

**NORTHWEST  
TERRITORIES  
WATER BOARD**



**NUNAPPA  
SIVUNIUKPAIT  
IMMAKUN**

# **Unipkat I-22 2011 Monitoring and Sampling Plan Proposal for a Type “B” Water Licence N7L1-1831**





June 20, 2011

Northwest Territories Water Board  
5114 – 49 Street, CJCD Building  
P.O. Box 1326  
Yellowknife, NT X1A 2N9

**Mr. Eddie Dillon,  
Chairperson  
NWT Water Board**

Dear Mr. Dillon;

**Unipkat I-22  
2011 Monitoring and Sampling Plan Proposal for a Type “B” Water Licence  
N7L1-1831**

IEG Consultants Ltd. (IEG) is pleased to submit a Site Monitoring and Sampling Plan for review to Northwest Territories Water Board (NWTWB). The enclosed scope of work represents our estimate of required services at the Unipkat I-22 site and is submitted according within the requirements of the issued Water Licence N7L1-1831.

If you have any questions, please call the undersigned at (403) 730-6837.

Yours truly,

**IEG CONSULTANTS LTD.**

Jeff Whitter  
Project Manager

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# **Unipkat I-22 2011 Monitoring and Sampling Plan Proposal for a Type “B” Water Licence N7L1-1831**

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Figure 1	Site Plan With Monitoring Well Locations
Detailed Curricula Vitae	Chris Langton, Jeff Whitter, Ryan Lennie

## **1. BACKGROUND**

Shell Canada Energy (Shell) conducted a sump remediation program at their former wellsite, Unipkat I-22 between February 2011 and April 2011.

Unipkat I-22 is located within the Inuvialuit Settlement Region, along the eastern bank of Arvoknar Channel, southwest of the Kendall Island Bird Sanctuary. The closest community is Tuktoyaktuk, NWT.

As part of the remedial program a Type “B” water licence was granted by the Northwest Territories Water Board (NWTWB). Licence N7L1-1831 requires a site monitoring and sampling plan to be approved by the board for future monitoring, sampling and reporting.

## **2. PROPOSED POST-REMEDATION MONITORING**

Shell will collect post-remediation monitoring data at the Unipkat I-22 site beginning in summer of 2011 in accordance with the following terms of reference. The monitoring program will include four aspects: visual monitoring of the site, collection and analysis of water samples from monitoring wells on site and the surface water pond, collection and analysis of data from thermistors on site, and soil sample collection and analysis.

### **2.1 Visual Inspection**

Shell will carry out a visual inspection of the Unipkat I-22 site, and record the following information:

- Date, Monitoring Event Number, and Weather Conditions at the time of Inspection. Weather conditions to be recorded include, as a minimum, temperature, precipitation, cloud cover, wind speed (qualitative) and direction;
- Name of Inspector(s);
- Record observations of potential seepage, addressing areas of water pooling or discharge, resurgence, shoreline stability, soil staining, vegetation stress, odours and/or hydrocarbon sheen;
- Inspect condition of monitoring well/thermistors and note damage, and/or repairs required;
- Provide a detailed sketch of the area using the existing base drawing for reference. Identify on the sketch any evidence of seepage, resurgence,

staining, vegetation stress, settlement, erosion or frost action, with dimensions, as required;

- Cross reference features of note using survey measurements using global positioning system coordinates;
- Provide an overall photographic record of the area. Record viewpoints for each photograph;
- Provide additional photographs, as required, to substantiate and document evidence of seepage, resurgence, staining, vegetation stress, settlement, and erosion and/or frost action;
- Ensure that all photographs incorporate a measure of scale;
- Survey elevation of sump area to monitor possible settlement, relative to local benchmarks; and
- Features of note.

## 2.2 Water Monitoring and Sampling

Groundwater conditions at the site will be monitored as per the proposed schedule and representative groundwater samples will be collected at specific locations. Eight groundwater monitoring wells were previously installed. During the remedial efforts at the site, two monitoring well locations were destroyed (MW4 and MW7), while two others (MW1 and MW3) were slightly pushed by heavy equipment. Following the remedial program four additional boreholes were drilled and completed as monitoring wells at the site. The surface water pond to the east will be included as a sampling location. The water monitoring program will require the monitoring of all accessible (and functioning) monitoring wells, and the surface water pond to the east. Locations of all the monitoring wells on site (both destroyed and current) are shown on Figure 1.

