



Qualifications Summary: Mr. Swanson is an experienced hydrogeologist and geochemist, having served the mining community for 19 years. His technical and managerial skills range from project management and drilling program supervision to complex hydrogeochemical and groundwater modeling projects.

Currently an independent consultant, Mr. Swanson is available for direct contracting opportunities with mining companies, financial institutions, and consulting firms requiring technical assistance or managerial support. In addition to his technical abilities, Mr. Swanson is an excellent team builder and can bring a variety of skills to bear through his network of other like-minded independents and larger consulting firms.

Degrees and Credentials

M.S., Hydrogeology, 1996, University of Nevada, Reno, Mackay School of Mines. M.S. Thesis focused on pre-mining water quality determinations of a mining impacted stream in Colorado.

B.S., Geology (Environmental Geochemistry), 1991, Michigan State University.

Certified Professional Geologist, State of Nebraska (G-0215).

U.S. Army Reserve, Field Artillery (13B), 1984-1990, served as a heavy weapons operator.

Experience

AquaLithos Consulting

Arvada, Colorado

At Present

President and Principal Geochemist / Hydrogeologist: Mr. Swanson launched AquaLithos Consulting in March 2009 and currently serves as an independent advisor to the mining community on matters related to geochemistry and groundwater. In this role he serves as a client advocate and technical expert facilitating the performance of large investigations involving multiple stakeholders and external consultants. He excels in the supervision and management of large consulting firms on behalf of the client and the performance of third party technical reviews. He also performs technical troubleshooting and training activities for consulting firms and mining clients performing deep groundwater characterization activities associated with core drilling and wireline hydraulic packer equipment.

2005 to 2009

SRK Consulting, Inc.

Lakewood, Colorado

Senior Geochemist / Hydrogeologist: Primary role was project management for mining clients. Served in a secondary role as a technical resource and junior staff mentor for issues related to mining geochemistry and hydrogeology. Typical duties and responsibilities included:

- **Geochemistry:** Thermodynamic and analytical geochemical modeling, using codes such as PHREEQC, MINTEQA2, GWB, for the purposes of acid rock drainage assessments, pit lake predictive analyses, tailings pond water quality, and dewatering fluids predictive studies.
- **Hydrogeology:** Hydrogeological modeling using codes such as MODFLOW, FEFLOW, SEEP/W, for projects related to tailings water fate and transport analysis, dewatering assessments, waste rock covers and mine pit lake filling studies.
- **Drilling Expertise:** Design, management, staff training and implementation of innovative and cutting edge hydraulic testing and geochemical sampling methods for deep diamond drilling programs. Pioneered the company-wide use of the IPI SWiPS wireline hydraulic packer devices. Devised techniques to maximize data collection efficiency from exploration drilling programs by combining ore reserve delineation drilling with hydrogeological characterization, geotechnical design, and geochemical baseline characterization activities.
- **Regulatory Affairs:** Negotiations with regulatory agencies for mining permits, environmental assessments, water quality discharge permits, and compliance issues.

- **Project Management:** Project management and business development duties, including budgetary control of projects. Served as a company technical resource for the scoping and budgeting of complex field programs and modeling projects.
- **Due Diligence:** Performed third party reviews and due diligence assessments related to mining property acquisitions and divestitures, provided technical input on bankable feasibility studies related to dewatering assessments, tailings impoundment design and operation, and resource assessments.

Clients typically included large to mid-tier international mining companies with projects ranging from scoping level to feasibility scale. Familiarity with gold, copper, uranium, base metal and industrial minerals operations. Extensive international experience.

RMT, Inc.**Grand Rapids, Michigan**

2001 to 2005

Senior Hydrogeologist: Roles included project manager, senior technical advisor, and technical services manager at a mid-sized environmental consulting firm. Responsibilities included:

- Acted as a company-wide technical resource on projects associated with complex hydrogeology, geochemistry and modeling related issues or regulatory requirements;
- Served as the company technical services manager for mining related projects;
- Interacted with clients, regulators, junior staff and project managers to resolve project technical issues involving groundwater flow, contaminant transport and modeling;
- Project management duties such as proposal development, project financial performance, contracting and invoicing, project staffing and cultivating positive client relationships;
- Performed of project related technical tasks including groundwater, surface water and geochemical modeling, aquifer testing, regulatory permitting, report generation.
- Mentored and trained junior staff in technical matters including field methods, modeling and software use and report generation skills.

Typical clients included manufacturing and mining companies. Major projects included remediation of acid mine drainage issues, industrial mineral mine acquisition and due diligence investigations, assessing contamination nature and extent via computer models, design and installation of water supply wells, wellhead capture zone determinations.

Brown and Caldwell**Denver, Colorado**

1998 to 2001

Project Hydrogeologist: Responsible for the timely execution of projects, project financial success, and client service. Projects included the facilitation of site closure agreements for industrial clients, performance of remedial and corrective actions, management of ongoing monitoring programs, and acquisition due diligence investigations. Clients included cement manufacturers, industrial mineral mines, aggregate quarries, and petroleum refineries.

Golder Associates, Inc.**Lakewood, Colorado**

1993 to 1998

Senior Staff Geochemist: Responsible for the execution of technical and organizational tasks on projects including facility environmental assessments, environmental impact statements and/or closure permitting. Performed a variety of field activities, constructed groundwater and geochemical models, generated project reports. Clients included precious metal and industrial mineral mines, water resources entities and solid waste landfills.

