hydrocarbon release at an explosives manufacturing site at Teck's Fording River coal mine. Investigated delineated soil, groundwater and vapour contamination through test pit and drilling. Installed monitoring wells and soil vapour probes and conducted routine monitoring. Evaluated options to remediate historical hydrocarbon contamination and provided estimated costs, eventually selecting risk-based remediation to address aquatic risks. Resolved legal agreements and coordinated release of escrow by meeting requirements of risk-based CoC under BC CSR. (03/2013 - 2019)

Teck, Lagoon D Closure Design, Elkview Mine, Sparwood, BC. Project Manager and Technical Lead for integrated hydrogeology, hydrology, geochemistry and water quality modelling evaluation of conceptual design for closure of a large tailings impoundment. Project was evaluated using Leapfrog, FEFLOW and GoldSim to predict impacts to baseflow in two nearby rivers and water quality. (03/2021 – Ongoing)

Teck, Subsurface Characterization to Support Feasibility Study of Tunnel Upgrades, Elkview Mine, Sparwood, BC. Project Co-ordinator for hydrogeological and geotechnical components of tunnel rehabilitation feasibility study of at the operating Elkview Coal Mine. Involved health and safety plan development, drilling, packer testing, geophysical logging and installation of vibrating wire piezometers to depths in excess of 150 m (450 ft) in support of the hydrogeological conceptual model. Developed water balance / water quality model to evaluate impacts on water quality. Passed ISO 14001 audit by Teck. (03/2015 – 06/2020)

Redfern Resources Ltd., Mine Permitting, Tulsequah Chief Mine, Atlin, BC. Developed hydrogeological conceptual model and estimated groundwater inflows to the Tulsequah Chief underground mine in support of environmental assessment amendment, feasibility study and *Mines Act* permitting. (05/2006 – 04/2009)

Merit Mining, Mine Permitting, Lexington-Grenoble Mine, Grenoble, BC. Responsible for development of a hydrogeological conceptual model to estimate mine inflows and assess environmental impacts in support of a *Mines Act* Permit. (03/2007 – 04/2008)

Canarc Resources Corp., Baseline Investigations and Permitting, New Polaris Mine, Atlin, BC. Hydrogeological assessment of the New Polaris underground gold mine. Mine inflows were estimated and groundwater quality was monitored during dewatering of the mine using an array of instrumentation to support exploration permitting. (01/2007 – 10/2008)

Commerce Resources Corp., Baseline Investigations and Environmental Assessment, Blue River Mine, Clearwater, BC. Conducted baseline hydrogeology investigation involving packer testing of exploration boreholes at the proposed Blue River niobium-tantalum mine. (05/2007 – 11/2008)

Indigenous and Northern Affairs Canada, Faro Mine, Environmental Assessment of Mine Closure Plan, Faro, YK. Project Manager and Hydrogeology Discipline Lead for multi-discipline environmental assessment of final closure plan for one of Canada's largest abandoned mines. Project involves assessment of impacts of mine waste and a 5km long valley bottom tailings impoundment on groundwater and surface water quality in an alpine region. Characterized baseline groundwater flow and chemistry. Applied MODFLOW-USG and SFR2 modelling code to predict groundwater-surface water interaction changes at closure. Part of a large multidisciplinary team focused on conducting EIS of mine closure plan. (10/2004 – 02/2007; 2016 - Present)

Yukon Government, Mount Nansen Mine, Site Investigations, Closure Options Design, Costing and Evaluation, Carmacks, YK. Project Hydrogeologist (2005-2009) and Project Manager (2010-2011) for site investigation and remedial options assessment at the Mount Nansen abandoned porphyry gold mine under Yukon Contaminated Sites Regulation. Designed and implemented hydrological, hydrogeological, geotechnical, water quality and geochemical investigations to support development and costing of remedial options. Investigation involved a combination of sediment coring and drilling on a saturated tailings impoundment and implementation of test pads for dewatering of sediments in advance of excavation. Included preliminary design of the tailings facility closure spillway, tailings covers, waste rock pile resloping, pit backfill, water balance development, receiving environment water quality modelling (GoldSim) and permafrost evaluations. Utilized predictive water balance and water quality model to evaluate effectiveness of each remedial option. Design drawings and preliminary costing were completed and presented to Little Salmon Carmacks First Nation and Yukon Government for selection of preferred remedial option. Evaluated monitoring data to meet regulatory and permitting requirements. (02/2005 – 11/2011)

Western Copper and Gold, Casino Mine Baseline Environmental Assessment, Dawson City, YK. Technical Lead for baseline hydrogeological investigations including drilling, packer testing and instrumentation with vibrating wire piezometers and thermistors to 350 m (1,050 ft) to characterize permafrost to support PFS and EIS for the proposed open pit porphyry copper gold mine. Coordinated complex logistics for site accessible only to small fixed wing aircraft. Developed conceptual groundwater model and contributed to water balance, water quality model and water management plans. (03/2008 – 08/2011)

Yukon Zinc, Hydrogeology Investigations and Environmental Assessment, Wolverine Mine, Ross River, YK. Developed a hydrogeological conceptual model and estimated mine inflows and dewatering requirements for the Yukon Zinc (Wolverine) mine as part of an EIA and mine permitting. Identified source of groundwater to meet process water demands of the mill in a complex geological setting. Coordinated complex logistics to mobilize equipment and personnel to site accessible only to Cessna Caravan sized fixed wing aircraft. (11/2004 – 10/2007)

PWGSC, Tundra Mine Water Balance and Water Quality Model, NWT. Technical Lead for development of site wide water balance and water quality model (GoldSim) to support closure design and establishment of long-term compliance monitoring points. Included assessment of Adaptive Management Phase and far future steady-state scenario in response to comments from Independent Peer Review Panel to support future Water License Amendment Process. (04/2016 – 2017)

PWGSC, Colomac Mine, Hydrogeology and Mine Closure Investigation, NWT. Technical Lead for detailed hydrogeological assessment of two sentinel monitoring wells in a discontinuous permafrost region. Investigation involved installation of temporary packers, measurement of vertical groundwater gradients and completion of pumping tests on discrete monitoring intervals for compliance monitoring during Adaptive Management Phase of mine closure. (04/2013 – 03/2014)

MMG, Izok Lake and High Lake Mines, Hydrogeology and Permafrost Investigation, NU. Discipline Lead for baseline hydrogeological investigation of hard rock and permafrost for the proposed Izok and High Lake polymetallic mines to support EIA and FS. Involved drilling and packer testing to depths greater than 3,000 feet below 1,200 feet of permafrost using chilled and heated brine. Geomechanical logging and structural assessment was conducted to develop a hydrogeological conceptual model. Three-dimensional groundwater models were developed to estimate flows to the open pits and deep underground mine workings and downgradient rivers for operations and closure. Three-dimensional groundwater model was constructed in MODFLOW to estimate flows to the open pits and deep underground mine workings and downgradient receptors. Developed dewatering estimates and contributed to water management plan, water quality modelling and closure plans. Characterized sub-permafrost brine groundwater and investigated groundwater treatment options. Collaborated with international research group (NASA, Princeton, Finnish Geological Survey, University of Waterloo, etc.) on scientific study to evaluate the possibility of biological activity below permafrost as an analogue for life on Mars. (03/2005 – 02/2014)

Northern Star Resources, Pogo Underground Gold Mine Water Balance and Dry Stack Tailings Facility Expansion, AK. Hydrogeology lead for development of mine water balance using GoldSim software to guide mine design and water management planning for a large and rapidly expanding hard rock underground gold mine. Developed conceptual model, water balance and conducted geochemical assessment to guide design of expanded and closure planning for DSTF to improve operations and minimize long term liabilities of heavy metals at closure. The work included reviewing hydrogeology data, groundwater modelling data, mineral process flow sheets, surface water flows and tailings geochemistry. (11/2019 – 06/2021)

U.S. Bureau of Land Management, Pebble Mine Environmental Impact Assessment, Anchorage, AK. Hydrogeology lead for first phase of an EIS that was recently finalized and submitted. The work included reviewing hydrogeology baseline data, groundwater and surface water modelling, Waste Management Plans and TSF Operation Plan as part of large multidisciplinary team.

Koza Gold, Groundwater Modelling and Environmental Assessment, Korudanlik Mine, Turkey. Constructed conceptual and digital groundwater models for the proposed Korudanlik open pit mine in Turkey. The project involved estimation of mine inflows, provision of dewatering recommendations and environmental impact assessment. (03/2012 – 12/2012)

Australian Department of Defense, Permafrost, Drainage and Geochemistry Characterization for Groundwater Management Strategy, Davis Research Station, Antarctica. Hydrogeologist and permafrost specialist for assessment of permafrost and groundwater management aspects in support of Comprehensive Environmental Evaluation of new 2,500 m long all-season aerodrome in Western Antarctica. Evaluated geology, hydrogeology and permafrost conditions and developed groundwater and surface water management strategy and dewatering strategy for construction of a new runway to provide year-round air support to Davis Station. Designed permafrost and hydrogeological investigations involving logging of ground ice and installation of an extensive network of thermistors to determine active layer thickness and permit thermal modelling of designed elements.

Golden Delicious Mine, Phase 2 Dewatering Study AngloGold Ashanti Australia Ltd., Western Australia. Technical Lead for numerical groundwater model development using FEFLOW to estimate monthly dewatering requirements for open pit mine to understand the dewatering requirements (abstraction volumes, bore depths and locations) and disposal requirements from an operational perspective. Translated conceptual geological model developed in Leapfrog into FEFLOW to estimate inflow and evaluate impacts on groundwater and surface water resources. Predicted time to flood at closure. Evaluated need for any changes to existing Groundwater Well License. (10/2019 – 2020)

<u>Water Resource Management</u>

City of Coquitlam, Coquitlam Town Centre Irrigation Well, Coquitlam, BC. Senior Hydrogeologist installation of an irrigation water supply well to meet the estimated water quantity demand for the Park (120 GPM) while avoiding lowering of water levels in nearby fish-bearing water bodies. Identified a deep confined aquifer that would meet the City's water demands that was hydraulically disconnected from surficial water bodies. Installed 8-inch diameter water well was installed in a confined gravel aquifer and conducted 24-hour long pumping test to confirm aquifer properties, well yield and degree of connection with surface water features. Water quality results met requirements for untreated irrigation use. (2020-present)

University Endowment Lands Trust, Emergency Water Supply Well Installation, Vancouver, BC. Technical Lead for drilling, installation and testing of emergency water supply well within Quadra Sands Aquifer on Point Grey Peninsula. Ongoing effort focused on obtaining a Water License under the British Columbia Water Sustainability Act and authorization from Coastal Health. (2019)

Fisheries and Oceans Canada, Rosewall Hatchery Groundwater Supply Expansion, Bowser, BC. Technical Lead for development of groundwater supply master plan for expansion of existing fish hatchery. Ongoing project evaluated condition and yield of four aging water supply wells and developed plan for well rehabilitation/replacement, wellfield expansion and operation of system in a manner that was protective of adjacent stream (Rosewall Creek) and avoids salt water intrusion into very productive alluvial aquifer system. Characterized stream flow, geology, hydrogeology and water quality. Developed coupled groundwater and surface water model to establish sustainable yield of aquifer, establish environmental flow needs of stream, and evaluate salt water intrusion. Installed two 12-inch diameter water supply wells and eight 2-inch monitoring wells to facilitate large, multiwell pumping test in support of water licensing. Conducted several pumping tests to support groundwater model calibration. Currently leading integrated team of civil, electrical and mechanical engineers to design and implement system expansion. (2021-Ongoing)

City of Vancouver, City-Wide Three-dimensional Geological Model and Numerical Groundwater Model, Vancouver, BC. Project manager and technical lead for development of three-dimensional geological model in Earth Volumetric Studio and Leapfrog leveraging provincial water well database and geotechnical drilling database maintained by City of Vancouver. Translated geological model into a numerical groundwater model extending from Point Grey Peninsula to Capitol Hill in Burnaby using FEFLOW software to assist in determining groundwater inflows to construction excavations and stream baseflow augmentation. Evaluated impacts of climate change on predicted dewatering rates associated with proposed civil infrastructure developments. (06/2019-08/2019; 2021-Present)

University of British Columbia, Hydrogeology Characterization and Stormwater Management Plan, Vancouver, BC. Hydrogeologist for assessment of the University of British Columbia Point Grey Campus to determine feasibility of infiltrating stormwater into the shallow groundwater aquifer without impacting geotechnical stability of the surrounding slopes. Involved performance assessment of inter-aquifer drain wells. (2011-2013)

University Endowment Lands Trust, Hydrogeology Characterization and Stormwater Management Plan, Vancouver, BC. Technical Lead for hydrogeological and geotechnical assessment of University Endowment Lands to support development of a stormwater infiltration bylaw for an area under intense development pressure. Conducted field reconnaissance, geotechnical/hydrogeological drilling investigation, aquifer testing and monitoring to support hydrogeological assessment and geohazards assessment. Developed 3D conceptual hydrogeological model and numerical groundwater model (FEFLOW) to serve as a tool for managing stormwater, groundwater resources and geotechnical risk. Calibrated numerical model to measured groundwater elevations and predicted groundwater impacts on slope stability. Presented results to UEL, UBC, MoTI and Metro Vancouver. (2017-2019)

***Water Sustainability Act* Permitting for Multiple Civil Infrastructure Projects, Metro Vancouver, BC.** Senior Hydrogeologist for evaluation of environmental impacts of dewatering on groundwater and surface water resources for multiple large civil infrastructure projects. Developed conceptual and numerical groundwater models to predict construction dewatering rates and evaluate impact of pumping on groundwater and surface water resources. Majority of projects were large civil infrastructure projects in Lower Mainland. Submitted multiple Short-Term Use Approvals to authorize construction dewatering for Burnaby Lake North Interceptor No. 2, Gilbert Trunk Sewer No. 2 and Douglas Road Main No. 2. (2018-2020)

Bonaparte First Nation. Groundwater Supply Well Development, Cache Creek, BC. Technical Lead for project to establish potable water supply for several house clusters to resolve long-term boil water advisory in effect for existing water supply systems. Evaluated existing surface water supply intakes and community needs in area at risk of forest fires. Identified alternative water source and installed several wells to meet and exceed the needs of the community. Actively collaborated with BFN, CIRNAC and FNHA and presented several times to members of the community (2018 – 2022).

Sts'ailes First Nation and INAC, Sts'ailes Gas Bar Water Supply Wells 1 & 2, Phase 1 Environmental Investigation and Conceptual Hydrogeological Model, Mission, BC. Ryan was Senior Hydrogeologist for investigation of gasoline contamination of an unconfined gravel aquifer and water supply wells. One of the wells was severely impacted by gasoline contamination from the nearby Sts'ailes Gas Bar in a remote, sensitive environment. Bottled water was being provided to affected reserve members. The second well was determined to be upgradient and unlikely to be affected by contamination if pumping rates were not increased. Ryan identified contaminant sources, and developed the hydrogeological conceptual model used to evaluate groundwater drawdown cones and reporting. (2012-2013)

Snuneymuxw First Nation and INAC, Peer Review of Phase I, II and III Site Investigations and Risk-Based Remediation Plan for Historical Coal Residuals, Nanaimo, BC. Senior Hydrogeologist for the 3rd Party review of various subsurface investigations undertaken to characterize the magnitude and extent of soil, groundwater and soil vapour contamination associated with a large coal residual pile adjacent to a river estuary. The findings were presented to the SFN Working Group. (03/2016)

Metro Vancouver, Capilano Fish Hatchery Water Supply Well Assessment, North Vancouver, BC. Technical lead for condition assessment of two water supply wells installed east of the Capilano Reservoir to supply water to the Capilano Fish Hatchery to determine root cause of well yield decline in recent years. Conducted two pumping tests and evaluated pumps and conveyance piping including total dynamic head. Recommended for upgrades to restore lost capacity. (2018-2019)

City of Calgary, Hydrogeological Investigations of Nose Hill Tunnel, Calgary, AB. Conducted preliminary hydrogeology evaluation in support of the North Calgary Water Servicing Strategy (NCWSS) Nose Hill Tunnel project. Coordinated collection and interpretation of hydrogeological data to support tunnel inflow assessment. Participated in value engineering workshop to select tunnel boring machine.

City of Calgary, Hydrogeological Investigations of Rangeview Tunnel, Calgary, AB. Conducted hydrogeological investigation and pumping tests to support evaluation of groundwater inflows to the 4,381 m long Rangeview Sanitary Trunk Sewer tunnel and the associated five shafts.

Calgary Airport Authority, Tunnel Inflow Assessment, Calgary, AB. Estimated groundwater inflows to tunnel beneath Calgary Airport Parallel Runways to support EIA, design, pump specification and implementation.

Town of Strathmore, East Calgary Regional Water Pipeline Construction, Strathmore, AB. Hydrogeologist for complex groundwater assessment for 800-metre-long horizontal directional drill (HDD) under Weed Lake. Supported the complex assessment of potential water quality and water quantity impacts on an artesian bedrock aquifer located below the shallow lake which received treated sewage effluent. The depth of the horizontal drill was constrained because it could not intersect the artesian aquifer that was used by local residential and municipal wells. Groundwater monitoring was required for a year after construction completion. Obtained regulatory approvals from Albert Environment and local municipality.