Collected samples will be submitted to an accredited laboratory for analysis of the following water parameters:

- Routine general chemistry parameters (including: calcium, magnesium, sodium, potassium, sulphate, chloride, bicarbonate, nitrate-nitrogen, nitrite-nitrogen) analysis;
- Petroleum Hydrocarbon (PHC) fractions F1 & F2, and benzene, toluene, ethylbenzene, xylene (BTEX) analyses;

- Polycyclic Aromatic Hydrocarbon (PAH) analysis; and
- Dissolved iron (Fe) and manganese (Mn) analysis.
- During each monitoring and sampling event a field duplicate sample will be collected from a groundwater monitoring well if sufficient water volume is present in the well. If limited water is contained in the wells, sample collection will proceed on a priority basis according to this preference: 1) BTEX, 2) PHC, 3) PAH, 4) Routine Parameters and 5) Dissolved Fe/Mn.

The following protocol will apply at each well location:

- Use of new groundwater sampling equipment (tubing and foot valves and/or bailers) to reduce the risk of cross contamination;
- Measurement of combustible vapours in the monitoring well (using a RKI Eagle Portable Gas Detector or similar field instrument);
- Measure the water/product level with an interface probe;
- Purging of the well until field parameters are stable (within 10%) or at least three well volumes, or until the well is dry in the case of low yielding wells;
- Monitoring of groundwater temperature, pH, electrical conductivity (EC); and
- After groundwater levels recover, groundwater samples will be collected and submitted under standard chain of custody protocol, for analysis of the parameters listed above.

Groundwater samples will be collected from all functional monitoring wells. At each monitoring well, using an interface probe decontaminated and cleaned after each use, the following will be documented, prior to purging:

- Well number;
- Water level;
- Depth to bottom of well;

- Height of stickup; and
- Presence and thickness of free product, if applicable.

### **2.3 Thermistor Data Collection**

Thermistors onsite are currently installed at 3 locations. One location was destroyed during the remedial efforts at the site. Thermistor data will be downloaded onto a field laptop and analyzed to monitor ground temperatures. An assessment of the thermal profile will be completed with the downloaded data after each site visit. Location of the thermistors are shown on Figure 1.

### **2.4 Soil Sampling**

Subsurface soil samples will be collected only during the summer 2011 site visit to characterize backfill material on both the north and south sides of the bentonite blanket currently installed at the site. The bentonite blanket separates clean backfill on the south side of the excavation from the PHC affected soils backfilled on the north side of the blanket. Subsurface soil sampling will be achieved using appropriate field tested mechanical methods (drill rig). Samples will be collected at a minimum 0.5 m interval spacing unless notable stratigraphic differences occur.

Surface soil samples will be collected when and where stressed vegetation is noted during the field visits.

Collected soil samples will be submitted to an accredited laboratory for analysis of the following soil parameters:

- PHC fractions F1 to F4 including BTEX;
- Regulated metals (CCME/AT1);
- Soil salinity; and
- True total barium by fusion.

All samples are to be kept cool prior to transport off site for analyses and will be submitted under standard chain of custody protocol, for analysis of the parameters listed above.



## 2.5 Quality Assurance and Quality Control

- Appropriate Quality Assurance (QA)/Quality Control (QC) procedures as per CCME Guidelines for sampling and analyses to assess accuracy and precision of results will be established. Monitoring wells have been fitted with seals (locks) to reduce the potential for tampering. If a well seal has been tampered with, the results will be reported as such and the data may be considered invalid.

QA/QC procedures will be established, as per CCME Guidance, for sampling and analyses to ensure accuracy and precision of results. A general guideline of a duplicate sample will be collected for every 10 soil samples.

Duplicate samples will be collected as per the details provided in each applicable section. The samples will be submitted to the laboratory under blind sample designations and analyzed in order to evaluate analytical precision and sampling procedures. The data will be evaluated using Zeiner's (1994) relative percent difference method.