Publications Eric has authored or co-authored eight professional publications related to groundwater modeling, surface water and groundwater geochemistry.

Key Experience: Mining and Industrial Minerals

- **Principal Hydrogeologist, Seafield Resources, Pre-Feasibility Mine Design and Hydrogeological Investigation, Miraflores Project, Quinchia Colombia:** Acted as the field team leader for a complex hydrogeological characterization of a breccia hosted gold deposit in central Colombia. Activities included wireline packer testing and deep borehole piezometer installations to characterize permeability decay curves with depth across the pit shell boundary and potential underground operations. Trained client staff on basic well installation techniques, transducer deployment and programming, and surface completion methods. Work was performed as an independent contractor to SRK Consulting.
- **Principal Hydrogeologist, Blackthorn Resources, Pre-Feasibility Study Hydrogeological Characterization, Mumbwa Project (Copper), Zambia:** Acted as a field trainer and technical advisor to AGES (Pty) Ltd. regarding packer testing in HQ boreholes at a proposed copper mine in Zambia. Successfully trained staff on proper usage of the IPI SWiPS hydraulic wireline packer system.
- **Principal Hydrogeologist, Volta Resources, Pre-Feasibility Study Hydrogeological Characterization, Kiaka Project (Gold), Burkina Faso:** Performed packer facilitated hydraulic tests in pre-drilled inclined boreholes to depths of 500m as part of a data acquisition task associated with a regional, pit scale and pit design groundwater model. Packer testing was performed in HQ diameter core holes using a SWiPS style hydraulic wireline packer. Hydraulic testing included multiple pressure step lugeon tests, and tests were performed in overlapping successively longer intervals (cumulative style packer tests).
- **Principal Hydrogeologist, Elemental Minerals, Pre-Feasibility Study Hydrogeological Characterization, Sintoukola Project (Potash) Republic of Congo (Brazzaville):** Served as the field team leader on contract to SRK consulting for an investigation of the hydrogeological properties of an evaporate sequence overlying an ore grade potash deposit. Project was focused on mine design factors involving the impermeable nature of an overlying anhydrite and halite horizon. Investigation involved the use of downhole packer testing associated with a core drilling program, long term airlift testing, and monitoring the effects of pumping in nearby piezometers. Significant project challenges included the design and implementation of brine mud drilling methods to prevent formation dissolution while testing.
- **Principal Hydrogeologist, Freeport McMoran Copper and Gold, Pit Slope Design Hydrogeological Characterization, Kisanfu Project, (Copper) Democratic Republic of Congo (DRC):** Served as technical expert and consultant trainer / advisor (for AGES (Pty) Ltd, South Africa) on behalf of Freeport. Trained client personnel and consultants on the use of various downhole packer instrumentation, redesigned testing program and procedures, supervised data acquisition on numerous hydraulic tests. Installed and trained staff on the operation of vibrating wire piezometer equipment. Served as a third party reviewer of test methods and results. Testing was in support of a feasibility scale investigation of the dewatering requirements for proposed mine.
- **Principal Hydrogeologist, Goldfields Ghana Ltd., Pit Expansion Hydrogeological Characterization, Damang Mine (Gold) Ghana:** Served as a technical expert for hydrogeological characterization associated with a planned pit expansion. Operated the SWiPS wireline hydraulic packer on core rigs drilling geotechnical holes in the pit pushback area. Assembled and managed a team of independent packer testing experts in conjunction with HydroGeoServices (South Africa).
- **Principal Hydrogeologist, Kinross Gold, Pit Slope Hydrogeological Characterization, Tasiast Mine (Gold) Mauritania:** Served as the technical advisor for the feasibility study and pit design for Kinross Tasiast. Principal duties include consultant training, management and technical advisory tasks associated with deep groundwater characterization tasks. Managed the training of the consulting team selected to perform packer testing and vibrating wire piezometer installations. Advised client on the overall program approach and field methods. Project consisted of packer testing on multiple drill rigs for several months using the IPI SWiPS hydraulic packer and pneumatic packers, plus the installation of 7 vibrating wire piezometers to depths of over 500m in inclined narrow diameter coreholes. Served as a third party reviewer associated with the deep groundwater characterization portion of the EIS.