Prospect Lake Golf Course, Hydrogeology Characterization and Water Source Identification, Saanich, BC. Hydrogeologist for assessment of groundwater and surface water resources for the Prospect Lake Golf Course. A water balance model was developed to guide water management practices on the golf course. It involved taking an inventory of surface water storage ponds, determining the magnitude and timing of irrigation needs and an assessment of the potential for groundwater supply well development on the property. (2004-2005)

City of Chilliwack, Groundwater and Surface Water Interaction Assessment, Chilliwack, BC. Hydrogeologist for assessment of groundwater/surface water interaction on unconfined Vedder Aquifer to refine a hydrogeological conceptual model and water balance for the aquifer. Inventoried springs discharging from the aquifer and recommended stream flow monitoring sites to investigate relationship between groundwater, spring discharge and ecological integrity of streams. (2006-2007)

Okanagan Falls Wastewater Treatment Plant, Water Supply Well, RDOS, Okanagan Falls, BC. Senior Hydrogeologist for design, construction and testing of water supply well and water treatment system installed to meet fire suppression, laboratory and potable water needs at a new wastewater treatment plant. Obtained CPCN from Interior Health. (2015-2016)

Groundwater Supply Well Installation, City of Whitehorse, YT. Evaluated pumping test data for several wells yielding in excess of 1,000 US GPM as part of a groundwater exploration program including an assessment of sustainable yield and water quality. Overall goal of the program was to establish additional sources of groundwater to blend with the existing surface water source during winter months to prevent pipe freezing. Addressed well losses during testing due to small annulus between casing and pump. (2004-2006)

Indigenous and Northern Affairs Canada, Town of Faro Water Supply Investigation, Faro, YT. Evaluated the potential for Town of Faro water supply wells to be under the direct influence of surface water in Vangorda Creek based on results of integrated groundwater and surface water investigation that included analysis of groundwater levels, pumping data and water quality data over a period of two years. Found wells were seasonally connected to surface system prone to contamination. (2006-2008)

Capital Regional District, Dewatering Assessment for Bedrock Excavations and Tunnel Outfall Microtunnel, Victoria, BC. Conducted hydrogeological investigation and dewatering assessment for excavations adjacent to the ocean to support construction of the Victoria Wastewater Treatment Plant and associated forcemain and outfall tunnels. Conducted packer testing, slug testing, water level monitoring and determined groundwater quality. Developed three-dimensional numerical groundwater model to estimate dewatering and water treatment requirements. (2017-2020)

Various Municipalities, Integrated Stormwater Management Plans, Various Locations, BC. Hydrogeologist for hydrogeological characterization, geological mapping and infiltration testing to support the development of Integrated Stormwater Management Plans (ISWMPs) for Partington Creek, Clayton, Gibsons, Anderson Creek and City of Vancouver Landfill. The effectiveness of infiltration basin maintenance was also evaluated. (2004-2014)

Shell, Site of the Future Geoexchange Well Feasibility Assessment, Vancouver, BC. Technical Lead for hydrogeological characterization and feasibility assessment of Fraser River Sand Aquifer to determine feasibility of establishing a geoexchange well field to meet the needs of a commercial retail gas station. Conducted desktop data compilation of regional water wells and designed drilling investigation to characterize aquifer properties and evaluate aquifer thickness. Developed numerical groundwater model to simulate operation of open loop geoexchange wells. Results found that commercial buildings required four wells (two extraction and two injection) to meet the heating and cooling demand. (2019)

Multiple Clients, Water Supply and Water Treatment Assessments, Various Locations, BC, YT, AB. Project Hydrogeologist for water supply well investigations involving drilling, pumping tests, condition assessments and estimation of long-term sustainable yield.

- City of Whitehorse Municipal Water Supply Wells (several). Whitehorse, YT.
- Commercial Laundry Facility. Langford, BC.
- Innisfail Police Dog Services Training Facility, Innisfail, AB.
- Whonnock Well, Maple Ridge, BC.
- Commercial Developments, Maple Ridge, BC.
- Coal Dust Suppression System Water Supply Well, Chetwynd, BC.

Publications / Presentations

Mills, R.D., C. Donnelly, R. Dandurand and J. Runnells. Innovative use of groundwater modelling tools for holistic assessment of remedial options for mine tailings in a marine intertidal environment at Toquaht Bay. In Proceedings of 44th Annual Mine Reclamation Symposium. September 2021.

Jia, K, R.D. Mills, S. Sumsion and T. O'Grady. Integrating decision analysis, engineering and water quality modelling for remedial option evaluation of the 2200 Level and Mount Sheer Townsite at Britannia Mine. In Proceedings of 44th Annual Mine Reclamation Symposium. September 2021.

K.Jia, R.C. Dickin, Mills, R.D, 2019: Geochemical Characterization of Groundwater and Porewater Contamination in Historical Mine Tailings Deposited in a Nearshore Marine Environment, 26th Annual BC MEND ML/ARD Workshop, Vancouver, BC.

Mills, R.D., K. Jia, M. Javadi, J. Runnells and L. Whitehead-Delong. Remedial Options Evaluation for the Abandoned Atlin Ruffner Mine. In Proceedings of 42nd Annual Mine Reclamation Symposium. September 2019.

Mills, R.D., G. Walker, K. Jia, M. Javadi, J. Runnells and L. Whitehead-Delong. Design, Construction and Performance of a Passive Water Management System at the Abandoned Atlin Ruffner Mine. In Proceedings of 42nd Annual Mine Reclamation Symposium. 2019.

R.C. Dickin, S.E. Dickin, L. K. Jia, L. Groat, U. Mayer, R. Mills, M. Sanborn, 2015: Groundwater Contamination Due to Historical Magnetite Mine Tailings Deposited in a Near-Shore, Marine Environment, Mine Closure 2015 Conference, Vancouver BC, June 2015.

Johnson, D. and R.D. Mills, 2006: Baseline hydrogeological testing and instrumentation of deep exploration boreholes for mine environmental assessment. Sea to Sky Geotechnique. October 2006. pp 1658 – 1663.

Dougall James Miln Harvey, Ph.D., P.Eng., FEC

Position: Senior Hydrogeologist

Education

Ph.D., Civil Engineering, University of Waterloo, Waterloo, ON (1999)

M.Eng., Civil Engineering, McMaster University, Hamilton, ON (1994)

B.Sc. (Eng), Water Resources Engineering, University of Guelph, Guelph, ON (1991)

B.Sc. (Hons Bio), University of Guelph, Guelph, ON (1985)

Years of Experience

With AECOM: 7
With Other Firms: 25

Licenses/Registrations

Professional Engineer (P.Eng.)

- Ontario, Canada (90340449)
- Nova Scotia, Canada (11308)
- Manitoba, Canada (44811)

Volunteering

Professional Engineers Ontario (PEO) – Grand River Chapter Councillor, Secretary

National Ground Water Association (NGWA) – Scientists and Engineers Section Board Member

Professional Affiliations

National Ground Water Association (NGWA)

- Member – Scientists and Engineers Section Board; Awards Committee; PFAS Sampling/Analysis Guidance Committee; Groundwater Modeling Advisory Panel

Fellow of Engineers Canada (FEC)

Training and Certifications

Course Developer and Instructor for:

- Applied Groundwater Modeling using Visual MODFLOW
- Finite Element Groundwater Modeling using FEFLOW
- Water Quality Data Management with AquaChem
- Aquifer Performance Test Analysis using AquiferTest
- Environmental Data Management using HydroGeoAnalyst
- NGWA's The MODFLOW Course

AECOM Project Manager Certification

Summary

Dr. Harvey is a hydrogeologist, groundwater modeler and water resources engineer working on projects related to water resources assessment, groundwater permitting, source water protection, construction dewatering analysis, landfill design, monitoring, remediation and closure, contaminated site assessment, and mine site impact assessment across North America for 30 years. Miln is an expert in the assessment and integration of hydrologic and hydrogeological data to develop conceptual site models for evaluating groundwater conditions and surface water-groundwater interaction. He is also an expert in the development of numerical groundwater models for simulating groundwater flow and solute transport conditions at Project Sites. Miln has developed more than 150 models for predicting groundwater heads and flows and the transport of organic and inorganic constituents in overburden and bedrock aquifers. Dr. Harvey works in AECOM's office in Kitchener, Ontario, Canada.

Experience

Distinguishing Qualifications

- More than ***25 years of experience*** in hydrogeological analysis including field work, conceptual model development, water budget analysis, numerical modeling and technical review of water resource investigations and contaminated site studies.
- Completed ***hydrogeological assessments*** for groundwater supply (municipal, industrial), contaminated sites, Source Water Protection, transit projects (rail corridors, light rail transit, subway stations, roadways), construction site dewatering, land development, earthen dams, landfill impact assessment and closure, and mine site analysis.
- An expert in ***finite difference and finite element groundwater modeling***, and in the use of MODFLOW (Visual MODFLOW, Groundwater Vistas) and FEFLOW to develop groundwater flow and solute transport models to aid in hydrogeological analysis.
- Designed, calibrated, and/or reviewed more than ***150 groundwater models*** for predicting flow and transport of organic (VOCs, chlorinated solvents, hydrocarbons) and inorganic (salts, metals, radionuclides) species in the hydrogeological environment.
- Developed groundwater models of ***municipal well systems*** to aid in the analysis of water supply, groundwater drawdown, wellfield capture, well interference, saltwater intrusion and pumping test analysis for public water supply.
- Developed groundwater models of ***construction sites and transit projects*** to aid in assessing dewatering impacts to the surrounding environment and municipal infrastructure and to aid in groundwater permitting and support of excavation design.
- Developed groundwater models of ***mine sites*** to assess groundwater flow around underground open pit, and in-situ recovery (ISR) mines, and Tailings Management Facilities (TMFs) for a variety of hard rock mines around the world.
- Developed groundwater models of ***contaminated sites and landfills*** across North America to aid in the design of remedial measures to minimize environmental impacts from groundwater contaminant plumes.
- Developed, marketed, and presented over ***90 Professional Groundwater Short Courses*** on Aquifer Performance Test Analysis, Environmental Database Management and Numerical Groundwater Modeling in over 20 countries around the world.

- Completed the design, inspection, monitoring, HELP modeling, leachate volume estimation, waste cell and closure planning of ***municipal and private landfills*** in Canada.
- ***Professional Engineer (P.Eng.)***, Ontario, Manitoba, and Nova Scotia.
- ***Sessional Lecturer***, Department of Civil and Environmental Engineering, University of Waterloo.
- ***Sessional Lecturer***, School of Engineering, University of Guelph.

Project Experience

Mine Site Assessment

- Technical support for **Sio Silica's** Environmental Act project proposal to Manitoba Clean Environment Commission for a silica sand extraction well mine project near Vivian, MB (01/23-present)
- FEFLOW groundwater modeling of **Freeport McMoran Morenci Mine** TSF in Morenci, AZ to assess seepage from the TSF to aid in closure design (05/22-present)
- Hydrogeological assessment of the **Rio Tinto Laterriere TSF** closure in Saguenay, QC including the use of a 3D regional FEFLOW groundwater model to assess closure design impacts to the hydrogeological environment (08/22-present)
- FEFLOW 2-D cross-sectional groundwater modeling of **Rio Tinto Kennecott Copper** tailings storage facility in Magna, UT to help in the design of a pumping station to mitigate potential environmental impacts (05/22-present)
- FEFLOW groundwater modeling of **Teck Coal Elkview Operations** Lagoon D TSF in Sparwood, BC to support closure design and rehabilitation to reduce water quality impacts on the Elk River (02/22-present)
- MODFLOW model (GWV) of **Strandline Resources** Coburn Mineral Sand Mine in Shark Bay, Western Australia to assess mine impacts from additional mine infrastructure and production water bores (02/22-present)
- Hydrogeological assessment and groundwater interceptor trench design for the **Vale Creighton Mine** in Sudbury, ON to aid in the reduction of off-site contamination from the mine site (01/21-present)
- Review of Hermann Mine Application for Mines Act & Environmental Management Permit for **BC MOE** (11/21-present)
- Review of New Afton Mine Application for Mines Act & Environmental Management Permit for **BC MOE** (10/21-present)
- MODFLOW groundwater model (GWV) of **GEMCO South32 Mine** in Groote Eylandt, Australia to assess impacts of groundwater mounding from quarry closures on environmentally sensitive features of the island (08/21-present).
- FEFLOW groundwater model of the **Gossan Valley mine** site in Western Australia to assess dewatering rates and potential mine tailing facility impacts (06/20-present)
- Conceptual hydrogeological and MODFLOW groundwater model (GWV) of the **Faro Mine**, Yukon Territory as part of the on-going Faro Mine Remediation Project (03/18-07/18)
- Site visit to the **Antamina Mine** head office in Lima, Peru to present a short course on Environmental Database Management for visualizing borehole geology, water levels and water quality data at Antamina's mines across Peru (06/16)
- Site visit to the **Faro Mine** site in Faro, YT to assess mine site features for the Faro Mine Remediation design. Reviewed field work plans for the **Faro Mine** 2014 field season, MODFLOW groundwater model (GWV), hydrogeologic design of the Cross Valley Dam Seepage Interception System, Groundwater Baseline Report and Aquatic Effects Assessment for the *Final Closure and Remediation Plan*; developed Field Sampling Plans for the activities identified in the Data Gaps Analysis (09/13-12/13)
- Hydrogeological assessment of the proposed **Tintina Mine**, YT to evaluate analytical groundwater modeling that had been completed to predict groundwater inflows into a proposed mine decline as part of advanced exploration at the site (10/13-11/13)
- Hydrogeological assessment of **Northern Gold Mine** in Matheson, ON in support of a PTTW application including borehole logging, monitoring well development, aquifer testing, groundwater monitoring, reporting and public consultation. Developed a MODFLOW model (VMOD) of the abandoned **underground mine** to assess impacts to groundwater and surface water flow systems from mine re-development by dewatering the workings and drilling a pumping well (10/12-03/13)
- Developed 30 separate 2-D, vertical, sat/unsat FEFLOW cross-section models of the proposed **Pebble Mine** near Iliamna, Alaska to aid in pore-water depressurization analysis of the time-varying pit shells for the operational pit (06/11-12/13)
- Pore-water pressure modeling (FEFLOW) for slope stability analysis of **Olympic Dam Mine** in southern Australia (09/11-12/13)
- Updated MODFLOW model (VMOD) of **North American Palladium** mine for a Permit to Take Water application (10/12-02/13)

- Site visit to the proposed **Yava ISR lead mine** in Cape Breton, NS and completed a hydrogeological assessment of field tracer testing to determine the feasibility of the in-situ mining process (08/12-09/12)
- Site visit to **Diavik Diamond Mine** in Lac de Gras, Northwest Territories to provide groundwater modeling training (VMOD) to the mine's geology and hydrogeology staff (06/12)
- Site visit to **Cameco In-Situ Recovery mine** for uranium extraction in Smith Ranch-Highland, Wyoming to provide groundwater modeling training (VMOD) to the mine's geology staff (01/12)
- MODFLOW model (VMOD) to assess the in-situ recovery (ISR) mining method, and presented an On-site groundwater fate and transport modeling Short Course at Cameco's Smith Ranch-Highland facility (Glenrock, Wyoming), to help Cameco Resources better operate their **in-situ uranium mines** in Wyoming and Nebraska (11/11-01/13)
- Conceptual hydrogeology and FEFLOW groundwater model of a fractured limestone aquifer in the Essex Valley in central Jamaica to define contaminant impacts of **Alpart bauxite mine** refinery with a dense sodium plume moving toward municipal supply wells (10/10-05/13)
- Peer review of the MODFLOW/MT3D model (VMOD) of the **Marathon Platinum Group Metals mine** near Marathon, Ontario and provided training to aid in the completion of the model for the environmental impact assessment of the mine site (08/10)
- Presented **Groundwater Modeling for Mining Applications** short course in Perth, Australia and discussed hydrogeological analysis and numerical modeling of hard rock mine sites in Australia (11/08)
- Presented **Groundwater Modeling for Mining Applications** short course in Butte, Montana (at Montana Technical University) and discussed hydrogeological analysis and numerical modeling of hard rock mine sites in Montana (01/08)
- Presented **Groundwater Modeling for Mining Applications** short course in Durban, South Africa and discussed hydrogeological analysis and numerical modeling of hard rock mine sites in South Africa (09/07)
- MODFLOW model (VMOD) of an aquifer in the Andes Mountains of Chile for determining the impacts of **groundwater extraction** to provide process water for an underground mine facility (05/99-08/99)