Field sampling QA/QC measures will include implementation of IEG's site investigation manual for guidelines and protocols regarding, field instrument calibration, water sampling techniques, and personal protection equipment. To prevent cross contamination, new/or cleaned (as appropriate) sampling equipment (new tubing and foot valves and/or bailers, or cleaned soil sampling equipment) will be used during sample collection. Nitrile gloves will be worn when handling samples and will be changed between sampling locations. Equipment will be decontaminated and dried using disposable paper towels to prevent cross contamination between sampling locations.

## 3. PROPOSED TEAM

The proposed IEG team includes Chris Langton, Jeff Whitter, and Ryan Lennie. Roles, responsibilities and team member's backgrounds are summarized below. Detailed curricula vitae will be provided on request.

**Chris Langton P.Geol. (IEG Manager Environmental Services).** Chris Langton will be the senior reviewer. Chris has more than 20 years of experience in environmental management, groundwater supply and groundwater contamination.

**Jeff Whitter B.Sc.Eng., P. Eng. (Technical Supervisor).** Jeff Whitter will be the Technical Lead for the project. Jeff has more than 8 years of experience in groundwater projects for environmental site assessments and groundwater contamination. Jeff has completed project planning, management, and reporting of compliance monitoring

studies. He has extensive experience in managing site assessments for the oil and gas industry, drilling supervision, aquifer testing, and groundwater monitoring.

**Ryan Lennie (Environmental Technician).** Ryan graduated with a diploma in Water Resources Engineering Technology. This program has equipped him with solid technical skills in surveying, drafting, computer applications and modeling, soil and concrete testing, water chemistry, hydraulics, surface and groundwater hydrology, atmospheric and hydrometric data collection and analysis, irrigation, water and wastewater treatment, river engineering, municipal infrastructure, environmental engineering and project management.

#### 4. SCHEDULE

Shell will monitor the Unipkat I-22 site as per the requirements of the NWTWB water licence during the summer/fall season on an annual basis in the following years: 2011, 2012 and 2013.

The proposed scope of work and the schedule for the project is provided in Table 1.

**Table 1: Proposed Schedule Milestones**

Submission of Monitoring and Sampling Plan	June, 2011*
Monitoring and Sampling Plan Approval	June 30, 2011
2011 Monitoring Program	August, 2011
2011 Annual Monitoring Report	September 30, 2011
2012 Monitoring Program	August, 2012
2012 Annual Monitoring Report	September 30, 2012
2013 Monitoring Program	August, 2013
2013 Final Monitoring Report	September 30, 2013

\* = denotes a change in submission date as per agreed conversation between IEG and INAC officials.

#### 5. DELIVERABLES

The annual monitoring report will be submitted to the NWTWB on or before September 30 of each year with a final report due in 2013.

## **5.1 Annual Groundwater Monitoring and Report**

The annual monitoring report will include the documentation requirements specified in the issued Water Licence N7L1-1831.

## **6. CLOSURE**

IEG looks forward to continuing a constructive and successful working partnership with the NWTWB. If you have any questions or comments, please contact Jeff Whitter at (403) 730-6837.

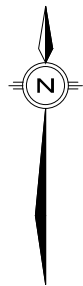
Yours truly,

**IEG CONSULTANTS LTD.**

A handwritten signature in blue ink, appearing to read 'Jeff Whitter', with a large, stylized flourish extending to the right.