- **Principal Consultant, Largo Resources, Mine Pre-Feasibility Study, Northern Dancer Project (Tungsten), Yukon Canada:** Served as a technical trainer for client's staff focusing on groundwater data acquisition methods. Trained Largo staff on the use and analysis of lugeon testing using the SWiPS hydraulic packer system, core logging techniques, and basic drilling program management practices.
- **Principal Consultant, Torex Gold, Mine Feasibility Study, Morelos Project (Gold), Mexico:** Served as a client advisor related to the project hydrogeological and geochemical portions of a feasibility study. Roles included advising client on project team composition, consultant procurement, proposal preparation and review, and strategic management
- **Principal Hydrogeologist, International Tower Hill Mines, Groundwater Characterization Study, Livengood Project (Gold), Alaska:** Served as field team leader under contract with SRK for permafrost well and piezometer installations, pumping well casing modifications, frozen well rehabilitation and monitoring, and Geoprobe sampling of shallow groundwater at a proposed gold mine in Northern Alaska.
- **Principal Hydrogeologist, General Moly Mines, Groundwater Baseline Study, Mt. Hope Project (Molybdenum), Eureka, Nevada:** Served as a senior advisor and special projects manager to the mine and directing the activities of several sets of consultants. Activities supervised include design and performance of long term multi well pumping tests, deep (1000m) hydraulic tests during core drilling operations using the IPI SWiPS packer system, comprehensive groundwater modeling using MODFLOW, installation of deep (1000m) vibrating wire piezometers, and a pit lake geochemical predictive model using PHREEQC. Additional duties include negotiating operational permits through the BLM, State of Nevada, and other stakeholders. Responsible for the production and review of supporting documents to facilitate an Environmental Impact Statement (EIS).
- **Principal Hydrogeologist, Silver Standard Resources, Groundwater Characterization Testing, Pitarilla Project (Silver), Mexico:** Served as a senior advisor to Knight Piésold Ltd. for deep (1000m) groundwater testing activities using the IPI SWiPS hydraulic packer system. Project scope includes troubleshooting and training consulting staff in the use and application of the packer system.
- **Principal Hydrogeologist, Redstone Resources, Aquifer Protection Permit, Zonia Project (Copper), Arizona:** Served as a senior advisor to a small privately held mine prospect in central Arizona. Project involves strategic planning associated with the advancement of the property related to water and geochemical issues. Activities include the collection of groundwater and geochemical data, supervision of contractors, liaison activities with the ADEQ, and water supply planning.
- **Principal Hydrogeologist, Compañía Minera Doña Inés de Collahuasi SCM, Deep Groundwater Characterization Project, (Copper), Northern Chile:** Served as an independent technical expert for E.L. Montgomery and Associates tasked with characterizing deep aquifer properties using the IPI SWiPS wireline packer system. Scope of activities includes training junior personnel on packer use, developing and reviewing work plans, supervising hydraulic testing operations, and installation of vibrating wire piezometers.
- **Senior Hydrogeologist, Tournigan Energy, Dewatering and Baseline Hydrogeology Study, Kuriskova Uranium Project, Kosice, Slovakia:** Designed and built a deep groundwater potentiometric monitoring installation for a planned underground uranium mine in eastern Slovakia. Installation consisted of a string of vibrating wire (VBW) transducers and thermistors placed within a fully grouted 500m deep HQ diameter borehole drilled during the exploration phase of the project. Served as a third party reviewer and advisor to client on the performance of hydraulic packer testing for permeability assessments.
- **Senior Hydrogeologist, Vale INCO, Mine Pit Dewatering Prefeasibility Assessment, Pipe 2 Mine (Nickel), Thompson, Manitoba:** Served as the field program manager for a long term hydraulic testing campaign designed to support an open pit dewatering plan. Project included management of deep drilling investigation techniques performed in diamond core boreholes to depths of greater than 700m. Investigation techniques managed and performed include the characterization of fracture permeability

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using wireline hydraulic packer systems (IPI SWiPS), installation of deep vibrating wire transducers in HQ boreholes, installation of deep (700m) 2-inch piezometers in HQ boreholes, and development of a water quality sampling plan for deep boreholes.

- **Project Manager, AngloGold Ashanti, Tailings Dam Seepage Predictive Model, Obuasi Mine, (Gold) Ghana:** Managed a tailings dam impact assessment for a gold mine in Ghana, Africa. Project consisted of performing a hydrogeological characterization of the proposed tailings dam location and projecting travel time and attenuation characteristics of tailings water constituents on downgradient groundwater receptors. Project performed using FEFLOW for the hydrogeological model and contaminant transport model.
- **Senior Geochemist, General Moly Corporation, Pit Lake Geochemistry Predictive Model, Mt. Hope Mine (Molybdenum), Eureka, Nevada:** Project encompasses the computational design and execution of an extensive thermodynamic model designed to predict the future water quality of a future pit lake created at the cessation of mining operations. Model was designed using PHREEQC and incorporated data from numerous static and kinetic test results, climatic data, wall rock projections, and groundwater quality information.
- **Senior Geochemist, Coeur d'Alene Mines Corporation, Open Pit Silver Mine Expansion Permit, Coeur Rochester Project, Nevada:** Served as primary author for the geochemistry portions of a large Environmental Assessment study required for expansion purposes at an open pit silver mine.
- **Senior Geochemist, ARMZ/TVEL (Russia), Dewatering Assessment, Elkon Uranium Project, Russia:** Performed a geochemical assessment of deep (+700m) groundwater quality in anticipation of mine re-opening and dewatering needs.
- **Senior Hydrogeologist, AREVA, Mine Shaft Groundwater Engineering Study, Shea Creek Uranium Project, Cluff Lake, Canada:** Served as the senior technical advisor for hydraulic testing using wireline hydraulic packer (IPI SWiPS) down to depths of 1000m for the purposes of characterizing operational dewatering characteristics of a vertical shaft at a proposed uranium mine.
- **Senior Hydrogeologist, AREVA, Leach Pad Drain Design, Trekopje Uranium Project, Namibia:** Performed groundwater modeling using SEEP/W to optimize liner drain geometry and materials at a green fields uranium mine in Namibia.
- **Senior Geochemist, Cameco, Uranium Tailings Porewater Geochemistry Predictive Model, Key Lake Project, Canada.** Served as the primary geochemical modeller for a project requiring prediction of porewater chemistry in uranium tailings at a mill/processing facility in Canada. Project was executed using the PHREEQC and MINTEQA2 models; and a modified thermodynamic properties database specifically designed for uranium minerals.
- **Senior Hydrogeologist, General Atomics Corporation, Tailing Storage Facility Water Balance, Cotter Uranium Mill, Canyon City, Colorado:** Performed dynamic water balance calculation for tailings impoundment areas under traditional depositional methods and dewater tailings (paste) conditions to assess economic feasibility of using impoundment for additional waste storage capacity.
- **Senior Geochemist, Eurokem (Russia), Pre-feasibility Analysis, Lake Elton Potash Project, Volgograd, Russia:** Performed initial planning / scoping activities associated with and underground and/or in-situ mining operation. Focus of project associated with defining impacts to surface water brine lake system and documenting baseline conditions.
- **Senior Hydrogeologist, Shore Gold, Pit Dewatering Assessment, Star Kimberlite Diamond Project, Saskatchewan, Canada:** Served as a senior advisor to client, training mine staff on piezometer installation methods and hydraulic testing techniques.
- **Senior Hydrogeologist, I-minerals Corporation, Hydraulic Test Analysis, Proposed Industrial Minerals (Feldspar) Mine, Helmer-Boville Project, Idaho:** Performed analysis of single packer