Water Resources Assessments

- MODFLOW model (GWV) of the overburden water supply aquifer beneath the **Town of Ridgetown, ON** in the Municipality of Chatham-Kent to update Wellhead Protection Area (WHPA) delineation (06/22-present)
- MODFLOW X-Z cross-section model through the **Kamloops, BC** Wastewater Treatment Ponds from the uplands to the Thompson River to aid in a water balance assessment of the ponds including seepage to the river (03/22-present)
- MODFLOW surface water-groundwater model of the Rosewall Creek watershed north of **Nanaimo, BC** to assess sustainable groundwater use from supply wells for a salmonid fishery beside the creek (01/22-present)
- Updated the FEFLOW model of the Georgetown area in **Halton Region, ON** to assess the impacts of reduced groundwater pumping from the Georgetown municipal wells on baseflow discharge to Silver Creek and Black Creek (11/19-01/21)
- Hydrogeological assessment of the Holmedale Canal for the **City of Brantford, ON** to assess SW-GW interaction prior to canal rehabilitation to increase water storage including the development of a MODFLOW groundwater model (VMOD) to assess the interaction between the canal and the hydrogeological environment (10/19-present)
- MODFLOW model (VMOD) of the overburden/bedrock water supply aquifer beneath the **Town of Stratford, PEI** to delineate Wellhead Protection Areas (WHPAs) and minimize environmental impacts for their municipal wells (11/17-05/18)
- MODFLOW model (VMOD) of the Oak Ridges Aquifer Complex in southern Ontario to assess the impact of a long-term pumping test on groundwater levels around the **York Region** municipal wells (09/15-11/15)
- MODFLOW model (VMOD) of the Winter River watershed in PEI to assess the impact of the **City of Charlottetown** municipal wells on aquifer discharge to rivers. The calibrated model was used to assess the well impacts on the Winter River as part of submitting a Groundwater Management Plan of the watershed to the PEI Water Act (08/15-11/15)
- Tier 2 Groundwater Quantity Stress Assessment for the **Upper Thames River Conservation Authority** including a Tier 2 Water Budget, as part of their groundwater protection initiatives that involved the development of a GAWSER/FEFLOW model of UTRCA as part of the groundwater protection study (11/10-06/13)
- PEST sensitivity analysis of the FEFLOW groundwater flow model of the Murzuk regional aquifer system in the Sahara Desert of southwestern Libya for a **groundwater supply assessment** (12/10-01/13)
- MODFLOW model (VOD) of the **City of Fairpoint** aquifer in Florida to assess municipal well impacts; developed a FEFLOW model using the same data to compare model development, calibration and simulation (01/09-05/09)
- Contaminant Threats Assessment for **Halton Hamilton Source Water Protection Committee** (01/03-08/03)

- Hydrogeologic assessment of **Grey and Bruce Counties, ON** including aquifer characterization, groundwater use assessment, contaminant sources inventory and the development of twenty-two (22) MODFLOW groundwater models (VMOD) calibrated using PEST to delineate WHPAs for 78 municipal wells in 46 communities (03/02-03/03)
- MODFLOW model (VMOD) of the Alliston Aquifer Complex which was calibrated using PEST to delineate WHPAs for 7 municipal wells for the **Town of Alliston**, and defined the water balance of the aquifer for South Simcoe County (01/02-04/02)
- MODFLOW model (VMOD) of the overburden/fractured bedrock aquifer system in **Town of Orangeville, ON,** which was calibrated using PEST to delineate WHPAs for the Town of Orangeville & surrounding municipalities (01/01-03/04)
- MODFLOW model (VMOD) of a coastal, sand aquifer in **Toms River, NJ** to determine the best alternative for WHPA delineation for the Town wells downgradient of a Superfund site where waste oil had been illegally dumped (04/96-04/98)

Federal and Municipal Infrastructure Projects

- MODFLOW model (VMOD) of the Halton Waste Management Site in Milton, ON as part of the impact assessment of Cell 4 development on the hydrogeological environment for the **Region of Halton** (10/22-present)
- Hydrogeological assessment of Junction Creek for the **City of Sudbury, ON** as part of creek reconstruction and stormwater management upgrades (11/21-present)
- Remedial options assessment of Pickering Nuclear Generating Station for **Ontario Power Generation (OPG)** using MODFLOW and MT3DMS (GWV) to establish end-use remediation scenarios for the on-site tritium plume that is impacting the overburden and bedrock aquifer system adjacent to Lake Ontario east of Toronto, ON (06/20-present)
- Remedial options assessment of the former Bruce Nuclear Spent Solvents Treatment Facility near Tiverton, ON for **OPG** based on historical hydrogeological investigation (08/21-01/22)
- Hydrogeological assessment of the Springbank Wefater Storage Reservoir project site in the **City of London, ON** as part of detailed design for replacement of the existing water storage reservoir (12/20-11/21)
- Hydrogeological assessment of nine (9) candidate sites for a Municipal Class Environmental Assessment of snow storage facilities in the **Region of Peel, ON** (11/20-present)
- Hydrogeological assessment of the siting of the new Oak Ridges Air Management Facility in the **Town of Richmond Hill, ON** including a groundwater permit application to deal with odour complaints from the Yonge Street sewer system (03/18-present)
- Hydrogeological assessment of a 10-km watermain installation project for the **Nation Municipality** to supply municipal water to the community Limoges, ON (01/21-10/21)
- MODFLOW model (VMOD) to assess construction dewatering requirements a culvert replacement in **City of Uxbridge, ON** where the construction is adjacent to sensitive historical commercial buildings (08/20-present)
- Hydrogeological assessment of the Valens Reservoir earthen dam in Valens, ON to assess water levels over three (3) years for the **Hamilton Conservation Authority** to estimate seepage through the dam for a dam safety assessment (09/16-present)
- Peer Review of the East Metro MODFLOW model (GWV) of the greater Minneapolis-St Paul area for the **MPCA** as part of a remediation project to assess PFAS (perfluoroalkyl substances) contamination of the municipal water supply wells for 14 communities in southeastern Minnesota (04/20-10/20)
- Hydrogeological assessment of the SWM Ponds for construction dewatering and the Environmental Management and Monitoring Plan for the **Gordie Howe International Bridge** for the Windsor-Detroit Bridge Authority (03/20-present)
- Hydrogeological assessment of the Moose Mountain Bridge Reconstruction for the **City of Sudbury, ON** to assess dewatering requirements prior to construction (03/20-present)
- Hydrogeological assessment of four (4) candidate sites in the **City of London, ON** for a long-term water storage solution as part of a Municipal Class Environmental Assessment of water supply capacity (05/18-05/19)
- Reviewed proposals from geomembrane suppliers and testing labs for the supply of HDPE geomembrane for the Near Surface Disposal Facility, for **Canadian Nuclear Laboratories (CNL)** Geomembrane Technical Review Committee (11/16-01/18)
- Reviewed the Conceptual Site Model and Numerical groundwater models of the **CNL** Near Surface Disposal Facility landfill near Ottawa, ON developed by Golder Associates (11/16-12/19)
- Hydrogeological assessment of the **City of Peterborough, ON** Jackson Creek Flood Diversion Sewer project and submission of the Hydrogeological Report in Support of a Category 3 PTTW for sewer construction (01/19 – present)
- MODFLOW model (VMOD) of a former maintenance yard for the **Town of Peace River, AB** for the purpose of designing a remediation system for a groundwater salt plume prior to construction of the new Peace River Bridge (11/17-06/18)

- Hydrogeological investigation report for the design of the upgrades to the Alexandria Sewage Works in the **Township of North Glengarry, ON** (07/18-08/18)
- Water quality assessment and options evaluation for the remediation of Bayfront Beach in the **City of Hamilton, ON** to address coliform bacteria contamination of the beach environment (07/17-07/18)
- Hydrogeological assessment of the **Town of Perth, ON** Sewage Treatment Plant upgrades including monitoring well installation, water sampling, conductivity testing, water level monitoring and dewatering assessment (05/17-08/17)
- Hydrogeological assessment of the snow disposal facility for **Regional Municipality of York** in Markham, ON including MW installation, water level monitoring and water quality sampling, infiltration testing and dewatering assessment (10/16-01/17)
- MODFLOW model of a large municipal septic field (VMOD) to aid in the design of the updated wastewater treatment system for the **Town of Westport, ON** (05/16-06/16)
- Reviewed the **Town of Digby, NS** Water System Contingency Plan to assess the response to Emergency situations that might affect the Town's water system including potential contamination to the town wells (03/16-10/16)
- Hydrogeological report in support of a Category 3 Permit to Take Water application for construction dewatering of a new treatment building for the **City of Kitchener, ON** Wastewater Treatment Plant in Kitchener, ON (11/15-12/15)
- MODFLOW model of the Boat Harbour basin (VMOD) in **Pictou County, NS** to assess groundwater flow through the watershed to aid in the design of a construction dewatering system (extraction wells) for remediating harbor sediments, and to assess the impact of construction dewatering on the Pictou Landing First Nations water supply wells (09/15-03/16)
- Conceptual hydrogeologic and numerical MODFLOW model (GWV) of the **OPG** Western Waste Management Facility at Bruce Nuclear near Tiverton, ON and completed updated particle pathline analysis in preparation for monitoring well installation for delineating **tritium contamination** of the middle sand aquifer (03/14-05/14)
- Hydrogeologic assessment for the **Village of Brussels, ON** in support of the Category 3 Permit to Take Water application for the Brussels Municipal Well Supply System (01/14-03/14)

Private Infrastructure Projects

- Developed an **Aquifer Protection Plan** for a canola processing plant north of Regina, SK that located on land designated as High Sensitivity with respect to the Regina Aquifer (11/21-03/22)
- MODFLOW model of a **contaminated site** (VMOD) for a National Retail store in the City of Ottawa, ON to aid in a risk assessment of contaminants of concern and potential design of a remediation system (05/19-present)
- Scope of work for a geotechnical investigation of the rock mass quality at the Honeywell property in Amherstburg, ON to assess the competence of the rock mass above the **salt solution cavern** in the Salina Formation (04/19-11/19)
- MODFLOW model of a large **septic field** (VMOD) for the YMCA Cedar Glen Outdoor Centre in the Regional Municipality of York, ON to aid in the design of the sewage treatment facilities (05/18-present)
- Supplementary hydrogeological field investigation of a **former industrial facility** in Peterborough, ON to support a Category 3 PTTW application for construction of stormwater management facilities (06/19-present)
- Feasibility assessment to identify potential sites that meet the geological and hydrogeological siting requirements for a **Hydrostor facility** using GIS within the southeastern states of Alabama, Mississippi, and Georgia (03/18-08/18)
- MODFLOW model of a large **septic field** (VMOD) for a private resort to aid in the design of the size and flow rate of the sewage treatment facilities for private client Township of Georgian Bay, ON (01/17-01/18)
- Developed a SEAWAT (MODFLOW/MT3D) model of a coastal watershed (VMOD) in Borden-Carleton, Prince Edward Island to assess the potential impact of an **industrial supply well** on water table drawdown, reduction in baseflow to local creeks and streams, and the potential to induce seawater intrusion into the freshwater aquifer (03/15-06/15)
- MODFLOW model of the groundwater flow system beneath a contaminated metals manufacturing factory (VMOD) in Richmond Hill, ON to aid in the assessment of the **groundwater remediation system** (01/16-05/16)
- Water quality analysis of storm water in a catch basin at a **Waste Transfer Station** east of Toronto, ON to assess options for off-site discharge including storm and sanitary sewer (SUB) and surface drainage (PWQO) ditches (10/15-12/15)
- Conceptual and numerical MODFLOW model (GWVistas) of the ERCO manufacturing facility in Saskatoon to assist in making predictions of **contaminant flowpaths** and travel times through the hydrogeologic environment below the site (07/13-08/13)
- Environmental Compliance Application (ECA) for the **decommissioned storm water pond** for an industrial facility in Sarnia, ON including a Summary Report in response to a Provincial Officers Order for closure of the site (12/13-02/14)
- Hydrogeological conceptual model and FEFLOW numerical model of the **Essex Valley** aquifer system in Jamaica to include new field data (monitoring well installation and testing) and updated water balance information (10/10-08/11)

- MODFLOW/MT3DMS model (VMOD) calibrated using PEST to assess the impact of an **industrial supply well** on water table drawdown and baseflow discharge reduction near the municipal wellfield in Borden-Carleton, PEI (03/14-06/14)
- MODFLOW model (VMOD) calibrated using PEST to support the design of a dewatering system for the overburden aquifer beneath a high-rise **condominium development** near a TTC subway line in Toronto, Ontario (10/12-01/13)
- Environmental audit of Well Flow Back operations at a **hydraulic fracturing site** in Eastern Pennsylvania for a Natural Gas Fuel supply company (05/12-07/12)
- MODFLOW/MT3D groundwater flow and solute transport model (VMOD) for BASF Chemicals of a **brownfield redevelopment** site in Wyandotte, MI on the Detroit River, which was calibrated using PEST to assess capture efficiency of the extraction well system and used to provide design assistance for updating the operation of the extraction system (03/01-11/01)
- MODFLOW model to represent **natural attenuation** (VMOD) processes in a coastal, aquifer system in Seattle, WA to determine the transport of a chlorinated solvent and BTEX plume emanating from a RCRA oil-recycling facility (08/99-10/00)

Contaminated Site Remediation Projects

- MODFLOW/MT3DMS model (GWV) of the **Southern Wood Piedmont** company site contaminated with DNAPL (benzene, naphthalene) as part of remediation system design (01/23-present)
- Review a groundwater model report (GMS/MODFLOW) of the former **Wolverine Tannery** site, which contaminated the hydrogeological environment with PFAS to aid in design of a trench/well groundwater remediation system (12/22-present)
- MODFLOW/MT3DMS model (GWV) of the **Marathon Oil** facility in Melvindale, MI to aid in the contaminated site investigation of the property (01/22-present)
- MODFLOW model (VMOD) assessment of the **Atlas Chemical** facility in Waynesboro, GA to aid in the contaminated site investigation of the property (11/21-present)
- Hydrogeological assessment of the **Queens County Solid Waste Management Facility** north of Liverpool, NS as part of site closure and post-closure cost calculation and supporting reports.
- Surface water-groundwater (SW-GW) flow and solute transport model of the East Metro area of Minnesota for the **Minnesota Pollution Control Agency (MPCA)** using MODHMS software (GMS/WMS) to determine the impact of PFAS source areas on surface water and groundwater resources and their relation to drinking water supply (10/20-present)
- Engineer of record for the implementation of the engineered cap and cover for the decommissioned **Canadian Nuclear Laboratories (CNL)** Nuclear Power Demonstration (NPD) reactor facility near Rolphton, ON (07/19-present)
- Hydrogeological assessment and designed a groundwater interception system for the **Harrietsfield Landfill** near Halifax, NS to aid in the development of a closure plan to address on-site and off-site contamination (09/18-present)
- Hydrogeological review of a private landfill for a confidential client in **Northern Ontario** to assess risk of environmental impacts to groundwater and surface water downgradient of the site, including the development of a MODFLOW groundwater model and MT3DMS solute transport model (VMOD) to assess potential flow paths and solute transport (01/20-present)
- Hydrogeological assessment of stormwater management pond (SWMP2) at the **Region of Waterloo Landfill** to in aid the design of a clay liner to minimize impacts to the environmentally sensitive area adjacent to the landfill (11/19-present)
- Hydrogeological investigation of a contaminated site for a confidential client in **Oakville, ON** to determine the extent a hydrocarbon plume, develop a conceptual hydrogeological model in preparation for the development of a groundwater flow and solute transport model to assess the potential movement of the plume (01/20-present)
- Engineered earthen barrier design for the decommissioned **CNL** Whiteshell Reactor-1 Disposal Facility (WRDF) near Pinawa, MB including the use of hydrologic (HELP) modeling of water flow through the barrier to assess engineering design to minimize infiltration into the decommissioned works (09/19-03/20)
- Engineered earther barrier design for the decommissioned **CNL** Nuclear Power Demonstration (NPD) reactor facility near Rolphton, ON including the use of USEPA HELP to model the water balance of the engineered barrier (10/16-07/19)
- Peer review of the groundwater model for the **CNL** Near Surface Disposal Facility landfill (VMOD) near Ottawa, ON developed by Golder Associates (11/16-12/19)
- Hydrogeological assessment of a hazardous waste landfill to identify potential sources of VOCs detected in an on-site monitoring well, Lambton Facility Landfill, **Clean Harbours Canada**, Corunna, ON (08/14-05/15)
- Annual Landfill Compliance Monitoring Reports for the **Municipality of West Perth** in Mitchell, ON and for the Resolute Forest Products in Thorold, ON (09/15-11/15)
- MODFLOW/RT3D model (VMOD) of the **Gloucester Landfill** near Ottawa, ON contaminated with chlorinated solvents to assess Mefonitored Natural Attenuation in place of the existing pump-and-treat remediation system (12/10-05/11)

- MODFLOW/MT3DMS model (VMOD) of a bedrock aquifer in **Eastern Ontario** to determine the landfill leachate impacts on the groundwater system and potential discharge to surface water drains (09/00-12/00)
- Design, inspection, monitoring, and closure planning for municipal landfills for the Region of Halton, City of Sudbury, Regional Municipality of Haldimand-Norfolk, Town of Marmora, Township of Lake of Bays, Township of West Lincoln, City of Peterborough, Town of Fort Erie, and the City of Hamilton (1990-1992).