Jeff Whitter  
Project Manager

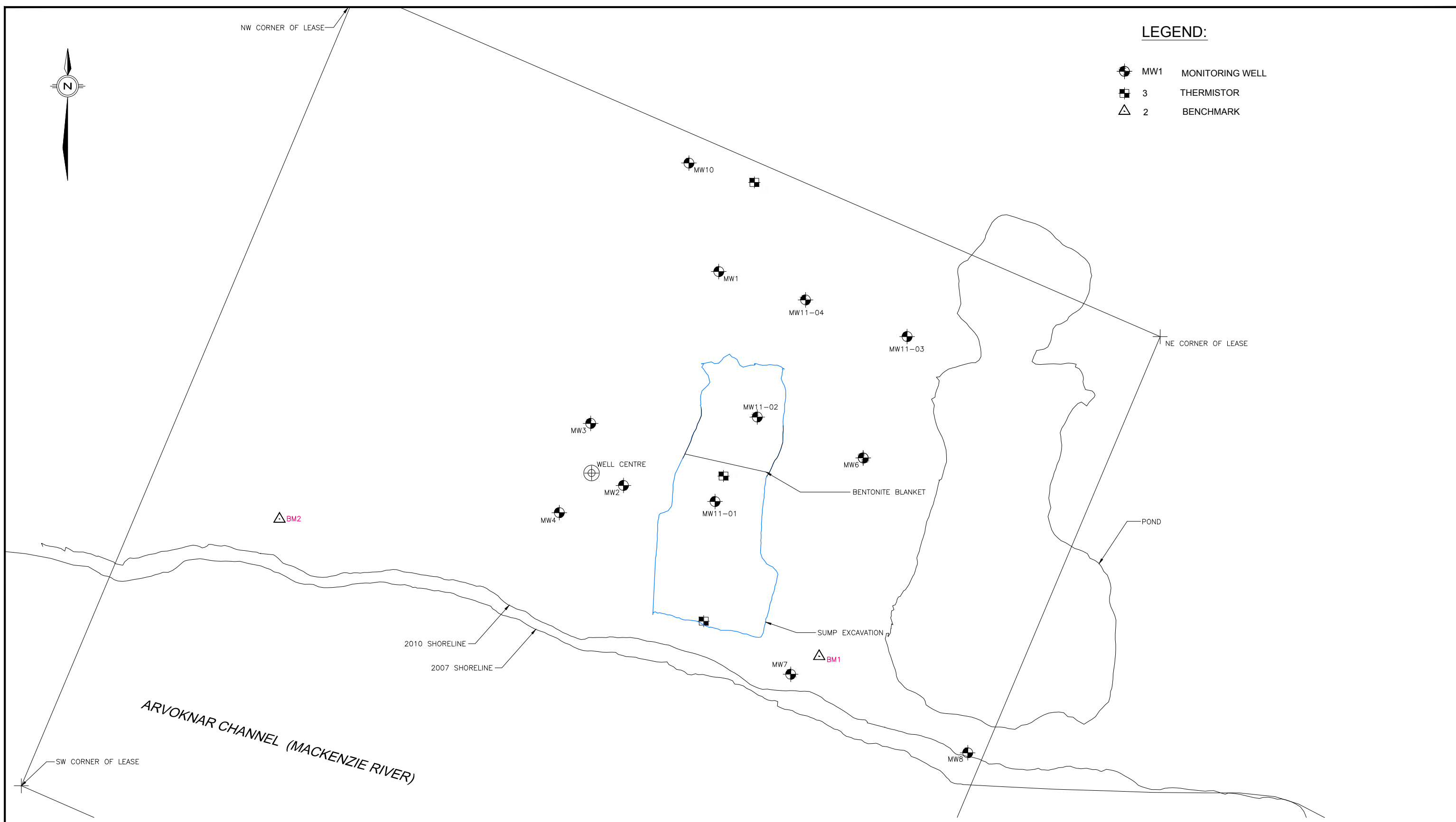
## **ATTACHMENTS**



NW CORNER OF LEASE

**LEGEND:**

-  MW1 MONITORING WELL
-  3 THERMISTOR
-  2 BENCHMARK



ARVOKNAR CHANNEL (MACKENZIE RIVER)

2010 SHORELINE  
2007 SHORELINE

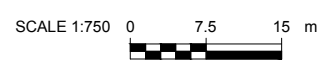
TO BE READ WITH IEG REPORT DATED MAY 2011

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT




PROJECT		UNIPKAT I-22	
TITLE		SITE PLAN WITH MONITORING WELL LOCATIONS	
PROJECT No.	A04025A02	FIG. No.	FIGURE 1



A04025A02.FIG-1.dwg

KCCP-BM



## EDUCATION

B.Sc. (Hons.) in Hydrogeology, Earth Surface Processes, Hydrology and Applied Hydrology, Rhodes University, Grahamstown, South Africa, 1987

B.Sc. in Geology and Physical Geography, Rhodes University, Grahamstown, South Africa, 1986

## CERTIFICATES

Consulting Engineering Practice and Management  
Melbourne Business School, 1996.