hydraulic tests in a proposed industrial feldspar mine to assess hydraulic properties of mine pit and facilitate pit dewatering planning.

- **Senior Geochemist, BHP Billiton, Open Pit Copper Mine Aquifer Protection Permit Modification Study, Pinto Valley Mine, Globe, Arizona:** Performed analyses of long term water quality data to identify and explain trends and assess the long term geochemical changes taking place at an open pit copper mine in Arizona. Performed geochemical modeling using PHREEQC, constructed piper diagrams, and looked at water quality trends as they relate to water level fluctuations.
- **Senior Geochemist, Xstrata, Copper Mine Environmental Closure Plan, Tintaya Mine (Copper), Peru.** Served as the technical specialist for issues related to geochemistry and hydrogeology on a mine closure plan for an open pit copper mine in southern Peru.
- **Senior Technical Reviewer, Carmacks Copper Project, Glamis Gold (now Western Copper), Yukon Territory, Canada:** Reviewed the Environmental Assessment portions relevant to geochemistry and groundwater for a proposed copper operation in central Yukon Territory. Served as a technical advisor to the Canadian provincial government for specialty issues related to this project.
- **Senior Hydrogeologist, NewWest Gold (now Newmont), Hydrogeological Characterization, Sandman Project, Winnemucca, Nevada:** Designed and implemented a plan to characterize subsurface hydraulic properties for a shallow and deep aquifer system prior to development of an open pit gold mine near Winnemucca, Nevada. Program consisted of falling head tests performed concurrently with drilling and within installed piezometers.
- **Senior Geochemist, Teck Cominco (now Torex), Proposed Gold Mine Acid Rock Drainage Assessment, Morelos Project, Iguala Mexico:** Characterized various rock types present at a proposed gold and copper mine in southern Mexico. Project involved the selection and management of samples for kinetic and static acid producing potential tests. Testing performed on both pilot scale tailings material and anticipated waste rock.
- **Senior Hydrogeologist, Compañía Minera Dona Inés de Collahuasi SCM, Open Pit Copper Mine Groundwater Model and Pit Slope Stability Assessment, Chile:** Served as the senior modeller and technical advisor to a program to characterize the dissipation of residual pore pressures in fine grained pit wall rock at an open pit copper mine in Chile. Modeling consisted of developing a finite element mesh across existing geological cross sections and simulating the draindown and pore pressure conditions in these rocks as a function of time after dewatering, distance to pit slope and specific materials properties. Results were used in the subsequent calculations for pit wall design
- **Senior Hydrogeologist, BHP Minerals, Open Pit Copper Mine Groundwater and Pit Lake Geochemistry Transport Model, San Manuel Mine, Arizona:** Served as the senior technical reviewer and modeller for a closure model predicting the timing and ultimate level of a pit lake that will form following mine closure.
- **Senior Technical Advisor, Confidential Client, Phosphate Mining and Fertilizer Manufacturing Operations Acquisition Due Diligence Assessment, Confidential Locations:** Performed an estimate of the total environmental liabilities associated with a phosphate mining and phosphoric acid manufacturing operation for a potential buyer. Purpose of investigation was to quantitatively evaluate environmental liabilities associated with each aspect of the mining, beneficiation and waste material disposal operations. Project involves a critical review of the likelihood that new ore reserve areas can be successfully permitted for extraction, evaluations of the geochemical and geotechnical stability of waste materials in phosphogypsum stacks, and the potential impacts of TMDL assessment on NPDES permits.
- **Senior Technical Advisor, Potash Mining Acquisition Due Diligence Assessment, Confidential Locations:** Performed investigation of issues related to a series of potash mining operations for a client considering purchasing these assets. Focus of investigation was to identify large liabilities associated with acquisition including NPDES permitting, avian mortality, and groundwater impacts.