Transit Projects

- Review of contractor's environmental submissions for **Metrolinx** for the Maple GO Station and King GO Station (12/22-present)
- Hydrogeological review of construction management plans, including groundwater management and dewatering plan for the upgrades to the **TTC Russell Carhouse** facility in Toronto, ON (10/22-present)
- Hydrogeological review of the **Morningside Grade Separation** for MetroLinx to aid in the design of a groundwater soak-away pit to infiltrate groundwater discharge from the grade separation sub-drains (12/21-present)
- Renewed hydrogeological investigation of the **Hamilton LRT** for MetroLinx including the re-evaluation of 105 monitoring wells (MWs) for groundwater information to support engineering design (11/21-present)
- Hydrogeological assessment of the **CN Flyover** grade separation in Milton, ON for Kitchener Corridor Expansion (06/20-12/20)
- Hydrogeological assessment of **CN track corridor** in Grimsby, ON to assess infiltration through LID design (03/19-11/20)
- Hydrogeological assessment of Scarborough Centre Station for the **Toronto Transit Commission** in Toronto, ON as part of expansion of subway service to the east of Toronto including development of a MODFLOW model of the aquifer system beneath the site (VMOD) to assess construction dewatering for the station box and concourse levels (06/16-01/21)
- Hydrogeological assessment of subway station design for the **TTC Relief Line South** (Osgoode Station to Pape Station) in Toronto, ON as part of Toronto Transit Commission's expansion of subway service (02/18-12/20)
- Hydrogeological assessment of the **Hamilton Light Rail Transit** for MetroLinx including the installation of 105 monitoring wells (MWs) in 380 boreholes (BHs), water level measurements, water quality sampling, slug test and pumping test analysis, construction dewatering assessment, and well decommissioning (06/16-01/20)
- Hydrogeological assessment of eight (8) sites along the **Lakeshore West GO Line** (stations, grade separations and a layover facility) as part of Metrolinx's Regional Express Rail upgrades to Lakeshore West Line (05/18-04/19)
- Hydrogeological assessment of the **Milton and Meadowvale GO Stations** as part of the redevelopment of these stations for Metrolinx's Regional Express Rail upgrades along the Milton Line (03/18-05/18)
- Hydrogeological assessment of a wetland beside the **Lakeshore East Rail Corridor Expansion** including development of a Hydrogeological Impact Statement following TRCA Assessment Guidelines (02/18-present)
- Hydrogeological assessment of the **Rutherford GO Station** as part of the redevelopment of the station for Metrolinx's Regional Express Rail upgrades along the Barrie Line (11/17-present)
- Dewatering assessments for the construction of the **Ottawa Light Rail Transit** Confederation Line West and East Extensions in Ottawa, ON which included the development of a 3-D MODFLOW model (VMOD) of the Sir John A. Macdonald Parkway Tunnel to estimate construction dewatering requirements and support of excavation (SOE) impacts (03/16-12/16)

Land Development Projects

- Hydrogeological Assessment of a **commercial development** property in Ottawa, ON adjacent to a local creek to aid in the design of a large warehouse plant (11/22-present)
- Hydrogeological assessment of a **residential development** property in the northeastern area of London, ON adjacent to the Thames River (06/17-present)
- Hydrogeological assessment of a **residential development** property in Dorchester, ON including a field assessment of hydrogeological conditions and a dewatering assessment for a PTTW application (08/17-12/20)
- Peer review of the MODFLOW model (VMOD) of **Oak Ridges Centre** for the City of Vancouver, which was developed by the proponent to assess groundwater as a source of cooling water for the condominium development (03/19-06/19)
- Hydrogeological analysis of a proposed **commercial development** in Vaughan, ON which was completed to characterize the hydrogeological setting and provide guidance for construction dewatering and permitting (09/15-10/15)
- MECP Guideline D-4 Assessment of the groundwater quality for a **residential development** property across the road from former pesticide storage area and closed landfill in Northumberland County, ON (03/16-04/16)

- MODFLOW model (VMOD) to define inflows to the underground parking structure for a **condominium** in Toronto which requires a Permit to Take Water for a permanent dewatering system (10/12-01/13)

Engineering Design

- **Landfill Design** – used AutoCAD and USEPA HELP to design leachate collection systems and site servicing for landfills in Ontario including: Region of Halton, City of Sudbury, Regional Municipality of Haldimand-Norfolk, Town of Marmora, Township of Lake of Bays, Township of West Lincoln, City of Peterborough, Town of Fort Erie, and the City of Hamilton.
- **Dewatering Design** – used analytical and numerical groundwater models to aid in the design of dewatering systems (wells and trenches) and to estimate extraction volumes for construction dewatering, mining projects and contaminated sites.
- **Groundwater Remediation Design** – used hydrogeological analysis and groundwater modeling tools for the design of groundwater extraction and containment systems to minimize the impact of existing and potential on-site/off-site contamination.
- **Wellfield Design** – used groundwater models for assessment and design of wellfields (locations and pumping rate), and for the optimization of individual wellhead pumping rates to minimize well interference and maximize groundwater capture.
- **Septic Bed Design** – use of numerical groundwater models to aid in the design of large septic systems (flow rates, area/height of the septic bed) for municipal and private development projects.
- **Nuclear Facility Decommissioning/Capping Design** – design of engineered barriers for decommissioned nuclear reactor facilities including hydrologic (USEPA HELP) modeling of water flow through the earthen barrier to assess the feasibility of the engineering design to minimize infiltration into the concrete cap protecting the decommissioned works.

University Sessional Lecturer

- **Groundwater Engineering (ENGG 3220)**, School of Engineering, University of Guelph (2021, 2019). Introductory course on groundwater engineering, which included teaching fundamental concepts in applied quantitative hydrogeology and provide understanding of practical engineering tools and approaches for analysis including field and lab work.
- **Hazardous Waste Management (ENGG 6670)** School of Engineering, University of Guelph (2022). Graduate course on the concept of hazardous waste management (treatment, management, and disposal alternatives).
- **Solid and Hazardous Waste Management (ENGG 4340)** School of Engineering, University of Guelph (2021, 2011). Advanced course on the concept of solid waste composition, generation, properties, treatment and disposal alternatives.
- **Project Management Fundamentals (ENGG 6090)** School of Engineering, University of Guelph (2021, 2020, 2019). Graduate course on the concepts, principles, and practices for project management with special focus on planning, controlling and managing projects to success in the field of engineering.
- **Contaminant Transport (ENVE 573)** Civil and Environmental Engineering, University of Waterloo (2022, 2017). The principals of contaminant transport in environmental media (surface water and groundwater) and modeling of the Advection Dispersion Reaction Equation (ADRE).
- **Physical Hydrogeology (Earth 458)** Earth Sciences, University of Waterloo (2017). An introduction to physical hydrogeology, including Darcy's law, the groundwater flow equations, applications to flow nets, aquifer testing, groundwater resources, and groundwater protection. The role of groundwater in the hydrologic cycle is explored with emphasis on natural groundwater flow systems and their influence on stream flow. Physical processes controlling groundwater contamination are introduced.
- **Environmental Resources Management (ENVE 320)** Civil Engineering, University of Waterloo (2010, 1997, 1996a, 1996b). 50 students. Environmental systems analysis, resource utilization and allocation, including economic analysis, decision making methods, and environmental risk assessment.
- **Engineering Design and Communication (ENG 1C04)** Faculty of Engineering, McMaster University. First year engineering (1997). 600 students. The Principals of Engineering Design and Communication.

Groundwater Short Courses

- *Applied Groundwater Flow and Contaminant Transport Modeling* Australia (Brisbane, Sydney, Melbourne, Perth, Kensington, Adelaide); New Zealand (Auckland); China (Beijing); Hungary (Budapest); Czech Republic (Ostrava); Estonia (Tallinn); Belgium (Ghent); India (Hyderabad); Italy (Rome; Messina); the Netherlands (Delft); Jamaica (Kingston); Namibia (Swakopmund); Kazakhstan (Aksai); Sweden (Stockholm); Russia (Moscow); Canada (Waterloo, Guelph, Winnipeg, Calgary, Diavik Mine; Vancouver); United States (Melville, NY; Philadelphia, PA; Sacramento, CA; Princeton, NJ; Las Vegas, NV; Hanford, WA; Houston, TX; Butte, MT; Glenrock, WY).
- *Finite Element Groundwater Modeling* Waterloo, ON; Toronto, ON; Calgary, AB; Vancouver, BC.

- *Contaminated Site Risk Assessment Modeling* South Africa (Johannesburg); Czech Republic (Ostrava); Alberta Environment (Calgary, Edmonton, Red Deer); United States (Olympia, WA).
- *Aquifer Performance Test Analysis* Waterloo, Canada; Butte, Montana; Beijing, China.
- *Environmental Database Management* Lima, Peru; Athens, Greece; Delft, Netherlands; Dubai; Kazakhstan; Waterloo, Canada.
- *Water Quality Data Management and Modeling* Kitchener, ON; Waterloo, ON; Butte, Montana; Aksai, Kazakhstan.
- *Modeling for Mining Applications* Waterloo, ON; USA (Butte); South Africa (Durban); Australia (Perth).
- *Regulatory Review of Hydrogeology Studies* – Waterloo, ON; Seattle, WA.

Professional Experience

- 2015- **AECOM**, Senior Hydrogeologist, Remediation Group, Kitchener, ON – oversight of hydrogeological assessment for water resources and solid waste management studies, transit and infrastructure design projects and construction dewatering assessments including groundwater modeling analysis for the Geosciences Group in Canada.
- 2014-2015 **RWDI**, Project Director, Hydrogeology Group, Guelph, ON – review of hydrogeology studies and groundwater modeling projects, and business development for hydrogeological services.
- 2013-2014 **CH2M Hill Canada**, Senior Hydrogeologist, Environmental Services Group, Kitchener, ON – hydrogeological analysis and technical oversight / review of hydrogeology studies and numerical groundwater modeling projects.
- 2010-2013 **Schlumberger Water Services (SWS/WHI)**, Senior Hydrogeologist, Operations Division, Kitchener, ON – project management, hydrogeological analysis and numerical groundwater model simulation for civil engineering projects.
- 2003-2010 **Waterloo Hydrogeologic Inc**. **(WHI/SWS)**, Training Division Manager, Waterloo, ON – organized and presented professional Groundwater Short Courses involving aquifer performance test analysis, water quality database design and management, groundwater flow and transport model design and application.
- 1999-2003 **Waterloo Hydrogeologic Inc**. **(WHI)**, Hydrogeologist, Consulting Division, Waterloo, ON – groundwater modeling and hydrogeologic analysis for source water protection and contaminated site remediation (MODFLOW, FEFLOW).
- 1994-1999 **University of Waterloo**, Graduate Student, Waterloo, ON – RA/TA in Civil and Environmental Engineering.
- 1992-1994 **McMaster University**, Graduate Student, Hamilton, ON – RA/TA in Civil Engineering.
- 1990-1992 **Proctor and Redfern Engineering**, Environmental Engineer, Hamilton, ON – survey, design, construction oversight, hydrological / hydrogeological review, on-going development and closure of municipal solid waste landfills in Ontario.

Publications

Abbey, D., Harvey, D.J.M., Martin, P.J., and Carnegie, A. 2001. Using public water well records to generate model input data: overcoming the challenges. MODFLOW 2001 and Other Modeling Odysseys, Golden, CO, 11-14 September 2001.

Banks, W.D., Martin, P.J., Harvey, D.J.M. and Merry, A.G. 2003. Implementation of Groundwater Management Plans by Municipalities at a Watershed Scale. 56th CWRA Annual Conference, Vancouver, B.C., 11-13 June, 2003.

Harvey, D.J.M., Mock, P. Van Dyke, J., Finegan, J., Hermance, J., and Bean, D. 2017. Integrated Surface Water-Groundwater Modeling. NGWA Groundwater Modeling Advisory Panel White Paper, National Ground Water Association (NGWA), Westerville, OH, 43801.

Harvey, D.J.M. and Guiguer, N. 2001. Determining practical input for reactive transport modeling: a case study. MODFLOW 2001 and Other Modeling Odysseys, Golden, CO, 11-14 September 2001.

Harvey, D.J.M. and Martin, P.J. 2003. Parallel Model Calibration of a Brownfield Site Under Varied Hydraulic Conditions Using PEST. MODFLOW and More 2003: Understanding through Modeling, Golden, CO, 16-20 September 2003.

Harvey, D.J.M. and Sykes, J.F. 1999. A risk assessment of the delineation of wellhead protection areas. ModelCARE'99 International Conference on Calibration and Reliability in Groundwater Modeling, Zurich, Switzerland, 20-23 September 1999.

Hesch, W., Chmakov, S., Harvey, M., and Panday, S. 2013. Which Unstructured Grid is the Best for Your Model: Comparing Various Grid Geometries for MODFLOW-USG. MODFLOW and More 2013, Denver, CO, 2-5 June 2013.

Merry, A.G., Martin, P.J., Meyer, P. and Harvey, D.J.M. 2002. A methodology to assess the calibration and predictive sensitivity of model parameters: defining suitable objective functions. ModelCARE 2002 International Conference on Calibration and Reliability in Groundwater Modeling, Prague, Czech Republic, 16-20 June 2002.

Sykes, J.F., Harvey, D.J.M. and Wilger, C. 1996. The risk associated with aquifer remediation: the influence of parameter uncertainty. ModelCARE'96 International Conference on Calibration and Reliability in Groundwater Modeling, Golden, Colorado, 24-26 September 1996.

Sykes, J.F., Harvey, D.J.M. and Wilger, C. 1996. Risk analysis for the uncertainty in the remediation time of a contaminated aquifer. 4th Environmental Engineering Specialty Conference (CSCE) Edmonton, Alberta, May 28-June 1, 1996.

Wadley, S., Harvey, D.J.M. and Debebe, A. 2006. Integrating MODFLOW Model Input and Output Data using HydroGeo Analyst. MODFLOW and More 2006: Managing Ground-Water Systems, Golden, CO, 21-24 May 2006.

Cheibany Ould Elemine, PhD., P.Geo.

Senior Geochemist

Education
PhD., Hydrogeochemistry
M.Sc., Hydrogeochemistry
B.Sc., Applied Geology

Awards
Top in Technology Award. (2012).
Monbusho Scholarship Recipient (1998-2004).
National Scholarship Recipient (1993-1997).

Years of Experience
With AECOM: <1
With Other Firms: 19

Training and Certifications
Introduction to Geochemical Modeling using Phreeqc
Geochemical Modeling using The Geochemist's Workbench
Mine Water and Chemical Balance Analysis
Metal Mining Discharges - Impacts and Controls

Professional Affiliations
Engineers and Geoscientists of British Columbia (EGBC)
Association of Professional Engineers and Geoscientists of Saskatchewan (APEGS)
Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (NAPEG)

Areas of Expertise
Mine Waste ARD/ML Characterization
Mine Waste Management
Aqueous and Isotope Geochemistry
Assessment of fate and transport of metals
Water Quality Assessment

Summary

Cheibany Ould Elemine is a senior geochemist with 20 years of academic and consulting experience. His experience includes the development and implementation of characterization programs for solid and aqueous-phases (e.g., waste rock, tailings, groundwater, etc.) and leading mine waste CO_2 sequestration studies. He designs characterization programs to assess the geochemical properties of material in the laboratory and the field, and uses the results to evaluate potential environmental impacts from mining, pipelines and infrastructure projects. He designs acid rock drainage and metal leaching (ARD/ML) characterization programs and develops optimized mine waste and environmental management plans. He also conducts investigations into the geochemical behavior and fate of contaminants of potential concern in groundwater, tailing impoundments, waste rock dumps and mine drainages. Dr. Cheibany has been a senior geochemist and subject matter expert for several mining, pipeline, infrastructure and environmental projects in Canada, United States, South America and Africa. He also served as a qualified professional (QP) and due diligence reviewer for several projects worldwide.

Selected Project Experience

Sand Mining Projects

Sio Silica Inc. (formerly CanWhite Sands Corp.), Environment Act Proposal – Vivian Sand Facility Project, Vivian, Manitoba.. Senior Geochemist. Developed the ARD/ML Management Plan and responded to information request from Stakeholders (2022 – now).

Canadian Premium Sand, Environment Act License Application - Wanipigow Sand Project, Seymourville, Manitoba. Senior Geochemist. Reviewed the ARD/ML assessment report and developed the ARD/ML Management Plan (2022)

Hard Rock Mining Projects

Hudson Bay Mining & Smelting Co., Limited – Flin Flon 2025 Decommissioning and Reclamation, Flin Flon, Manitoba. Senior Geochemist. Reviewed site background data and lead the development of geochemical characterization program. Lead the analysis and interpretation of geochemical data. Member of technical steering committee and contributor to project planning, risk assessment and conceptual option development.

Confidential Client, Waste Rock Characterization, Saskatchewan. Senior Geochemist. Reviewed site background data and lead the development of geochemical characterization program. Lead the analysis and interpretation of geochemical data.