Geophysics Course Component, M.Sc. in Mineral Exploration, Rhodes University, Grahamstown, South Africa, 1987.

## PROFESSIONAL REGISTRATIONS

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

## PROFESSIONAL AFFILIATIONS

International Association of Hydrogeologists (IAH)

## PROFESSIONAL HISTORY

*Klohn Crippen Berger Ltd. / IEG Consultants Ltd.*  
Senior Hydrogeologist, 2006 - Present

*Klohn Crippen Consultants Ltd.*  
Senior Hydrogeologist, 2004 - 2005

*HLA Envirosiences Pty Limited*  
Principal Hydrogeologist, 2002 - 2004

*SRK Consulting*  
Principal Hydrogeologist, 1999 - 2001

*Coffey Geosciences Pty Ltd.*  
Associate Principal Hydrogeologist, 1995 - 1999

*Steffen Robertson and Kirsten (CE) Inc.*  
Senior Hydrogeologist, 1991 - 1995

*Lorraine Gold Mine*  
Geologist, 1990 - 1991

*Atomic Energy Corporation, South Africa*  
Hydrogeologist, 1989 - 1990

*Groundwater Consulting Services*  
Hydrogeologist, 1988 - 1989

Chris has 20 years of experience in groundwater projects for mine environmental management, groundwater supply and groundwater contamination.

Chris has worked on site characterization, contamination assessments, remedial plans and monitoring programs for waste facilities. He has experience in the design of new facilities and in the operation and closure of toxic liquid and solid waste facilities, and municipal and metropolitan landfill sites.

He has managed multi-disciplinary teams for mining feasibility studies and has been involved in due diligence assessments for mining and financial institutions. In addition, Chris has experience in mine water balance studies, mine dewatering, tailings and waste rock dump water budgets and mine closure plans.

Chris has led regional groundwater assessments for water supply developments and water resource management.

## KEY PROJECT EXPERIENCE

### SITE CONTAMINATION ASSESSMENTS

**Talisman Energy**  
*Alberta, Canada*  
Review of Phase I, II and III site soil assessments.

**AltaGas Ltd.**  
*Alberta, Canada*  
Review of Phase I, II and III site soil and groundwater contamination assessments.

**Defence Construction Canada**

*NWT, Canada*

Review of DEW Line monitoring projects at sites in the Inuvialuit Settlement Region (ISR).

**Shell Energy**

*NWT, Canada*

Review of historical well site and drill sump assessments in the NWT

**Brisbane City Council**

*Brisbane, Australia*

Detailed hydrogeological review and contamination assessment studies of a major historical toxic liquid and solid waste facility.

**Borden Chemicals**

*Gibson Island, Brisbane, Queensland, Australia*

Hydrogeological and groundwater contamination assessment at a chemical manufacturing plant.

**Permitting for Regional Waste Facility**

*Port Elizabeth Municipality, South Africa*

Investigation of hydrogeological aspects for permitting of Class II waste facilities at Arlington, Port Elizabeth. Negotiations with regulatory authorities were required for aquifer classification and protection, in the terms of the proposed waste disposal activities.

**Port Elizabeth Municipality**

*Port Elizabeth, South Africa*

Research into groundwater abstraction in the Port Elizabeth municipal area for the Water Research Commission. This project involved extensive liaison with stakeholders. Research aims included terms of groundwater management, legal implications and implications for municipal water supply. Key issues included options for a legal framework for municipal control over, and preservation of the resource, in preference to riparian groundwater ownership rights and potential saline intrusion to the aquifer.

**Groundwater Monitoring System, Mossgas Refinery**

*Mossel Bay, South Africa*

Installation of a groundwater monitoring system at the Mossgas Refinery, Mossel Bay, for potential leakage detection monitoring from Class I and Class II toxic waste disposal facilities, gas to petroleum refinery.

**Aquifer Contamination and Potable Groundwater Supplies, House of Representatives**

*Riespruit, Kalahari Desert, South Africa*

Assessment of aquifer contamination and potable groundwater supplies at the town for the Regional Authority. The work involved stakeholder consultation, a borehole census and groundwater quality and contamination assessments.

**MINING PROJECTS**

**Suncor Energy Inc.**

*Fort McMurray, Alberta*

Groundwater monitoring and management scope including data collation and 2004 annual regulatory reporting.