- **Senior Technical Advisor, Mineral Processing Waste Pile Discharge Investigation, Confidential Client and Location:** Project consists of the investigation of the sources and potential mitigation measures that could be used to control the discharge of alkaline leachates containing elevated levels of mercury. Discharge is the result of the weathering of mineral processing waste (cement kiln dust) pile capped with a engineered soil cover. Project is currently subject of impending litigation between the U.S. EPA and three potential responsible parties.
- **Project Manager, Engineering and Hydrosystems, Inc., Impoundment Dam Failure, Infiltration Rate Assessment / Infiltrometer Study, Marquette, Michigan:** Managed a dam failure analysis investigation in conjunction with Dr. George Annandale of Engineering and Hydrosystems, Inc. for a confidential client. Liability associated with dam failure is currently subject of litigation between dam operator and dam designer. Scope of project included the performance of a series of double-ring infiltrometer tests on material comprising the dam core and plug fuse. Lead field team that performed testing on dam under adverse winter conditions under short deliverable deadline conditions. Field constructed large capacity Mariotte bottles to ensure accurate data recovery in high conductivity materials. Hydraulic gradients under rings determined using tensiometers with transducer equipped tensimeters for higher accuracy. Determined hydraulic conductivity using three independent methods all to within close values of each other.
- **Senior Hydrogeologist, Lafarge Corporation, Cement Kiln Dust Monofill Cement Kiln Dust Monofill Cover Model, Lebec, California:** Performed infiltration and water balance model for a CKD monofill cover using the HELP3 analytical model. The study was used to demonstrate compliance with site closure requirements. Modeling demonstrated that a proposed cover design would reduce total loadings of constituents leached from CKD to below acceptable levels.
- **Senior Staff Hydrogeologist, Phelps Dodge Madagascar (now Sherritt), Nickel Laterite Deposit Environmental Assessment Report, Ambatovy Madagascar:** Responsible for the writing and production of the hydrogeology, geology and geochemistry sections of a large environmental assessment report. Responsible for delegation of subsections to the appropriate personnel and review of final product including report text, appendices, and technical attachments. Responsible for the presentation of report results to client and client representatives. Addressed comments and concerns generated by reviewing agency (World Bank) and Malagasy government authorities.
- **Senior Staff Hydrogeologist, Phelps Dodge Madagascar (now Sherritt), Nickel Laterite Deposit Hydraulic and Solute Fate and Transport Model, Ambatovy, Madagascar:** Responsible for supervising and performing hydraulic and solute transport modeling for a proposed tailings impoundment facility in the Republic of Madagascar. Modeling consisted of a series of a two-dimensional cross section simulating flow from the tailings material through perimeter hillsides or tailings dams and into the underlying groundwater system. Modeling input parameters for the hydraulic model were derived from hydraulic testing performed in monitoring wells installed as part of the field program. Solute transport modeling parameters, such as retardation, were derived from laboratory attenuation tests and geochemical characterization tests. Model was calibrated to observed field conditions, including water levels and vertical gradients. Modeling was performed using SEEP/W and CTRANS.
- **Senior Staff Hydrogeologist, Phelps Dodge Madagascar (now Sherritt), Nickel Laterite Deposit Tailings Water Natural Attenuation Testing, Ambatovy, Madagascar:** # Devised natural attenuation test methodology and supervised performance of tests in a subcontracting laboratory. Tests provided data for the construction of adsorption isotherms for use in a solute transport model. Testing generated adsorption isotherms for Ni²⁺, Cr³⁺ and Cr⁶⁺ onto a variety of aquifer material types. Testing results were able to demonstrate that the migration of metals from the tailings impoundment would be significantly attenuated by adsorption onto natural aquifer materials. Values from testing were used to derive intrinsic sorption constants (K_{int}) for each of these metals onto the tailings materials, and each aquifer material type. These intrinsic constants were then used to support contaminant transport modeling.