Nickel Creek Mine, CO_2 Sequestration Study and Geochemical Assessment, Nickel Creek Platinum Corp., Yukon. Technical Lead for the development a plan to assess the potential for the waste rock and tailings to sequester CO_2.Reviewed the project database, coordinated the efforts to find research partners, assessed their proposals and helped select the research partner. Coordinated and supervised the study and assessed progress against milestones. Developed a preliminary ARD/ML screening for the waste rock (2021 – 2022).

Brewery Creek Mine Project, Geochemical Assessment and Environmental Monitoring, Sabre Gold Mines Corp., Yukon. Geochemist for the development of the characterization program for the heal leach material and waste rock. Reviewed site background data, developed the characterization program for the heap leach, analyzed the data and reported the findings. Lead the analysis and reporting of surface and groundwater monitoring data to fulfill water license reporting requirements. Lead the analysis of geochemical data and reporting for Lower Fosters deposit (2020 – 2022).

Kudz Ze Kayah Mine, Water License Application, BMC Minerals (No.1) Ltd., Yukon. Geochemist for geochemical characterization and lead for groundwater annual reporting. Performed the geochemical characterization of waste rock, overburden and tailings using static and kinetic data. Reviewed and conducted QAQC of laboratory reports, wrote and annually updated ARD/ML deliverables, prepared ARD/ML sections of the water license application and drafted responses to information requests from stakeholders. Lead the reporting for groundwater monitoring programs (2018 – 2022).

Mount Nansen Mine, Mine Reclamation, Crown-Indigenous and Northern Affairs Canada (CIRNAC), Yukon. Senior Geochemist for the project. Performed the geochemical characterization of waste rock, tailings and borrow sources and developed site screening criteria for site remediation. Compiled geologic, permafrost, geohazards, terrain and soil data for Yukon Environmental and Socio-economic Assessment Act (YESAA). Assessed groundwater quality at the site, lead the development of groundwater AMP and reviewed monthly AMP compliance reports. Developed plan for metal sequestration study to assess metal attenuation along downstream of the pit. (2018 –2022).

Flame and Moth and Bermingham Mines, Operational Waste Monitoring, Alexco Keno Hill Mining Ltd., Yukon. Project Geochemist. Continuously reviewed and selected waste rock and tailing samples from development works for confirmatory testing, tracked test results against performance criteria and updated site-specific screening criteria. (2019 – 2022).

Flame and Moth and Bermingham Mines, Water License Application and Environmental Monitoring, Alexco Keno Hill Mining Ltd., Yukon. Project Geochemist. Performed the geochemical characterization of waste rock, tailings and sludge for the Flame and Moth and Bermingham mines. Prepared and updated annual ARD/ML reports and prepared ARD/ML sections of the water license application. Prepared annual groundwater and surface water monitoring reports and responded to requests for information from stakeholders. (2018 – 2022).

Keno Hill District Mining Operations, Metal Attenuation Studies, Alexco Keno Hill Mining Ltd., Yukon. Geochemist for the assessment of metal attenuation in No Cash Creek and Christal Creek Catchments. Primary author of the No Cash and Christal Creek attenuation studies. Analyzed soil, vegetation, microbiome, and surface water quality and groundwater data to assess the potential for metal attenuation along the proposed discharge corridors. Prepared initial reports then supervised and reviewed subsequent revisions. (2019 – 2022).

Km1728 Wellgreen Mill and Tailings Site Remediation, Geochemistry and Water Quality Evaluations, Site Assessment and Reclamation Unit, Yukon Government, Burwash Landing, Yukon. Project Geochemist. Provided geochemistry support to the reclamation of the project. Reviewed and summarized the results of tailings characterization work to support the water license application. Lead the 2020 tailings characterization program. (2020 - 2022).

Norilsk Nickel Project, Prefeasibility Geochemical Assessment Reports, Norilsk Nickel, Kazakhstan. Senior Reviewer for due diligence review. Conducted a due diligence review of the geochemical assessment reports and information for the prefeasibility study, identified gaps to be addressed and made recommendation for future phases of the project. (2018).

Kami Iron Ore Project, Kami Iron Ore Mine and Rail Infrastructure, Alderon Iron Ore Corp. (Alderon), Labrador. Senior Advisor/Reviewer for the Project. Provided technical guidance and senior review for phase III pf the geochemical characterization program. Reviewed the results of Phase I and II assessment programs and the proposed plan for Phase III assessment, and recommended improvements to the plan, data management and analysis. (2016-2017).

Guyana Goldfield Aurora Gold Project, Feasibility Study, Guyana Goldfield Aurora Gold, Guyana. Geochemist for the project. Performed the geochemical characterization of waste rock and tailings and prepared deliverables (2012-2013).

Highland Valley Copper Project, HVC Metal Leaching Assessment, Teck Resources Ltd. British Columbia. Geochemist for the project. Performed the ARD/ML characterization of the tailings, conducted the analysis of the annual Special Waste Extraction Procedure (SWEP) test results and made recommendations for future testing. (2013).

Silvercorp Silvertip Project, Silvercorp Metals Inc. British Columbia. Geochemist for the project. Performed waste rock, tailings and sludge ARD/ML geochemical characterization, elaborated waste management plans and carried out a GIS based 3D model to highlight the spatial distribution of geochemical data. (2012-2013).

Tasiast Mine, Geotechnical and Civil Design and Construction Monitoring, Kinross Gold Corp., Mauritania. Geoscientist for the construction of the tailings storage facility. Supervised the over liner bedding placement, inspected the construction of the starter dyke and conducted the QA/QC of the construction material. (2012).

Oil Sands Mining Projects

End Pit Lakes Research Project, End Pit Lakes Research, Syncrude Canada Ltd., Alberta. Geochemist. Conducted the geochemical literature search and review for oil sands end pit lake studies, assessed the current geochemical knowledge relevant to future use of end pit lakes as reclamation options, carried out data gap analysis and proposed further research topics. (2011).

South Tailings Pond Performance Assessment Project, South Tailings Pond Groundwater Assessment, Suncor Energy Inc., Alberta. Lead geochemist for the assessment of the impact of process-affected water in the TSF on the Wood Creek Sand Channel. Oversaw the elaboration of baseline conditions and the assessment of groundwater geochemical evolution, and impact assessment. (2011).

Pipeline Projects

Coastal GasLink Pipeline Project, Geohazard Assessment, TransCanada Ltd., British Columbia. Lead Geochemist and SME for the project. Oversaw the ARD/ML geochemical characterization for the project including preliminary desktop screening and elaboration of field programs. Senior reviewed field reports, authored ARD/ML characterization reports and designed ARD/ML management and control plans. Liaise with client to discuss costs, schedule, regulatory requirements and integration of ARD/ML assessment into overall project plan. (2013-2017).

Westcoast Connector Gas Transmission Project, Geotechnical Assessment, Spectra Energy, British Columbia. Lead Geochemist and SME for the project. Provided technical advice on the ARD/ML geochemical characterization of the project, conducted senior review of field and ARD/ML reports, and elaborated ARD/ML mitigation and control plans. (2013 and 2021).

Alaska LNG Project, Geotechnical and Geohazards Assessment, ExxonMobil Alaska LNG LLC, Alaska. Lead Geochemist and SME for the project. Oversaw the ARD/ML geochemical characterization for the project including preliminary desktop screening, elaboration of field programs, and reporting. Liaised with regulators, managed project data and coordinated between team members and supporting teams. (2014 and 2016).

Infrastructure/Facilities Projects

Nexen Reclamation Project, Sulphur Guideline Review, Nexen Energy ULC., Alberta. Project Geochemist. Led the review the elaboration of a site-specific sulphur guideline for the clean-up and management of contaminated material. Developed scope, budget, and the design of the assessment program. Carried out data analysis, interpretation and reporting. (2017-2018).

Nexen Aurora LNG Project, Geotechnical Assessment, Nexen CNOOC Ltd., British Columbia. Lead Geochemist for the project. Led the ARD/ML geochemical characterization including scoping, budgeting and design of the assessment program. Conducted data analysis, interpretation and reporting. (2014-2017).

BC Hydro Site C Clean Energy Project, Geotechnical and Environment Assessment, BC Hydro, British Columbia. Geochemist for the project. Performed geochemical characterization of bedrock, overburden and borrow material. Developed scopes and budgets, field work plans, built field leach barrels, carried out data analysis and reporting. (2011-2013).

Other Projects

Gosen City Groundwater Project, Groundwater Assessment, Gosen City, Japan. Geoscientist. Supervised the sampling of groundwater, streams and springs. Performed the analysis and interpretation of geochemical and isotope data. Created water quality distribution maps and elaborated recharge and flow models. (2007-2008).

Tuestsu Earthquake Site Investigation, Landslide Susceptibility Mapping, Niigata Prefecture, Niigata, Japan. Geoscientist. Compiled geological, geotechnical and geographical data for landslide mapping and analysis. Carried out a landslide susceptibility analysis using logistic regression. (2008-2009).

Professional Experience

2022- AECOM, Senior Geochemist

2018-2022: Alexco Environmental Group / Ensero Solutions Senior Geochemist and SME, Vancouver, Canada.

2013-2018: WorleyParsons / Advisian Senior Geochemist and SME, Calgary, Canada.

2011-2013: Geochemist / GIS Specialist, Klohn Crippen Berger, Vancouver, Canada.

2007-2010: Geoscientist and GIS Implementation Lead, Kitac Corporation, Niigata, Japan.

2004-2007: Post-Doc and Research Fellow, Niigata University, Niigata, Japan

Clifton Samoiloff, B.Sc., EP(CEA)

Project Manager, Senior Scientist

Education

Advanced Diploma, Technology Management, Red River College

Certificate, Laboratory Auditor, Accademia Qualitas

Certificate, Quality Assurance Management, University of Manitoba

BSc, Microbiology, University of Manitoba

Years of Experience

With AECOM: 16
With Other Firms: 13

Professional Affiliations

ECO Canada, Environmental Practitioner - Certified Environmental Auditor (EP (CEA))

Standards Council of Canada, Laboratory Technical Assessor for the Program for Accreditation of Laboratories in Canada (PALCAN) – Former Technical Assessor

Mining Association of Canada (MAC), Toward Sustainable Mining - Qualified Verifier

Member, Manitoba Environmental Industries Association (MEIA)

Member, Manitoba Writers Guild

Summary

Clifton Samoiloff, B.Sc., is a Project Manager, Senior Scientist, and Certified Environmental Auditor (EP(CEA)) with the Environment business line of AECOM located in Winnipeg, Manitoba. He has over 28 years of experience in environmental assessment and permitting, environmental toxicology and chemistry, site assessment and remediation, Environment, Health & Safety (EHS) compliance auditing, environmental management, and stakeholder engagement. He has lead projects and provided senior technical support on many projects for clients within various market sectors, including mining and mineral processing, manufacturing, pulp & paper, chemical, food & beverage, and transportation throughout Manitoba and Canada.

Relevant Project Experience

Environmental Assessment and Permitting - Mining

Sio Silica Inc. (formerly CanWhite Sands Corp.), Environment Act Proposal – Vivian Sand Facility Project, Vivian, Manitoba. Project Manager and senior scientist for the development of an Environment Act Proposal for the construction and operation of a silica sand processing facility near Vivian, Manitoba. Project included a regulatory and environmental review, evaluation of baseline field studies, data analysis, environmental assessment, regulatory liaison, community engagement, report preparation and review, and general project coordination.

Hudbay Minerals Inc., Notice of Alteration Application – Refurbishment of the New Britannia Mill, Snow Lake, Manitoba. Project Manager and technical lead for the development of a Notice of Alteration to an Environment Act Licence for upgrading the New Britannia gold mill and installing new tailings pipelines and supporting infrastructure. Project included design and literature review, baseline field studies and data analysis, environmental assessment, regulatory liaison, community engagement, closure planning, report preparation and review, and general project coordination and tracking.

Canadian Premium Sand, Environment Act License Application - Wanipigow Sand Project, Seymourville, Manitoba. Development of an Environment Act Licence application for a 1,000,00 tpy high-grade silica sand open pit mine and associated infrastructure, including processing plant and access roads. The project included review of engineering design details, literature and regulatory review, environmental assessment, multiple rounds of community engagement and regulator meetings, development of an Environment Act License application and other regulatory approvals, development of environmental management plans, and various other reporting requirements.

Hudbay Minerals Inc., Environmental Consequence Classification of Facilities in Manitoba and Saskatchewan. Project Manager and environmental lead for the Environmental Consequence Classifications (ECC) of impoundment structures at facilities in Manitoba and Saskatchewan. Responsible for coordination and assessment of environmental and socioeconomic factors associated with each structure and the potential impact within inundation areas and downstream environments.

Rockcliff Metals Corporation - Development of an Advance Exploration Project (AEP) Approval Application for a Zinc/Copper Deposit (Tower Property) Located near Grand Rapids, Manitoba. Project included development of a project description for the mine and associated infrastructure, review of tailings management and water treatment options, planning and performance of field studies, an environmental assessment, leading community and stakeholder engagement, and the development of an AEP application and mine closure plan.

Hudbay Minerals Inc., Notice of Alteration Application – Anderson Tailings Impoundment Area, Snow Lake, Manitoba. Project Manager and technical lead for the development of a Notice of Alteration to a Clean Environment Commission Order for the expansion of the Anderson Tailings Impoundment Area located near Snow Lake, Manitoba. The project included the review of engineering design details and literature review, environmental assessment, development of a Project Description, regulatory liaison, report preparation, and project coordination, tracking and reporting responsibilities.

Hudbay Minerals Inc., Environment Act License Application – Lalor Concentrator, Snow Lake, Manitoba. Project Manager and technical lead for the development of an Environment Act Licence application for a 3,500 tpd zinc and copper concentrator and associated infrastructure, including access road and 17 km tailings line. Project included a design and literature review, regulatory review, field studies, public and First Nation engagement, data analysis, closure planning, report preparation, and review and project coordination, tracking and reporting responsibilities.

Minnova Gold Corporation, Environment Act License Application – Open Pit Mines, Sherridon, Manitoba. Development of an Environmental Licence application for the development and operation of five open pit mines, processing plant, and associated infrastructure located near Sherridon, Manitoba. Project included a review of mine design and literature review, regulatory review, field studies, public and First Nation engagement, data analysis and report preparation.

Hudbay Minerals Inc, Environment Act License Application – Lalor Mine, Snow Lake, Manitoba. Project Manager and technical lead for the development of an Environment Act Licence application for a 3,500 tpd zinc/copper/gold mine, 4 km access road, and associated infrastructure. Project included design review, literature and regulatory review, field studies and data analysis, multiple rounds of public and First Nation engagement, closure planning, report preparation and review, development of environmental management plans, and project coordination, tracking and reporting responsibilities.

Hudbay Minerals Inc., Environment Act License Application – Reed Mine, Grass River Provincial Park, Manitoba. Project Manager and technical lead for the development of an Environment Act Licence application for a 1,200 tpd copper mine, access road, and associated infrastructure. Project included design review and development of a project description, literature and regulatory review, field studies and data analysis, multiple rounds of public and First Nation engagement, closure planning, report preparation, and project coordination, tracking and reporting responsibilities.

Manitoba Conservation - Environmental Effects Monitoring, Northern Manitoba. Provided senior technical support for the assessment of the sensitivity of lakes surrounding Flin Flon and Thompson to acidifying compounds. Project involved the collection of water and sediment samples from 50 lakes for analytical testing, data analysis and interpretation, and report preparation, with the results of the study presented to Manitoba Conservation and Environment Canada.

Confidential Client - Environmental Due Diligence Review, Saskatchewan. Lead assessor for an environmental due diligence review of multiple mineral processing facilities located in Saskatchewan. The scope of the audit included a desktop review of regulatory compliance, environmental management processes, site characteristics, and other environmental due diligence issues.

Manitoba Science, Technology, Energy and Mines- Environmental Assessment and Remediation Planning, Northern Manitoba. Project Manager and technical lead for the completion of phase II environmental assessments and remediation planning at the former God's Lake Mine located on a remote island in Northern Manitoba. Scope of work included planning and conducting field investigations, installation of groundwater monitoring wells, interpretation of chemical data, development of a report on the effects of mine wastes on the surrounding environment, determination of remedial options, and project coordination, tracking and reporting responsibilities.

Hudbay Bay Mining & Smelting Co., Limited. - Chisel North Water Treatment Plant Feasibility Study, Snow Lake, Manitoba. Project manager for the review of water treatment plant capacity currently in operation at the former Chisel North Water Treatment Plant and the assessment of current and future plant capacity. Project scope included a site assessment of treatment plant and mining operations, assessment of current and future water flows, review of current plant capacity and efficiency, and the development of new plant design for increased water capacity.

Confidential Client - Environmental Site Assessments and Remediation Planning, Northern Manitoba and Saskatchewan. Project Manager for the performance of multiple and ongoing environmental assessments at legacy mining properties in northern Manitoba and Saskatchewan to identify any residual mining material or potential environmental impacts at each site. Each assessment relied on site reconnaissance information, historical data analysis, targeted environmental sampling, toxicity testing and environmental and human health risk assessment, regulatory review to ensure compliance, analysis and reporting, review of remediation options and remediation planning, and project coordination, tracking and reporting responsibilities. Environmental media sampled and analyzed during these assessments included soil, waste rock, surface water, and sediment.