**Suncor Energy Inc**

*Fort McMurray, Alberta*

Groundwater design components for the South Tailings Pond.

**Suncor Energy Inc**

*Fort McMurray, Alberta*

Groundwater baseline and site characterization for the North Steepbank Mine.

**Suncor Energy Inc**

*Fort McMurray, Alberta*

Basal aquifer management for the Millennium Mine.

**Albian Sands Energy**

*Fort McMurray, Alberta*

Basal aquifer management for the Muskeg River Mine.

**Shell Canada Energy**

*Fort McMurray, Alberta*

Hydrogeological site characterization and seepage management design for the Jackpine External Tailings Facility.

**Petro-Canada Oil Sands Inc.**

Hydrogeological site characterization and seepage management design for the Out of Pit Tailings Area.

**Petro-Canada Oil Sands Inc.**

Dewatering assessment and design for the Crusher Area.

**Cibaliung Gold Project**

*West Java, Indonesia*

Completed pre-feasibility level mining hydrogeological assessment and feasibility level dewatering and mine water management studies.

**Pasminco Century Zinc**

North Queensland, Australia

Designed and implemented a Surface and Groundwater Monitoring Plan, Initial Mine Closure Plan and Waste Rock Management Assessment.

**Pike River Coal Mine, Department of Conservation**

*New Zealand*

Reviewed mining development proposals for the Pike River Coal Mine and expansion to the GRD Macraes Project.

**Cape Flattery Silica Mine**

*North Queensland, Australia*

Developed a high capacity water supply from a coastal sand dune belt. Four wells were installed with a combined capacity in excess of 250 L/s. Subsequent work included the development of a production and environmental site water monitoring plan and site water balance studies.

**Udokan Copper Project**

*Siberia, Russia*

Due diligence and feasibility level planning review on water, tailings, waste rock and associated environmental issues surrounding the proposed development of a 12 Mtpa open pit copper mine.

**Mount Gordon Copper Mine**

*North Queensland, Australia*

Due diligence assessment of mine water and mine environmental management issues.

**Nakety Nickel Project**

*New Caledonia*

Due diligence assessment and feasibility level planning for a 6 Mtpa truck and shovel project in mountainous terrain. The assessment involved detailed discussion with local authorities in terms of changing legal and environmental regulatory systems and implications for project development.

**Lihir Gold Mine**

*Papua New Guinea*

Due diligence assessment of dewatering, depressurization, and mine water management issues.

**Goro Nickel Project**

*New Caledonian*

Management of geological resource, mining, groundwater and geochemical components of the study which were completed by a multi-office team operating from Brisbane, Denver and Vancouver.

**Goondicum Ilmenite Project**

*Queensland, Australia*

Managed a mining pre-feasibility study for a proposed clay/sand and decomposed gabbro sand mine containing ilmenite, titanomagnetite and apatite feldspar. The study considered resource-reserve issues, preliminary pit optimizations and various mining options.

**Chatree Mine Development**

*Thailand*

Work involved predictive site water balance modeling. A model was created to assess the site water balance for the proposed mine development under various design and operating scenarios. The model considered a range of input parameters simultaneously and included statistical reporting of confidence levels with other predictive outputs. The model allowed rapid assessment of alternatives in management of major components, for example processing rates, groundwater supply capacity and tailing return water management.



**Nifty Copper Mine**

*Pilbara, WA, Australia*

Established a monitoring network of piezometers around a heap leach complex. Also, an assessment and management of pit dewatering and contamination assessments associated with the heap leach complex. A detailed groundwater and contamination modeling assessment was completed for ongoing site management and mine closure planning.

**Stuart Oil Shale Project**

*Central Queensland, Australia*

Management of a detailed groundwater study, high-level groundwater modeling and liaison with Client and Regulators. Reviewed additional mine groundwater management studies, updated hydrogeological components of an EIS, and delivered a presentation of key groundwater management issues to Regulators.

**Kalgoorlie Consolidated Gold Mines (KCGM)**

*Western Australia*

Completed the hydrogeological component of a numerical risk assessment of tailings dam failure potential.