- **Senior Staff Hydrogeologist, Phelps Dodge Madagascar (now Sherritt), Nickel Laterite Deposit Field Investigation / Drilling Campaign, Ambatovy, Madagascar:** Conducted field investigation of a proposed nickel/cobalt mine on the island of Madagascar. The investigation was conducted for the purpose of evaluating several proposed tailings impoundment locations for potential environmental impacts. Project included two 8-week field investigations consisting of drilling and logging boreholes, installing monitoring wells, and conducting hydraulic aquifer testing including slug tests, pumping tests, and packer tests. Responsibilities included supervision of three Malagasy crewed drill rigs, geologic logging crews, geophysical sub-contractors, and a survey team. Responsible for procuring or manufacturing well construction supplies and supervising work crews for road and drill pad construction.
- **Senior Staff Hydrogeologist, Phelps Dodge Madagascar (now Sherritt), Proposed Limestone Quarry Environmental Assessment, Ambotondrazaka, Madagascar:** Supervised monitoring point survey, performed hydraulic testing and background noise monitoring at a remote limestone quarry location in the Republic of Madagascar. Supervised calculations of ranges of pit dewatering volumes based on results of hydraulic tests. Responsible for geology, geochemistry and hydrogeology portions of report. EA was performed in accordance with World Bank / World Health Organization standards.
- **Project Manager, M.A. Hanna Mining Company (now PolyOne Corporation), Underground Iron Mining Passive Treatment System Investigation Dober Mine, Iron River, Michigan:** Project encompasses the management of acidic discharge from a historic iron mine in the upper peninsula of Michigan. The project includes determination of the source of acidity (waste rock dumps or adit discharge), and an investigation of the causes of episodic performance failures of the passive treatment system.
- **Project Manager, M.A. Hanna Mining Company (now PolyOne Corporation), Underground Iron Mining Aquatic Toxicology Investigation, Dober Mine, Iron River, Michigan:** Managed a project investigating causes of Whole Effluent Toxicity (WET) test failures at a historic iron mine releasing acidic drainage in the upper peninsula of Michigan. Toxicity testing failures were related to laboratory quality control issues, presence of an unidentified contaminant in the effluent, and physical toxicity related to the active precipitation of particulates that may block digestive or gill structures. Toxicity testing is following U.S. EPA protocols for a Toxicity Reduction Evaluation.
- **Project Manager, M.A. Hanna Mining Company (now PolyOne Corporation) Underground Iron Mining NPDES Permit Negotiations, Dober Mine, Iron River, Michigan:** Project entails revising the NPDES permit for effluent from a passive treatment system associated with the discharge from a historic underground iron mine. NPDES permit negotiations with state agency have resulted in the elimination of unnecessary monitoring parameters, reduction in the frequency of monitoring and changing the methods required for other parameters. Changes to the NPDES permit will allow the client to monitor discharge using a remote (telemetry based) water quality and flow monitoring station at the outfall instead of daily monitoring by a technician. This change will result in significant long-term cost savings for client and a higher quality data set that can be monitored in real-time. Project involved design of five remote monitoring water quality stations, remote monitoring for flow at three existing weirs, cellular phone / solar panel based telemetry system, and web-based data display and archiving systems.
- **Senior Staff Hydrogeologist, Newmont Gold Corporation, - Batu Hijau Project Gold Mining Operation Environmental Assessment, Sumbawa, Indonesia:** Performed cost estimates and scope of work documents for the groundwater portion of a \$3M environmental assessment project in Indonesia. Project scope included estimates of time and cost for field investigation, finite element numerical modeling (FEFLOW and FEMWATER), and report generation.
- **Senior Staff Hydrogeologist, Blackbird Mine Site Group, Former Cobalt Mining Operation Passive Treatment System Design and Geochemical Model, Salmon, Idaho:** Performed geochemical modeling to examine mineral saturation indices in a proposed passive reaction treatment system for the treatment of acidic and metaliferous mine waters. Task included the modeling of mixing, mineral precipitation, and trace metal attenuation mechanisms under a variety of redox and pH conditions. Modeling was performed using PHREEQC and MINEQL.

- **Senior Staff Hydrogeologist, SF Phosphates (now Simplot), Phosphate Rock Mining Operation Phosphate Mine Tailings Dam Seepage Analysis, Vernal, Utah:** Responsible for predicting seepage volumes through an upgradient tailings dam raise design. Tailings consisted of gypsum (CaSO_4) saturated brines and associated solids. Modeling was performed by calibrating model results to reproduce existing conditions and then simulating the effects of the proposed raise. Modeling was performed using finite element code SEEP/W.
- **Senior Staff Hydrogeologist, Cyprus Miami Mining Company (now Freeport), Open Pit Copper Mine Aquifer Protection Permit / Geochemical Testing, Miami, Arizona:** Responsible for waste rock dump aquifer protection permitting investigation. Investigation consisted of an extensive field program focused on the examination of waste rock for evidence of acid-producing reactions, classification of waste rock into geochemically significant categories, and laboratory testing of representative waste rock sample. Laboratory testing consisted of both static (ABA) testing and kinetic (column) testing. Intensive geochemical characterization was performed as an alternative to a sample-intensive statistical testing program. Goal of investigation was to determine the long-term reactivity of each identified waste rock type.
- **Senior Staff Hydrogeologist, Cyprus Miami Mining Company (now Freeport), Open Pit Copper Mine Aquifer Protection Permit / Waste Rock Dump Unsaturated Zone Testing, Miami, Arizona:** Field investigation of in situ moisture content and unsaturated hydraulic properties of waste rock as part of an aquifer protection permitting investigation. Investigation focused on determining water balance through unsaturated waste rock materials for the purpose of determining discharging status. The goal of the program was to couple predicted geochemical behaviour and unsaturated water flow characteristics for a determination of overall discharging behaviour.
- **Senior Staff Hydrogeologist Cyprus Miami Mining Company (now Freeport), Open Pit Copper Mine Aquifer Protection Permit / Toe Drain Hydraulic Testing, Miami, Arizona:** Performed field hydraulic testing and monitoring of a long-term pumping test performed on a toe drain and sump system at the base of a leach solution collection pond impoundment. Testing involved constant rate pumping of toe drain system and monitoring of water levels in approximately 15 monitoring wells and piezometers using pressure transducers and data loggers.
- **Senior Staff Hydrogeologist, Minera Maria, S.A. de C.V., Mariquita Project Open Pit Copper Mine Heap Leach Optimization Modeling, Sonora, Mexico:** Responsible for unsaturated heap flow dynamics modeling investigation. Goal of modeling exercise was to examine and optimize ore crush sizes for a proposed copper heap leaching operation. Investigation consisted of laboratory moisture retention testing of ores crushed to various sizes, and modeling of moisture content in the heap under a variety of solution application rates and crush sizes. Modeling consisted of finite difference modeling at steady state using VS2DT. Laboratory testing was performed under several loading regimes to simulate the material behaviour at depth in the heap. Modeling assisted in selecting the ore crush size and application rates needed for optimal heap leach pad performance.
- **Senior Staff Hydrogeologist, Sunnyside Gold Corporation / Echo Bay Mines, Former Underground Gold Mine Pre-Mining Water Quality Study Sunnyside Mine, Silverton, Colorado:** Responsible for determining approach, supervising sample collection and analysis, and performing calculations and interpretations for a study commissioned to determine the likely range of water qualities in a watershed previous to mining activities. Study involved the quantification of trace metal adsorption and co-precipitation by iron oxyhydroxides. Active trace metal incorporation mechanisms were used as analogs for interpreting iron oxyhydroxides found in pre-mining age deposits. Pre-mining water quality predictions were used for permit closure negotiations with regulatory agencies.
- **Senior Staff Hydrogeologist, Sunnyside Gold Corporation / Echo Bay Mines, Former Underground Gold Mine Passive Treatment System Design Sunnyside Mine, Silverton, Colorado:** Investigated metal attenuation dynamics in a biologically induced reducing environment. Investigation was performed to examine the feasibility of treating AMD from an abandoned draining adit. Investigation focused on the potential to reduce surface water loadings of heavy metals.