Cabot Corporation, Notice of Alteration Application - TANCO Mine, Lac Du Bonnet, Manitoba. Development of a Notice of Alteration to an Environment Act Licence for surface and underground modifications at the TANCO Mine. Project included a design and literature review, field studies and data analysis, environmental assessment, regulatory liaison, closure planning, and report preparation.

Hudson Bay Mining & Smelting Co., - Review of Toxicology and Chemistry Data and Development of a Toxicity Identification Evaluation, St. Lawrence Zinc Company, New York. Project Manager and technical lead for the review and interpretation of historical acute and chronic toxicity tests data and analytical data and the design of an aquatic toxicity testing program to assist in the investigation of cause in effluent and receiving water samples. Project involved study design, coordination of sample collection, interpretation of toxicity test data, and reporting.

Cabot Corporation - Environmental Management System Development, Implementation and Review, Underground Mining Facility in Northeastern Manitoba. Project Manager and lead consultant for the development, implementation and review of an Environmental Management System and audit program for an active underground mining facility located near Lac Du Bonnet, Manitoba. The scope of project included environmental the regulatory compliance, environmental management processes, environmental monitoring programs, site decommissioning, and environmental due diligence issues.

BHP Billiton, Environmental Site Assessment - Staging Facility for Mine Construction, Jansen, Saskatchewan. Project included an environmental assessment of 12 potential sites for the development of a rail staging area to support construction of a potash mine near Jansen, Saskatchewan. Project included a review of design information, review of environmental and regulatory constraints, and development of an assessment report.

Hudson Bay Mining & Smelting Co., Limited - Development of an Advance Exploration Project (AEP) Approval Application for a Zinc/Copper Deposit (Bur Lake) Located near Snow Lake, Manitoba. Project included development of a project description for the mine and associated infrastructure, review of tailings management, road access, and water treatment options, planning and performance of field studies, an environmental assessment, leading community and stakeholder engagement, and the development of an AEP application and mine closure plan.

Hudson Bay Mining & Smelting Co., Limited - Development of an Air Dispersion Model, Flin Flon, Manitoba. Project Manager overseeing the development of an air dispersion model to assist with the prediction and prevention of elevated ground-level concentration of emissions from the Flin Flon copper smelter. Project included a review of meteorological and topographical data, smelting operations, historical emissions data, and computer modelling.

Manitoba Science, Technology, Energy and Mines - Environmental Assessment and Remediation Planning, Former Gods Lake Mine, Northern Manitoba. Project included a field investigation, installation of groundwater monitoring wells, interpretation of chemical data, and development of a report on the effects of mine wastes on the surrounding environment for the former God's Lake Mine located on a remote island in Northern Manitoba.

Manitoba Science, Technology, Energy and Mines - Environmental Assessment and Remediation Planning, Former Snow Lake Mine, Snow Lake Manitoba. Project included a field investigation, installation of groundwater monitoring wells, interpretation of chemical data, development of a report on the effects of mine wastes on the surrounding environment, and remediation planning for the former Snow Lake Mine located in Snow Lake, Manitoba.

Manitoba Science, Technology, Energy and Mines - Environmental Assessment and Remediation Planning, Former Baker Patton Mine, Northern Manitoba. Project included a field investigation, installation of groundwater monitoring wells, interpretation of chemical data, and development of a report on the effects of mine wastes on the surrounding environment for the former Baker Patton Mine located near Flin Flon, Manitoba.

Environmental Assessment and Permitting – Miscellaneous

Environmental Site Assessment for the Development of a Solid Waste Disposal Facility, Snow Lake, Manitoba. Project included a study design, review of existing design information, environmental baseline review, constraint mapping and development of an assessment report for the development of a landfill and sewage treatment sludge storage facility.

Environmental Site Assessment for the Development of an Electrical Transmission Line. Project included a study design, review of existing design information, environmental baseline review, site assessment, and reporting for the development of an electrical transmission line from Snow Lake to a mining facility located in the Grass River Provincial Park.

Environment Act License Application, Provincial Road 392, Snow Lake, Manitoba. Development of an Environment Act Licence application for relocation and upgrading of a 4 km section of Provincial Road 392 located near Snow Lake, Manitoba. Project included a detailed review of design information, literature review, regulatory review, data analysis and report preparation.

Environment Act License Application, Steinbach, Manitoba. Development of an Environment Act Licence application for sewage treatment plant lagoon expansion. Project included a site assessment, literature review, regulatory review, data analysis and report preparation.

Environment Act License Application, Wastewater Treatment Facility, Snow Lake, Manitoba. Development of an Environment Act Licence application for a wastewater treatment facility for Lalor Mine. Project included a detailed review of design information, literature review, regulatory review, data analysis and report preparation.

Environment Act License Application, Hydro Generating Station, Northern Manitoba. Development of an Environment Act Licence application for a water and wastewater treatment plant expansion for the Manitoba Hydro Wuskwatim Generating Station. Project included a detailed review of design information, literature review, regulatory review, data analysis and report preparation

Development of an Environment Act License and Screening Level Environmental Assessment (CEAA) for the Development of Three Bioenergy Demonstration Projects Located in Manitoba. Project included site investigation, data collection and analysis, design review and literature search, development of mitigation measures, regulatory review and reporting.

Environment Act License Application for Development of a Water Treatment Plant, Flin Flon, Manitoba. Development of an Environment Act Licence application for development of a sewage treatment plant and associated infrastructure for the City of Flin Flon. Project included a site assessment, design review and literature search, regulatory review, data analysis and report preparation

Development of a Screening Level Environmental Assessment (CEAA) for Upgrading of a Wastewater Treatment System and Sewage Lagoon, Nelson House First Nation, Manitoba. Project included site investigation, data collection and analysis, design review and literature search, development of mitigation measures and regulatory review.

Environment Act License Application, Dominion City, Manitoba. Development of an Environment Act Licence application for sewage treatment plant lagoon expansion. Project included a site assessment, literature review, regulatory review, data analysis and report preparation.

Development of a Screening Level Environmental Assessment (CEAA) for the Development of a Class II Landfill and Landfarm Facility, South Indian Lake First Nation, Manitoba. Project included data collection and analysis, literature search, development of mitigation measures and regulatory review.

Environment Act License Application – Notice of Alteration, Lockport, Manitoba. Development of an Environment Act Licence application and Notice of Alteration for sewage treatment plant lagoon expansion at Happy Though School. Project included a site assessment, design and literature review, regulatory review, data analysis and report preparation.

Development of a Screening Level Environmental Assessment (CEAA) for Expansion of a Sewage Lagoon, Pukatawagan First Nation, Manitoba. Project included data collection and analysis, design review and literature search, development of mitigation measures and regulatory review.

Development of a Screening Level Environmental Assessment (CEAA) for Expansion of Wastewater Treatment System and Sewage Lagoon, Fairford First Nation, Manitoba. Project included site investigation, data collection and analysis, design review and literature search, development of mitigation measures and regulatory review.

Environment Act License Application, Northern Manitoba. Development of an Environment Act Licence application for a sewage treatment plant expansion for the Manitoba Hydro Laurie River Generating Station. Project included a site assessment, literature review, regulatory review, data analysis and report preparation

Development of a Screening Level Environmental Assessment (CEAA) for Housing Sub-division Development and Associated Infrastructure, Split Lake First Nation, Manitoba. Project included site investigation, data collection and analysis, design review and literature search, development of mitigation measures and regulatory review.

Development of a Screening Level Environmental Assessment (CEAA) for Expansion of a Wastewater Treatment System, Little Grand Rapids First Nation, Manitoba. Project included data collection and analysis, design review and literature search, development of mitigation measures and regulatory review.

Development of a Screening Level Environmental Assessment (CEAA) for Expansion of a Wastewater Treatment System and Sewage Lagoon, Pauingassi First Nation, Manitoba. Project included data collection and analysis, design review and literature search, development of mitigation measures and regulatory review.

Environmental Audit and Compliance (Manitoba)

Environmental Compliance Audit, Grocery Retail Facilities, Winnipeg, Manitoba. Lead auditor for an internal environmental compliance audit for two grocery retail facilities. The scope of the audit included a review of regulatory and corporate compliance and environmental management system, site characteristics and other environmental due diligence issues.

Environmental Compliance Audit, Grocery Distribution Facility, Winnipeg, Manitoba. Lead auditor for an internal environmental compliance audit. The scope of the audit included a review of regulatory and corporate compliance and environmental management system, site characteristics and other environmental due diligence issues.

Environment, Health and Safety Compliance Audit, Electronics Manufacturing Facility, Winnipeg, Manitoba. Lead auditor for an internal environment, health and safety compliance audit of an electronics manufacturing and distribution facility. The scope of the audit included a review of federal and provincial regulatory compliance, review of site characteristics, risk review and other EH&S due diligence issues.

Environmental Compliance Audit, Rubber Hose Manufacturing Facility, Winnipeg, Manitoba. Lead auditor for an internal environmental compliance audit of a rubber hose manufacturing and distribution facility. The scope of the audit included a review of regulatory compliance, review of site characteristics and waste management practices, and other environmental due diligence issues.

Environmental Due Diligence Review, Confidential Client, Manitoba. Lead assessor for an environmental due diligence review of an underground mining operation located in Manitoba. The scope of the audit included a site visit and review of regulatory compliance, environmental management processes, site characteristics, and other environmental due diligence issues.

Environmental Compliance Audit, Retail Property, Winnipeg, Manitoba. Lead auditor for an internal environmental compliance audit of a 400,000 sq. ft. retail outlet mall. The scope of the audit included a review of regulatory compliance, review of site characteristics and waste management practices, and other environmental due diligence issues.

Environmental Compliance Audit, LED Vertical Farm, Opaskwayak, Manitoba. Lead Auditor for an environmental compliance audit of an LED vertical farm used to cultivate vegetables, fruits and herbs for local distribution. The scope of the audit included a review of regulatory compliance and other environmental due diligence issues.

Environment, Health and Safety, and PSM Compliance Audit, Brandon, Manitoba. Lead Auditor for internal corporate compliance audit for a fertilizer manufacturing and distribution facility located in Brandon, Manitoba. The scope of the audit included regulatory compliance, environmental management processes, process safety, site characteristics, and other environmental due diligence issues.

Environment, Health and Safety Compliance Audit, Paint Warehouse, Winnipeg, Manitoba. Lead Auditor for internal corporate compliance audit for a paint and solvent storage and distribution facility. The scope of the audit included regulatory compliance, environmental management processes, site characteristics and other environmental due diligence issues.

Environmental Compliance Audit, Grocery Distribution Facility, Winnipeg, Manitoba. Lead auditor for an internal environmental compliance audit. The scope of the audit included a review of regulatory and corporate compliance and environmental management system, site characteristics and other environmental due diligence issues.

Environmental Compliance Audit, Mining Facilities in northern Manitoba. Lead auditor for an internal environmental compliance audit covering active and inactive mining facilities located in and around the communities of Flin Flon and Snow Lake, Manitoba. The scope of the audit included a review of regulatory compliance, environmental management processes, site closure and environmental due diligence issues.

Environmental, Health and Safety Compliance Audits, Confidential Beverage Industry Client: Winnipeg, Brandon and Dauphin, Manitoba. Conducted environmental, health and safety compliance audits of three warehouse and shipping facilities located throughout Manitoba. The scope of the audit included a review of regulatory and corporate compliance, site characteristics and other environmental due diligence issues.

Environment, Health and Safety Compliance Audit, Oak Bluff, Manitoba. Lead Auditor for internal corporate compliance requirements for a 12-acre fertilizer distribution and storage terminal. The scope of the audit included regulatory compliance, environmental management processes, site characteristics (geology, groundwater) and other environmental due diligence issues.

Environmental Management System Compliance Audit, Winnipeg, Manitoba. Auditor for an EMS compliance audit requirements for a fire equipment and security supplies storage, distribution and installation facility. The scope of the audit included regulatory compliance, environmental management processes, site characteristics (hazardous materials, environmental impacts) and other environmental due diligence issues

Marlene Gifford, M.Sc., P.Biol. (AB), R.P.Bio. (BC), Adv. GIS Dipl.

Biologist, Environmental Assessor

Education

BSc, University of Manitoba, 1990

M.Sc. Department of Zoology, University of Manitoba 1993

Advanced GIS Diploma, Red River College (Honours) 2011

Years of Experience

With AECOM: >5

With Other Firms: 23

Professional Affiliations

Alberta Society of Professional Biologists

College of Applied Biology British Columbia

Training and Certifications

Advanced training (Feb. 2020) on the federal Impact Assessment Process*: Impact Assessment Act*

Fisheries and Oceans Canada (DFO) 2-day Fisheries Act workshop, May 2015

First Nations Cultural Awareness Workshop (Keeyask Generation Project), 2009

Summary

Marlene is a terrestrial and aquatics senior biologist and environmental permitting specialist with over 28 years of professional experience. Her career has largely focused on obtaining provincial and federal environmental permitting and approvals for industrial projects such as mining, linear infrastructure developments such as roads and associated water crossings, and energy facilities such as renewable power projects.

Project Experience Examples

Environmental Impact Assessments and Regulatory Permitting – Mining / Resource Extraction Related

CanWhite Sands Corp., Vivian Sand Processing Facility and Silica Sand Extraction Projects Environmental Assessments, Rural Municipality of Springfield, Manitoba. Leading the preparation of the Environment Act Proposals (environmental assessments) for the Environment Act Licence applications and associated regulatory and virtual public liaison.

Canadian Premium Sand. Wanipigow Silica Sand Mine. Seymourville, Manitoba. Collected baseline environmental information, including an Indigenous Knowledge study for the project site; participated in an Indigenous, public and stakeholder engagement program and regulatory agency liaison; lead the development of provincial impact assessment documentation (Environment Act Proposal); prepared a cumulative effects assessment and additional information requirements for the federal Canadian Environmental Assessment Agency (CEA Agency) screening requirements.

Hudbay Minerals Inc., New Britannia Mill Notice of Alteration, Snow Lake, Manitoba. Contributed to development of Notices of Alterations to Manitoba Environment Act Licences related to the existing mining (ore milling) facility.

Tantalum Mining Corporation of Canada Ltd., TANCO Mine Closure Plan, Lac du Bonnet, Manitoba. Contributed to the development of the TANCO Mine Closure Plan required under Manitoba mining legislation as a requirement of mine approval. 2020. (*completed*).

1911 Gold Corporation, True North Gold Mine Closure Plan, Bissett, Manitoba. Contributed to the development of the True North Gold Mine Closure Plan required under Manitoba mining legislation as a requirement of mine approval.

Confidential Client, Mining Development Permitting, Manitoba. Preparing an Advanced Exploration Project Plan proposal for Manitoba Mines Branch for a proposed mine development.

Confidential Client, Mining Development Permitting, Manitoba. Contributing to the preparation of a Notice of Alteration for an existing l mine to accommodate additional ore processing and tailings disposal.

BURNCO Rock Products Ltd., BIA for a Concrete Plant and Concrete Recycling Facility, Alderside, Alberta. Completed a BIA report for a proposed Ready Mix concrete plant and concrete recycling center for review and approval by the MD of Foothills to support a regulatory decision to redesignate the land use category from Agricultural to General Industry.

Mountain View County and Rolling Mix Concrete Ltd., BIA for a Gravel Pit, Newall, Alberta. Completed a BIA report for a proposed gravel pit development area to provide supporting information including baseline environmental studies, impact assessment and mitigation for inclusion within a Concept Plan for the application of land use redesignation and County development permit required to allow for Project development.

Environmental Impact Assessments and Regulatory Permitting – Other Development Examples

Manitoba Hydro and Various Wind Energy Clients, Environmental Assessment/Licenses/Approvals, Manitoba and Saskatchewan. Assisted in producing seven Environmental Impact Assessment (EIA) documents and obtaining environmental licenses/approvals for eight wind energy facilities (seven in Manitoba and one in Saskatchewan); advised on the regulatory permitting procedure and requirements for three proposed wind farms in Saskatchewan; contributed to the EIAs (federal and provincial) for Manitoba Hydro's major power projects including the Wuskwatim and Keeyask generating stations and associated linear infrastructure; assisted Manitoba Hydro in the Clean Environment Commission's multi-week public and technical review of the Wuskwatim Generating Station project.

Manitoba Floodway and East Side Road Authority, Environmental Assessment/Licenses/Approvals, All-season Road, Berens River First Nation to Poplar River First Nation, Manitoba. Preparation of the EIA reports for submission to federal (under *Canadian Environmental Assessment Act, 2012*) and Manitoba regulatory authorities for the environmental review and approval of the proposed all-season road and associated water crossings including clear-span and multi-span bridges at four river crossings; assessment of potential environmental effects and proposed mitigation measures. Also assisted with preparation of public and First Nations engagement materials and participated in engagement meetings.

Manitoba Floodway Expansion Authority, Red River Floodway Expansion Project, Winnipeg, Manitoba. Contributed to the development of provincial and federal (CEAA) EIAs of the Red River Floodway Expansion project.