**Toka Tindung Gold Project**

*Indonesia*

Pre-feasibility study involving field investigations to provide the preliminary design criteria for land-based tailings disposal, multiple open pit designs, management of surface water and river diversion requirements and groundwater characterization and mine dewatering assessments. A definitive feasibility study covering the same scope items was completed with an expanded scope to include additional satellite deposits.

**SASOL**

*Sasolburg, South Africa*

Hydrogeological member of a multi-disciplinary team constituted to address water balance and environmental impact management issues. The site incorporated deep level gold mining at 1500 m, intermediate coal mining at 250 m, and a coal to light fuel refinery on surface at Sasolburg, South Africa. A positive water balance, surface subsidence control and issues surrounding boron and fluoride contamination were assessed.

**ANGLOVAAL**

*Allanridge, Orange Free State, South Africa*

Environmental assessment of seepage and methods for improved seepage management at Loraine Gold Mine (Anglovaal Ltd). A review of the supernatant discharge practice and license conditions revealed inconsistencies in infringement allegations made against the mine by regulators. A successful response was prepared resulting in retraction of the allegations of the illegal tailings return water releases.

**ANGLOVAAL**

*Alanridge, Orange Free State, South Africa*

Collation of historical water level data and assessment of dewatering influence of No.1 shaft on agricultural practices. Prepared a report for mine management to demonstrate to local stakeholders that deep level mining had minimal impact on near surface groundwater resources.

**Grootegeluk Coal Mine**

*Ellisras District, South Africa*

Assessment of dewatering operations, acid drainage potential and monitoring data review for Grootegeluk Coal Mine, South Africa.

**De Beers**

*Venetia Diamond Project, South Africa*

Assessment and exploration well design for a proposed diamond mine water supply from the Limpopo River on the Botswana/South Africa border.

## **WATER SUPPLY PROJECTS**

### **Brisbane City Council**

*Rochedale, South East Brisbane*

Assessment of alluvial aquifer capacity, agricultural extraction, groundwater impacts and contamination from intensive market gardening. Natural recharge and options for artificial recharge were assessed in terms of current agricultural land use and future urban groundwater supply capacity. Passive and active groundwater recharge options were considered. Passive recharge options focused on natural infiltration via temporary off channel stormwater storage in parklands. Active recharge options included recharge wells using pressure and gravity well flow. Potential impacts of reduced aquifer discharge on stream flows and storage impacts in a neighbouring alluvial aquifer were also assessed.

### **Conceptual Site Water Management for Pacific Harbour Golf Course, QM Properties**

*Bribie Island Queensland, Australia*

Conceptual hydrogeological planning and field investigations. Conceptual site water management included groundwater recharge and abstraction engineering concepts as sustainable resource management options. Project approach received an EPA award for sustainable development. Subsequent detailed hydrogeological studies included construction of a calibrated pre-construction groundwater model to assess the capacity for irrigation from a shallow aquifer, artificial recharge options and potential impacts of third party abstraction from a lower aquifer.

### **Umgeni Water Board**

*Kwazulu, South Africa*

Involvement in rural groundwater supply projects for several village areas.

### **Government of Namibia**

*Kaokaveld and Ovamboland, Namibia*

Field management and collation of hydrogeological census information for a two-year international aid funded project on water supply in the Kaokoland and West Ovamboland provinces of Namibia. This project involved a period of field management of the borehole census, involving two teams working in a remote area using GPS mapping and navigation. Consultation with local landowners and other stakeholders was integral to the identification of water sources and livestock numbers.

### **Groundwater Supply Investigation, Various Private Clients**

*Alicedale District Eastern Cape, South Africa*

Regional investigation of potential groundwater supply for 28 farms.

### **Groundwater Strategies, Ciskei Government**

*South Africa*

Final preparation of groundwater strategies for the Ciskei National Water Development Plan, for the Department of Public Works in Ciskei.

### **Matheson and Bremner**

*Gamtoos Valley, Eastern Cape, South Africa*

Satellite interpretation of target features for groundwater exploration in the Gamtoos Valley. Yields of up to 90 L/s were obtained from deep large diameter wells in fractured quartzite geology.