- **Senior Staff Hydrogeologist, Sunnyside Gold Corporation / Echo Bay Mines, Former Underground Gold Mine Post Adit Plug Geochemical Predictive Model Sunnyside Mine, Silverton, Colorado:** Responsible for the prediction of water quality, including pH and trace metal concentrations, of waters impounded by a proposed adit plug. Prediction involved extensive computer geochemical modeling using PHREEQE, PHREEQPTZ, and MINTEQA2. Water quality predictions were used for permit closure negotiations with regulatory agencies.
- **Senior Staff Hydrogeologist, Homestake Mining Corp. (now Barrick), Former Underground Silver Mine Metal Loadings Analysis Bull Dog Mine, Creede, Colorado:** Determined metal loading dynamics relative to stream discharge and pH in surface water impacted by mining activities. Interpreted metal loading in the sediment bedload and made comparisons to surface water dissolved load. Calculations were used for closure permit negotiations with regulatory agencies.
- **Senior Staff Hydrogeologist, Stillwater Mining Corporation, Underground Platinum/Palladium Mine, Nitrogen Mass Balance, Stillwater, Montana:** Responsible for the construction of a water and nitrogen balance model for an underground mining operation. Nitrogen sources (explosives use), disposal mechanism (land application), and intermediate pathways were quantified and incorporated into a nitrogen management model used to optimize mining and disposal operations.
- **Senior Staff Hydrogeologist, ASARCO, Former Metal Mining District California Gulch Superfund Site Investigation, Leadville, Colorado:** Performed analysis of groundwater/surface water interactions for a CERCLA site impacted by mining activities. Determinations were performed to assess sources and loadings of dissolved particulate and sediment-transported heavy metals.
- **Senior Staff Hydrogeologist, Battle Mountain Gold (now Newmont), Phoenix Project Open Pit Gold Mine Tailings Water Recirculation Geochemical Model, Lander County, Nevada:** Used a water balance model incorporating tailings recirculation water and groundwater laden with chloride to predict chloride concentrations in mill water and tailings pond water over time. Chloride balance used to optimize groundwater withdrawal rates and timing. Predictions of chloride concentrations capable of inducing mineral precipitation were performed using the geochemical model PHREEQC.
- **Senior Staff Hydrogeologist, Homestake Mining Company (now Barrick), Open Pit Gold and Silver Mine Leach Pad Draindown Analysis Santa Fe Mine, Nevada:** Responsible for determining the heap draindown dynamics after cessation of the solution application. Draindown dynamics were simulated using a finite difference code (VS2DT) and an analytical model (HELP3). Draindown was predicted as a function of time and volume and was used to size the passive treatment system (biopass) for closure purposes.
- **Senior Staff Hydrogeologist, Homestake Mining Company (now Barrick), Open Pit Gold and Silver Mine Passive Treatment System (Biopass) Discharge Model, Santa Fe Mine, Nevada:** Performed an aquifer loading study on effluent from a passive treatment (biopass) cell. The study focused on determining transport time of effluent through the unsaturated zone and the extent of mixing zone in the underlying aquifer. Modeling was performed using SEEP/W and CTRANS/W.
- **Senior Staff Hydrogeologist, Sunnyside Gold Corporation / Echo Bay Mines, Former Underground Gold Mine Conjunctive Flow Study Sunnyside Mine, Silverton, Colorado:** Investigated this site to determine the volume of conjunctive groundwater flow beneath a stream impacted by mining activities. Managed falling head tests of conjunctive flow aquifer. Analyzed and interpreted the test results and incorporated results into a basinwide water balance study.
- **Senior Staff Hydrogeologist, Sunnyside Gold Corporation / Echo Bay Mines, Former Underground Gold Mine Watershed Water Balance, Sunnyside Mine, Silverton, Colorado:** Performed a water balance study on a small watershed impacted by mining activities. Study was commissioned to confirm groundwater movements between drainage basins.
- **Senior Staff Hydrogeologist, Newmont Mining Corporation, Open Pit Gold Mine Tailings Rheologic Model, James Creek Project, Carlin, Nevada:** Performed hydrological modeling of the saturation state and moisture content of a spent tailings impoundment. Model results were used to assist

in predicting stable slope cut angles for tailings relocation activities. Modeling of unsaturated zone moisture content was performed using VS2DT.