Canadian Premium Sand. Solar Glass Manufacturing Facility. Selkirk, Manitoba. Leading the development of provincial impact assessment documentation (Environment Act Proposal); prepared a 'regulatory roadmap' document describing likely regulatory reviews and approvals required for the Project; conducted an environmental risk project site reconnaissance; prepared public engagement materials and participated in the public information session for the Project.

Indigenous and Northern Affairs Canada (INAC), Environmental Review for a new Community Access Road and Associated Road Improvements, Berens River First Nation, Manitoba. Prepared the Project Description Form and Simple Environmental Review Report required for INAC's Environmental Review and Approval Process for the construction of a new 4-km community access road and improvements to 1.5 km of connecting existing community roads for the Berens River First Nation. She also prepared a Request for Review to Fisheries and Oceans Canada (DFO) for federal review of an associated double-culvert crossing over a fish-bearing stream.

Marten Fall First Nation, Community Access Road and Industrial Supply Road, Marten Falls, Ontario. Provided senior technical quality review for environmental studies work plans and Project Description submission for the federal and provincial review process under the federal *Impact Assessment Act* and provincial *Environmental Assessment Act* for a >150 km long community access road to a remote First Nation. Provided lead reviewer services for baseline studies plans and reporting for a future industrial service road connecting to the proposed Marten Falls Community Access Road.

Rural Municipality of Victoria Beach, EIA for Faith Bible Camp Wastewater Treatment System, Manitoba. Prepared the Environment Act Proposal impact assessment document for licencing application to the provincial Environmental Assessment Branch for wastewater treatment system upgrades, including proposed treated effluent discharge to a wetland.

Parks Canada. Clear Lake Main Pier Assessment. Riding Mountain National Park, Manitoba. Completed environmental assessment, advising on regulatory approvals, and preparing recommended environmental protection and follow-up measures for the refurbishment of the Clear Lake main pier.

Mathias Colomb Cree Nation, Water Treatment Plant Upgrade, Pukatawagan, Manitoba. Led the preparation and submission of project description and simple environmental review forms to Indigenous Services Canada (ISC; formally INAC) and liaison with government regulators to facilitate environmental approvals for project construction.

Pine Falls Paper Company, EIA for Pine Falls Paper Mill, Manitoba. Contributed to the writing and completion of an EIA for the Pine Falls Paper Mill.

Nutri-Pea LP Processing Facility Notice of Alteration. Portage la Prairie, Manitoba. Completed a Notice of Alteration regarding Clean Environment Commission (CEC) Order 885 to provide an updated facility description indicating alterations and improvements made at the facility over the years since the CEC Order 885 was issued and describe planned near-term alterations / improvements.

Matt Kowalski, Ph.D., P.Eng.

Water/Wastewater Process Engineer

Education

Doctor of Philosophy (PhD), Environmental Engineering, University of Manitoba, 2020

Master of Science (MSc), Environmental Engineering, Gdansk University of Technology

Bachelor of Science (BSc), Chemical Engineering, Gdansk University of Technology,

Years of Experience

With AECOM: 3

Awards & Publications

Edward R. Toporeck Graduate Fellowship in Engineering, University of Manitoba 2019

A. Keith Dixon Graduate Scholarship in Engineering, University of Manitoba 2019

Petro Cdn Resources Grad Fellow. in Env. Issues in Eng., University of Manitoba 2019

Edward R. Toporeck Graduate Fellowship in Engineering, University of Manitoba 2017

International Graduate Student Scholarship, University of Manitoba 2016

Summary

Matt is a water and wastewater process engineer in the Winnipeg office. He has a PhD in environmental engineering with experience in wastewater modeling, data sampling and analysis, preliminary design, detail design, and report writing. He has been with AECOM for more than three years and has worked on projects ranging from lift station upgrades to process modeling and design of BNR wastewater treatment plants.

Project Experience at AECOM

- North End Water Pollution Control Center Interim Phosphorus Removal Review - AECOM provided consulting services for an interim phosphorus removal detail review, BioWin modeling, and bench-scale testing at the North End sewage treatment plant. Responsible for BioWin modeling, mass balances and review of alternative chemicals for phosphorus removal.
- Hudbay Minerals Inc. New Britannia Mill Engineering Services - AECOM provided engineering services for detailed design for a mining concentrator facility. Involved in the commissioning of the process equipment.
- North End Water Pollution Control Centre - Sequencing Batch Reactor Optimization. Responsible for conversion of SBR process from nitrification/denitrification to nitritation/denitritation in order to reduce energy and chemical consumption.
- Prince Albert Wastewater Treatment Plant Upgrade – AECOM is providing consulting services for plant modelling and pre-design. Responsible for BioWin modeling and review of alternative upgrade configurations to meet existing as well as future treatment objectives.
- Grand Beach Lift Station and Forcemain Upgrades - AECOM is providing engineering services for detailed design and construction of a new 10.6 L/s wastewater lift station including new submersible pump system, and associated site, process mechanical, electrical and automation works. As well as construction of new 150 mm forcemain connecting the new lift station and Grand Beach Lagoon.
- Paint Lake Lift Station Upgrade - AECOM is providing engineering services for upgrade of a 6.3 L/s wastewater lift station including new submersible pump system, maintenance of the existing lift station barrel connection to the existing distribution system and associated site, process mechanical, electrical and automation works.

- RM of Morris Water Distribution System Upgrades - AECOM provided detail design and contract administration services for a new concrete two-cell water reservoir with a total capacity of 1000 m3 and a pumphouse. Responsible for process support and contract administration.
- City of Cold Lake LagoonGuard™ MBBR Pilot Study – AECOM has conducted a LagoonGuard™ MBBR Pilot Study for the Cold Lake Regional Utility Services Commission upgrade the existing Wastewater Treatment Facility. Responsible for data analysis and report preparation.
- Morden Wastewater Treatment Plant Third Party Review – AECOM was retained to complete a third-party review of the existing facility design and provide cost estimates for construction and operation. Responsible for BioWin modeling and process review as well as budget costing and report writing.
- RM of Stanley Septage Lagoon Review – AECOM was retained to evaluate the continued use of the existing RM of Stanley Septage Receiving Lagoon. Responsible for data analysis, conceptual design of a new lagoon, lifecycle cost analysis and report writing.
- City of Regina WWTP – AECOM is providing technical and project management support. Involved in solving several technical issues, updating wastewater flow and loads projections and modelling their impact on the operation of the plant.
- Walnut Creek WWTP - AECOM is providing engineering services for WWTP upgrade. Responsible for BioWin modelling and mass balance preparation.
- God's Lake First Nation WWTP - AECOM provided engineering services for WWTP upgrade. Responsible for preliminary and detail design.
- GE Booth WWTP - AECOM is providing engineering services for WWTP upgrade. Responsible for data analysis and mass balance preparation.
- Morden Wastewater Treatment Regionalization Feasibility Study - AECOM was retained by the Manitoba Water Services Board (MWSB) to complete feasibility study for the Regional WWTP servicing the City of Winkler and Morden, and to prepare an updated cost estimate for the Regional WWTP. Responsible for data analysis, conceptual design, cost analysis and report writing.
- MDI WWTF – AECOM undertook a wastewater servicing feasibility study of MDI's wastewater production at their facility. Responsible for data analysis, mass balance preparation, modelling and report preparation.
- Cargill High River WWTP – AECOM was engaged by Cargill Meat Solutions to undertake a wastewater treatment evaluation for the beef processing facility located in High River, Alberta and develop a strategy to control the concentrations of phosphorus and chloride in the wastewater treatment plant's (WWTP) effluent. Provided process support and responsible for modelling and mass balance preparation.
- Winkler WWTP Upgrade – AECOM provided detail design services for the construction of a new wastewater treatment plant capable of treating 40 ML/d primary treatment and 23.6 ML/d secondary treatment. Provided process support.
- Hudbay Minerals Inc Chisel WTP – AECOM provided condition assessment services. Responsible for condition assessment of process equipment, cost estimates and report preparation.
- NEWPCC Biosolids Upgrade – AECOM is providing engineering services for NEWPCC Biosolids upgrade. Responsible for forecasting design population and modelling sludge production for the design year. Provided process support and mass balance preparation.
- NEWPCC Primary Clarifier Upgrade Project - AECOM is providing engineering services for NEWPCC Primary Clarifier Upgrade Project. Responsible for process design.
- Hudbay Minerals Inc. – provided a Flin Flon Tailings Impoundment System pH Adjustment Options Analysis for interim tailings treatment alternatives.
- Hudbay Minerals Inc. – AECOM is providing engineering services for a 2025 Decommissioning and Reclamation plan for Flin Flon Tailings Impoundment System. Responsible for water treatment process design.

TOM MEUZELAAR, PH.D.

PRINCIPAL CONSULTANT | FOUNDER

EDUCATION

Colorado School of Mines
2015
Ph.D. Geology
Washington State Univ, 1995
M.S. Geology
Univ of Utah 1992
B.S. Geology

PROFESSIONAL HISTORY

Life Cycle Geo, LLC
Principal Consultant
2019-Present
Golder Associates, Inc.
Senior Consultant
2011-2019
RockWare, Inc.
Consulting Geochemist
1999-2011
Envirosearch
Junior Environmental Consultant
1998

PROFESSIONAL AFFILIATIONS

Produced Water Society
Member
Association of Applied Geochemists
Fellow, past Council Member
Society of Mining Engineers
Member, Mining Engineering Journal Editorial Committee

PROFESSIONAL SUMMARY

Tom Meuzelaar is founder and owner of Life Cycle Geo. He specializes in geology, geochemistry and data science and has more than twenty years of industry experience. He is value oriented, and client focused, has effectively executed large, complex projects and is a demonstrated leader of technical teams, with a focus on empowering and mentoring. He is a highly diversified geoscientist who has consistently delivered at the highest technical level. Dr. Meuzelaar has supported mining in solving challenging water/rock related problems through all project life cycle stages. He has worked on numerous mine materials and water permitting projects all over the world and has considerable experience working with project stakeholders in challenging regulatory environments. He has considerable experience in characterization and prediction of acid rock drainage and metals leaching, as well as contaminant source, fate and transport evaluation, especially through predictive modeling.

Dr. Meuzelaar has evaluated complex geochemical models to assess a variety of equilibrium and kinetic gas/water/rock processes at variable temperature, pressure, salinity, redox and transport conditions. He has extensive experience as petrographer, mineralogist and geologist, and has taught or co-taught over 35 geochemical modeling short courses, including courses at Goldschmidt conferences, federal research organizations, multinational energy corporations, environmental and mining consultancies and major universities.

SPECIFIC AREAS OF EXPERTISE

- **Data analytics capabilities**: Unsupervised principal component analysis, multivariate regression, clustering. Supervised machine learning (classification, regression, outlier identification). Deep learning techniques applied to compositional image datasets (e.g., hyperspectral mineralogy).
- **Geochemical Modeling** (The Geochemist's Workbench): speciation, reaction path, reactive transport, redox/mineral/gas kinetics, advanced attenuation, microbial metabolism, high salinity/Pitzer, high temperature/gas
- **Petrography**: thin section petrography, specializing in carbonate and sandstone reservoirs. Extensive experience in the evaluation of XRD, XRF, QEMSCAN, and microprobe data
- **Web development/development**: HTML, XHTML, Javascript, CSS, XML, CGI/Perl, C++, Visual Studio, search engine optimization

LIFECYCLEGEO

REPRESENTATIVE PROJECTS – CHARACTERIZATION/PERMITTING

Materials and Characterization *Touro Mine, Atalaya Mining, Spain*	Provided permitting support through materials characterization (ARD and metals leaching) of metamorphosed, graphitic metasediments and metavolcanics. Co-published paper with client discussing challenges with environmental characterization of highly metamorphosed, sulfide- and graphite-bearing waste materials
Materials Characterization and Mine Permitting *Minnesota, USA*	Supported client with materials characterization, including evaluation of a multi-year accelerated weathering program (humidity cell). Addressed characterization challenges with incomplete pyrrhotite digestion, presence of graphite in metasediments and metavolcanics.
Mine Water and Materials Management (2018-current) *British Columbia, Canada*	Currently providing long-term permitting and mine design support for a large (50^{+}-year mine life) multi-deposit site in challenging physiographic terrain with significant water and materials management challenges located in British Columbia. Providing support with on-going geochemical characterization, detailed ARD and metals leaching evaluation, development of material environmental classification and segregation criteria, development of a conceptual site water balance and water quality model.
Materials Characterization and Mine Permitting *Arizona, USA*	Currently providing long-term permitting and mine design support for a planned large underground porphyry copper deposit in the SW US. Support includes materials characterization, baseline water quality assessment, predictive water quality modeling, proactive engagement with regulatory agencies and development of site mine materials and water management plans.
Tailings Storage Facility Seepage Investigation *Mexico*	Technical lead for a large, multi-disciplinary seepage remediation investigation, design and operation program at an active gold mine. Worked interactively with multiple project teams and provided technical guidance for the water chemistry team involved with plume characterization, source material evaluation, attenuation studies, baseline evaluation, multivariate statistical analysis of large datasets and reactive transport modeling.
Materials Characterization and Long-Term Water Quality Estimates *Bear Lodge, Wyoming, USA*	Technical lead for a large characterization and water quality modeling project for a proposed rare earth element mine, towards submission of a Mine Plan of Operations, Environmental Impact Assessment, Feasibility Study, and Permit-to-Mine application. Long term water quality predictive work towards a waste rock facility and post-closure pit lake.
Discharge Demonstration *New Mexico, USA*	Currently supporting client with predictive water quality modeling for several waste rock facilities, an open pit and haul road. Several of the facilities have ARD potential.

MOHSEN BARKH P.Eng., PMP.

PROFILE: A results-driven **Senior Mine Water Treatment Engineer** with more than 20 years of experience encompassing several critical technical areas with an emphasis on industrial water and wastewater treatment projects. Thorough understanding of all aspects of project management and treatment facility development and technical issues. Committed to tackling and resolving hard issues affecting technical operations with a critical eye for analyzing all the issues before making a decision. Ability to complete projects on time and within budget. Certified Project Management Professional, with exceptional talent in managing different stakeholders such as contractors and clients. Advanced computer skills and a member of APEGBC and PMI.

20
Years in Workforce

6
years in this job

P.Eng.

P.M.P

M.Eng.
Environmental Engineer

B.Sc.
Chemical Engineer

AREAS OF EXPERTISE

- ✓ WATER TREATMENT PROJECT MANAGEMENT
- ✓ SUPERVISION AND TEAM BUILDING
- ✓ COLLABORATING AND PROBLEM SOLVING
- ✓ PROPOSAL PREPARATION
- ✓ BUSINESS DEVELOPMENT IN SOUTH AMERICA AND AFRICA
- ✓ EQUIPMENT SIZING
- ✓ CONDUCT R&D PROJECTS IN MINE WATER TREATMENT
- ✓ PROCESS DEVELOPMENT
- ✓ COORDINATING BASIC ENGINEERING STUDIES
- ✓ HANDS-ON LAB EXPERIENCE
- ✓ PILOT PLANT AND TRADE-OFF STUDY

SELECTED ACHIEVEMENTS

✓Completed treatment trade-off study for mine feed water using ocean water, well water and city water considering Ion exchange and membrane technologies
✓Conducted research study on selenium removal process using Ion exchange process and presented results as an academic paper
✓Completed a sulphate reduction trade-off study for mine wastewater use in Peru.

PROFESSIONAL EXPERIENCE

Principal Engineer 2020-Present
RECENS WATER CO. Vancouver, BC
Providing water treatment design and consulting for industrial construction projects

Senior Project Manager 2018-2020
TERVITA CO., Richmond, BC
An environmental science and engineering firm that offers a wide range of onsite and mobile water treatment services:

- ✓ *Senior Project Manager for:*
  - ***Conoco Philip*** *dewatering pilot project, Fort St. John BC*
  - ***Trans-mountain*** *Pipeline Construction, Burnaby BC*
  - ***LNGC/ Boskalis*** *Project, Kitimat BC*

My role as a senior project manager included:

- ✓ *Supervising proposals preparation and cost estimation*
- ✓ *Preparing technical and engineering advice for technology selection*
- ✓ *Designing treatment facilities for two types of contaminated water*
- ✓ *Supervise design, procurement and operation of mobile treatment facilities*
- ✓ *Liaising with clients and other stakeholders*
- ✓ *Provide technical reports for MOE of BC*

20
Years in Workforce

6
years in this job

P.Eng.