- **Senior Staff Hydrogeologist, Pegasus Gold Corporation, Open Pit Gold Mine Capillary Break Cover Model, Zortman, Montana:** Responsible for modeling a series of cover designs for various facilities at an active mine. Modeling involved assessing the effectiveness of a capillary break cover and a traditional low-permeability cover design. Modeling was performed using HELP3.
- **Senior Staff Hydrogeologist, LAC Minerals (now Barrick), Open Pit Gold Mine Infiltration Pond Design Bullfrog Mine, Beatty, Nevada:** Responsible for the design and sizing of an infiltration pond for storm water control.
- **Senior Staff Hydrogeologist, LAC Minerals (now Barrick), Underground Gold Mine Heap Leach Pad Closure Fate and Transport Model, Richmond Hill Mine, South Dakota:** Performed a contaminant fate and transport analysis for discharge from a treatment plant. Modeling was performed using the TPLUME model.
- **Senior Staff Hydrogeologist, Battle Mountain Gold (now Newmont), Open Pit Gold Mine Pit Backfill Geochemical Study, San Luis Mine, Colorado:** Presented results of geochemical testing to state regulatory agencies on behalf of client. The testing results demonstrated to the state agency that pit backfilling would not impact ground or surface water.
- **Senior Staff Hydrogeologist, PTFI Freeport / Freeport McMoRan Open Pit Gold and Copper Mine Geologic Characterization Report Irian, Jaya, Indonesia:** Composed a geologic and geochemical background description section for waste rock dump design report.
- **Senior Staff Hydrogeologist, Sunnyside Gold Corporation / Echo Bay Mines, Former Underground Gold Mine Spring and Seep Survey Sunnyside Mine, Silverton, Colorado:** Performed a survey of springs, seeps, and wetland areas in the region of an underground gold mine. The survey included locating springs on a map, estimating flows, collecting water quality samples, and preparing a technical report presenting results.
- **Senior Staff Hydrogeologist, ASARCO, Open Pit Gold Mine Tailings Paste Feasibility Study, Rock Creek Mine, Montana:** Responsible for moisture retention testing and unsaturated flow modeling of experimental tailings paste backfill material. Testing was performed under a variety of simulated overburden loads. Testing was used to derive unsaturated flow parameters for the modeling.
- **Senior Geochemist, Tailings Storage Facility Liner Usability Study, General Atomics Corporation, Cotter Uranium Mill, Canyon City, Colorado:** Developed plans for dewatering and consolidating existing tailings using a wick drain system to increase storage capacity in an existing permitted tailing disposal facility. Examined existing head conditions on liner and methods to reduce total head on liner to satisfy regulatory agency concerns.
- **Senior Staff Hydrogeologist, Homestake Mining Company (now Barrick), Open Pit and Underground Uranium Mine Quarterly Water Sampling, Pitch Mine, Saguache County, Colorado:** Performed water quality sampling in surface water and groundwater monitoring wells for radionuclides from inactive uranium mine.
- **Senior Staff Hydrogeologist: Homestake Mining Company (now Barrick), Open Pit and Underground Uranium Mine Adit Plug Investigation, Pitch Mine, Saguache County, Colorado:** Supervised drilling and downhole video camera operation for an adit plug feasibility study at a uranium mine. Field investigation involved locating an open adit from historical records, drilling into the adit, and using a downhole camera to assess the conditions for plug placement.
- **Senior Staff Hydrogeologist, Homestake Mining Company (now Barrick), Open Pit and Underground Uranium Mine Well and Inclinometer Installation, Pitch Mine, Saguache County, Colorado:** Supervised drilling, logging and monitoring well installation as part of closure activities for an open pit uranium mine. Installed and retrieved data from slope stability inclinometers to assess depths and rates of ground movement.

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- **Senior Staff Hydrogeologist, Consolidated Edison / Cotter Corporation, Uranium Ore Processing Facility Uranium Tailings Paste Study, Canyon City, Colorado:** Oversaw laboratory testing of tailings samples for moisture retention properties. Prepared technical report and other correspondence with state agencies regarding the technical aspects of placing tailings in a sub-saturated (thickened) state.
- **Staff Scientist, U.S. Government, Polar Ice Coring Office, Greenland Ice Sheet Project 2 (GISP2), Summit Camp, Greenland:** Acted as a staff scientist and technician for an 8 week drilling campaign designed to penetrate two miles of ice at the center of the Greenlandic ice sheet. Served as an ice core technician, sample technician, and weather balloon operator. Work performed as a graduate student at University of Nevada, Reno.