P.M.P

M.Eng.
Environmental Engineer

B.Sc.
Chemical Engineer

PROFESSIONAL EXPERIENCE (CONTINUED)

Senior Project Manager 2011-2018
SGS CANADA Inc., Burnaby, BC
Water/Wastewater Treatment department of Mineral Services offers a wide range of environmental services for mining projects such as:

- ✓ *Lab test and process development for:*
  - ***Jadar** mine in Serbia*
  - ***Sothern Copper** mine in Peru*
  - ***SASA** mine in Macedonia*
  - ***Polyus Gold** mines in Russia*
  - ***Syerston** project in Australia*
- ✓ *Process development, pilot plant study and basic engineering for:*
  - ***Atacocha** mine in Peru*
  - ***Husab** mine in Namibia*
  - ***Canadian zinc** mine in Canada*
  - ***Seabridge Gold & Pretium Gold** in Canada*
  - ***AREVA** mine in France*

My role as a process engineer and project manager included:

- ✓ *Supervising and managing research projects such as cyanide and copper recovery as well as ammonia and selenium removal*
- ✓ *Liaising with clients and other stakeholders*
- ✓ *Designing lab work to select the optimum treatment process*
- ✓ *Supervising basic design, equipment sizing, CAPEX, and OPEX estimate*
- ✓ *Conducting pilot plant studies to prove the concept and collect technical data*
- ✓ *Joining detailed design engineering teams as a senior process engineer*
- ✓ *Mentoring junior engineers and EITs*

Design Engineer (Contract) 2008-2009
RESCAN ENVIRONMENTAL SERVICES LTD. (ERM), Vancouver, BC
An environmental science and engineering firm that offers a wide range of services to the natural resource industry and mining projects such as:

- ✓ *Engineering Design for:*
  - ***Davidson Mine** Project in Canada*
  - ***Sydvaranger Gruve** Slurry Pipeline in Norway*
  - ***Ramu Mixing/Disposal** Project in Papua New Guinea*

My role as a process design engineer included:

- ✓ *Designing and executing bench-scale experiments for industrial scale-up*
- ✓ *Designing the ammonia treatment facility for mine process water*
- ✓ *Preparing technical and economic trade-off studies*
- ✓ *Conducting troubleshooting for tailing disposal systems in the mining industry*

Managing Director Farayandsazan, Tehran, Iran 2000-2003

EDUCATION

Applied Project Management Diploma, SFU, Vancouver, BC 2014
Master of Environmental Engineering, UBC, Vancouver, BC 2004-2006
M.A. Sc. in Chemical Engineering, Tehran University, Iran 1990-1993
B.Sc. in petrochemical Engineering, Amirkabir UNIVERSITY, Iran 1986-1990

Feisal Somji, B.Sc., MBA

Founding Director, President, and Chief Executive Officer

Years with Sio Silica Corporation - 7

Total Years of Experience - 20+

Summary

Mr. Somji has 20+ years of experience ranging from grassroots exploration to mine development. Mr. Somji started his career managing an exploration and mine development services company with over 300 employees and divisions including diamond drilling, ground and airborne geophysics, geological consulting, geochemical analysis and laboratory services. He has acted as an officer and director of several public companies involved in silica sand, gold, diamond, silver, copper and base metal assets in North America, South America, Asia and Africa. Mr. Somji negotiated first-ever Canadian Federal Government Diamond Valuation Contract under a joint venture with 3 Indigenous groups and is a Founding Director of Aboriginal Joint-Venture Mineral Exploration Firm. Mr. Somji also provides expertise in areas of corporate finance and governance where he has raised over $150 million and helped several projects go public on the TSX-V, Frankfurt Exchange, American exchanges and the Lima stock exchange.

Education

Bachelor of Science, University of British Columbia 1992

Diploma in Aviation (Commercial Pilot's License with Multi-Engine, Float Plane and Instrument Flight Rules ratings), University College of Fraser Valley – Graduated Top of Class 1992

Masters in Business Administration, Queen's University 2002

Volunteering

Kidney Foundation of Canada

Kidney March

Alberta Children's Hospital Radiothon

Member of the Big Hearted Mavericks

World Partnership Golf Tournament

Experience

Founding Director, President and CEO: Sio Silica Corp. – 2016 – Present

- Discovery of a Tier 1 Silica Sand deposit in Manitoba

Founding Director, Chairman of the Board: Electrum Copper – 2020 – Present

- Put a copper, molly gold project into production in the state of Coahuila de Zaragoza, Mexico

Founding Director, Vice President: 1824455 Alberta Ltd. – 2014 – 2018

- Initiated exploration for Silica Sand deposits across Canada.
- Discovered 5 different projects

Founding Director, President and CEO: Rio Alto Mining – 2007 – 2011

- Founded and took public Mexican Silver Mines Ltd., which later became Rio Alto Mining.
- Acquired large land position for silver/lead/zinc potential in Mexico
- Raised $15 million
- Acquired Rio Alto (a private company) in 2009 and re focused the company on the La Arena gold copper project in Peru hosting 4 mill oz gold and 3 bill lbs copper.
- Raised $107 million, put the project into production in 18 months and raised the company market capitalization to nearly $1 billion

Founding Director: Savannah Diamond Corp. 2005 – 2009

- Controlled the largest land position in Tanzania focused on diamonds, gold and uranium
- Private company

President: Meridian Geoscience Ltd. 1997 – 2001

- Fully Integrated Mineral Exploration Company.
- Exploration projects in Canada, USA, Mexico, South Africa, DRC, Zambia, Namibia, Finland
- International Negotiation, Corporate Finance

Managing Director: Kitikmeot Geoscience Ltd. – 1996 – 2000

- Founded Inuit joint-venture exploration services company
- Supported Inuit through the BHP Diamond Mines and Diavik Diamond Mines Environmental Review negotiations
- Participated as panel member on various workgroups for the development of Regulations and Policies for the creation of Nunavut.

President: Adamas Management Ltd. – 1998 – 2000

- Founded Diamonds International Canada (DICAN) Ltd., a joint venture between three Northern Indigenous Groups and a U.K. based International diamond consulting firm, for the purposes of Canada's first Federal Government Diamond Valuation Contract.
- Valuate diamonds from BHP's Ekati Diamond Mine, NWT for government royalty purposes
- DICAN still contracted by Canadian Federal Government for all diamond production valuations in Canada

President: Meridian Aviation Corp. – 1997 – 1999

- Operated Beech King Air B200 executive turbo prop aircraft. Clients included Mining, Forestry, Oil and Gas, and Private Sector Companies.
- Sold aircraft due to profit opportunity resulting from a strengthened King Air market in the US and weakened Canadian dollar. Also anticipated downturn in Forestry and Mining industries.
-

Senior Manager: Canamera Geological Ltd. – 1992 – 1997

- Senior Project Manager for the Jericho Diamond Project, NWT with annual budget of $12 million, and for the 5034 Diamond Project, NWT with annual budget of $5 million.
- Operations Manager for exploration programs covering over 1 million acres in the NWT and exploration budgets of $20 million per year. Resulted in the discover of 15 Kimberlite Pipes, two of which completed Feasibility Studies
- Responsible for all Government, Indigenous and Community communications and negotiations

Brent R. Bullen, B.Comm., MBA

Director, Chief Operating Officer

Years with Sio Silica Corporation - 4

Total Years of Experience 38

Summary

Mr. Bullen has over 34 years of senior executive experience and has created corporate value in excess of $1.7 billion with operations in both North America and International Construction and Energy Service Sectors. Mr. Bullen established Canadian Fracmaster in Qatar and was an integral part of Canadian Fracmaster's growth in Russia and authored the technical economic studies used to registered 4 of the 5 Russian Joint Ventures by Canadian Fracmaster in Russia with an estimated market value in excess of $750 million in 1992. Mr. Bullen was co-founder and President of the Valens Group of Companies providing over $300 million in value creation for well services, remediation and stimulation in Central Siberia ad associated construction of infrastructure project from pipelines, refineries, hotel business centers, schools, apartments ad worker housing in Russia, Poland, Germany, Kyrgystan and Khazakhstan. Mr. Bullen was co-founder of Neutrino Resources Inc. a TSE listed company, co-founder of DynaFrac Well services restructured into CalFrac Well Services. Mr. Bullen has several inventions to his name and co developed the Sio Extraction Patent. Mr. Bullen holds a B.Comm from University Of Calgary Haskayne School of Business and a Masters in Business from Queen's University.

Education

Bachelor of Commerce, Finance and Petroleum Land Management University of Calgary Haskayne School of Business 1989

Masters in Business Administration, Queen's University 2002

Experience

Director, Chief Operating Officer: Sio Silica Corp. – 2019 – Present

- Co-Inventor of the Sio Extraction System and Pending Patent
- Discovered the High Purity Process and Value proposition for the Sio Manitoba Resource
- Leadership of product pivot

Founding Director, President, Chairman of the Board: Neutrino Energy Services Inc. – 2015 – Present

- Environmental Drill Cuttings Management for Western Canadian Drilling Activities

Founding Director, Bow West Management Corporation – 2014 – 2021 (Sold)

- Largest Developer and Owner of Commercial and Private Aircraft Hangars at YBW Airport

Founding Director, President, and Chairman of the Board: Springbank Hangar Developments Ltd. – 2007 – 2014(Sold)

- Largest Developer of private aircraft hangars (over 90 built and delivered)

Founding Director, President, and Chairman of the Board: Osiedle Baltyk Canada Limited – 2000 – 2018 (Sold)

- Private development company operating in Poland
- First Coastal Gated community in region of 581 units with total final sales exceeding $56 million USD

Founding Director, President, and Chairman of the Board: Torrac Oilfield Services Ltd. 2001 – 2015 (sold)

- Financed, Managed and Operated and grew company 20% year on year since inception.
- Private company focused on Environmental Drill Cuttings Management

Owner / Director: Hammerhead Graphics Ltd. 2004-2007 (Sold)

- Commercial Graphics and Specialty Vehicle Wraps sold to Management

Founding Director, President EssEll Coatings Ltd. - 2000 – 2002 (Sold)

- Funded and Developed Boronized surface coating system
- Responsible for Market Development - Executed exclusive coating with Wood Group ESP LLC on all ESP pumps deployed to middle east
- Purchased by Client for worldwide deployment of Boronized ESP components.

Co-Founder, Director, President: DynaFrac Well Services Inc. - 1997 – 1999 (Sold)

- Oilfield Stimulation Company in Western Canada sold and restructured into CalFrac Well Services
- Co-developed proprietary on the fly rapid hydration of water gel eliminating pre=mix and hydration times
- Co-developed proprietary 100% viscosity enhanced methanol frac fluid system
- Co-developed proprietary dry eye blender tub allowing proppant introduction without frac fluid exposure to atmosphere
- Co-developed proprietary asphalt precipitation suppression for acid stimulation of formations

Owner, President: Western Crating International. – 1993 – 1998 (Sold)

- Funded and developed Calgary's second largest industrial crating company for expediting solutions
- Arranged an employee buyout of the company

Co-Founder, Director, President: Cantex International Inc. – 1992– 1994 (Sold)

- Funded and developed 108 room hotel business centre in Khanty Mansiisk Russia

Co-Founder, Director, President: Deuruneft GmbH. – 1992– 1994 (Sold)

- Funded and developed $112 million 10R well revitalization contract in Raduzhny, Russia
- Leadership for expatiate and national staff

Co-Founder, Director, President: Valens Group of Companies – 1992– 1995

- Private firm with 350 employees providing residential and commercial construction, oil field remediation and stimulation in Russia, Kyrgyzstan, Germany and Poland.
- Offices in Canada, Gibraltar, Cypress, Poland, Kyrgyzstan, and Russia
- Notable projects include
    - Black Sea Energy Sold to and Ivanhoe Company
    - Ownership, Construction and Operation of Kyrgoil Refinery in Kyrgyzstan
    - Expatriate apartment building construction in Dzhalal-Abad Kyrgyzstan
    - World Cup Biathlon Facility in Khanty Manssiisk Russia
    - 135 unit residential development in Warsaw, Poland
    - Warsaw Theatre development
    - 60 home community in Abinsk, Russia
    - 600 room Hotel/Business Center in Salekhart, Russia
    - School for 1200 students in Salekhart, Russia
    - Oil and Gas pipeline from Strezhevoy to Nizhnevartovsk, Russia

Senior Financial Analyst USSR: Canadian Fracmaster Ltd.. – 1990– 1992

- Developed the technical economic study adopted by the Ministry of Fuel and Energy USSR to foreign joint venture investment into the Oil and Gas fields in Central Siberia
- Integral part of 3 person negotiating team responsible for 4 joint venture registrations through Moscow

Manager Arabian Gulf: Canadian Fracmaster Offshore Ltd.. – 1990– 1992

- Developed JV with National Oilwell Maintenance Co. (NOWMCO) in Qatar
- Secured 40% of local onshore market
- Developed and initiated training programs for local training and leadership
- Set up Chem Frac trading for Canadian Fracmaster supply to international operating bases

Senior Land Assistant: Amoco Canada. – 1990– 1992

- Team member Contract verification and merging on Mineral, Lease and land for Amoco / Dome merger

Research: Canadian Fracmaster Ltd.. – 1989

- Developed the industry first fully computerized cement mix system deployed by Canadian Fracmaster in Qatar and North America Operations
- Developed the first computer version of the Canadian Fracmaster Engineers Handbook for client deployment

Laura Weeden, B. Eng., P.Eng. (MB, AB)

Vice President Operations

Professional Engineer, Association of Professional Engineers and Geoscientists Manitoba, Professional Engineer, Association of Professional Engineers and Geoscientists Alberta

Years with Sio Silica Corporation - 5

Total Years of Experience - 10

Summary

Laura Weeden, P.Eng. is a professional engineer with 10 years experience in various industries related to construction, energy and mining. Prior experience includes technical and leadership roles at Baker Hughes, Schlumberger and Pomerleau with expertise in drilling, project management, field operations, design and construction. She has been recognized for her success having been awarded the 2020 International Society of Petroleum Engineers – Young Member Outstanding Service award, the 2018 Young Women in Energy award, and an Oilweek 2016 Rising Star. She has held several leadership roles through her involvement as the Chair of the Canadian Energy and Climate Nexus, and Past Chair of the Society of Petroleum Engineers – Calgary Section.

Education

University of Calgary - Project Management Fundamentals Certificate, in progress.

Dalhousie University, Bachelor of Civil Engineering, 2012

Saint Mary's University, Diploma in Engineering, 2009

Volunteering

Chair | Canadian Energy and Climate Nexus | 2020 – Present

Past - Chair | Society of Petroleum Engineers Calgary Section | 2020 – 2021

Chair | Society of Petroleum Engineers Calgary Section | 2019 – 2020

Chair | Society of Petroleum Engineers Young Professionals | 2016 – 2019

Girl Guides of Canada |2013 - 2018

Experience

Sio Silica Corp. | Vice President Operations | Calgary, AB | 2018 – Present

- Execution, testing and optimization of extraction method, and associated field operations. Co-Inventor of the Sio Extraction System and Pending Patent.
- Project management and contributions of overall mine design, environmental permitting and material processing.
- Contributor and organization lead for all environmental permitting activities, technical documents, public and technical responses, public hearing filings and presentations.
- Coordination of all contractors for the project.
- Development, organization and presentation of community meeting materials, articles, and printed documents.
- Contributing to the overall budgeting inputs, financial tracking of the company and funding.
- Leadership of team meetings, design changes, field operations and daily operations.
- Mentorship and supervision of new hires.

Baker Hughes | Account Manager, Drilling Services | Calgary, AB | 2013 – 2018

- Responsible for building and maintaining client relationships through customized solutions based on technical specifications and requirements.
- Working with engineering, and operations to design, and recommend customized solutions and technologies for customers throughout Canada.
- Implementation of new unique service in the Viking in Alberta and Saskatchewan using offshore technology to geosteer in 1-2 m thick formations for enhanced production.
- Project management of remote operations, negotiations, contract, and technical documentation for integrated services provided in central Canada including, drill bits, directional drilling, wireline and water management.
- Preparation and delivery of technical presentations to clients and industry on directional drilling motors, measurement while drilling systems and logging while drilling systems.
- Presenter and panellist on new technology and innovation available in the industry at the Quebec Oil and Gas Association Conference, 2014 and 2015.

Schlumberger | Field Engineer Trainee | Red Deer, AB | 2012 – 2013

- Responsible for learning all aspects of the Cementing Well Services technical and field operations.
- Working with a field team of operators in extreme and remote outdoor conditions on drilling rig sites duties included; rig up, rig down, job preparations, job supervision, equipment maintenance, interaction with clients and rig crews and related job calculations.
- Assisted in reviewing each completed engineering cementing job program assigned to confirm that operations could meet the technical requirements. Training and practical execution completed for design of cement jobs, job calculations for cement volumes, water content, additives etc.
- Attended Schlumberger Field School for formal technical training in the field and classroom instruction including topics such as mud removal, casing design, downhole tools, remedial jobs (plugs, squeezes) and cement chemistry.

Pomerleau Inc. | Project Coordinator | Halifax, NS | 2012

- Responsible for assisting in the project management of a commercial, industrial or institutional construction project both on site and in office.
- Management and preparation of Requests for Information, and Change Orders.
- Management of shop drawings, progress claims and construction schedule.
- Preparation, maintenance and associated duties of LEED plans including Erosion and Sedimentation Control Plan, Waste Management Plan and Indoor Air Quality Plan.

Transport Canada | Engineering Support - Road Safety Systems | Ottawa, ON | 2011

- Researched and compiled literary reviews on: Engineering best practices to address the aging population and driver distraction to be presented to the Transportation Association of Canada.
- Edited major research document regarding international road design and engineering best practices for the World Road Association.
- Complied Canadian jurisdictions survey data on Road Safety Audits.