### **Algoa Regional Services Council**

*Alexandria, South Africa*

Assessment of municipal water supply potential from a coastal dune field. A detailed drilling investigation was undertaken to understand the sand and dune rock aquifer characteristics.

**Algoa Regional Services Council**

*Paterson, South Africa*

Successful development of a municipal groundwater supply with a 2 ML/day capacity from two deep production wells, for the town of Paterson in the Eastern Cape. Existing production borehole capacities were less than 0.25 ML/day and surface water supply options were orders of magnitude more expensive. A contract for access to riparian groundwater rights and groundwater sale rates was drawn up and executed prior to the commencement of works. Ground EM techniques were used to assess fracturing in the near surface environment.

**Venda Local Government**

*Masisi, Venda, South Africa*

Established potable groundwater supplies to nine villages in the Venda region of the northeastern Transvaal of South Africa from groundwater resources, where previous groundwater supplies were largely insufficient or non-potable.

**Lesotho Agricultural College**

*Maseru, Lesotho*

Installations of a 32 L/s capacity wellpoint system, manifold, and retractable pump in the Caledon River for agricultural irrigation purposes.

**OTHER PROJECTS**

**National Groundwater Quality Project,  
Department of Water Affairs and Forestry**

*South Africa*

Planning and inception of a project to produce a National Groundwater Quality Map of South Africa for the Department of Water Affairs and Forestry.

**Drakensberg Pumped Storage Scheme,  
ESKOM**

*Natal, South Africa*

Investigation of leakage and leakage flow paths from the surge shafts of the Drakensberg Pumped Storage Hydroelectric Scheme in Natal. Geophysical investigations were carried out to focus drilling and monitoring well installations. Hydrochemical fingerprinting and groundwater

level monitoring during a system shutdown were used to verify leakage assumptions and to trace leakage pathways.

**Candidate Nuclear Reactor Sites  
Groundwater Quality Assessment, ESKOM**

*South Africa*

Assessment of regional groundwater quality and aquifer characteristics for candidate nuclear reactor sites in the southern and western Cape.



## EDUCATION

Bachelor of Science in Civil Engineering  
University of New Brunswick, 2000

## CERTIFICATES

PSMJ - Project Management Bootcamp, 2008

HGA- Making Sense of Environmental Data,  
Waterloo Training Course, 2006

Hydrogeology Course Component, M.Sc. University  
of New Brunswick, graduate level courses 2002-2005

Short course on the Interpretation of Pumping Tests  
in Complex Settings – UNB, 2005

H<sub>2</sub>S Alive

CSTS

ATV Training Course

TDG

Ground Disturbance Level II

Standard First Aid

## PROFESSIONAL REGISTRATIONS

Registered Professional Engineer- Association of  
Professional Engineers, Geologist and Geophysicists  
of Alberta.

## PROFESSIONAL HISTORY

*Klohn Crippen Berger Ltd.*  
Hydrogeologist, 2010-Present

*EBA Engineering Ltd.*  
Hydrogeologist/ Project Manager 2006-2010

*Neill and Gunter Ltd.*  
Junior Environmental Engineer 2005-2006

*University of New Brunswick.*  
Research Assistant/ Stipend lecturer 2002-2005

*Golder Associates Inc.*  
Staff Civil Engineer I 2001-2002

*Gemtec Ltd.*  
Junior Environmental Engineer 2000

Field Inspector 1999

Lab Technician 1998

Jeff has over 8 years of experience in consulting which has involved project management, hydrogeology, and contaminated sites. He has extensive experience in managing groundwater assessments for the oil and gas industry, drilling supervision, aquifer testing, and groundwater monitoring. These skills relate to water supply, groundwater contamination projects, mine baseline testing and compliance monitoring.

Jeff has experience in aquifer characterization and groundwater monitoring projects. This includes the planning, co-ordination and execution of field programs, and the associated reporting.

Jeff has experience carrying out environmental site assessments with non traditional contaminants (sulpholane, DIPA). He also has experience conducting pumping tests and bail/slug tests to determine aquifer properties. He has written interpretive and factual aquifer characterization and environmental assessment reports.

Other experience includes 3-D computer groundwater modelling for the optimization and predictive interpretation of groundwater flow and contaminant transport. He has produced numerous conceptual 3-D geologic models using various computer aided software.

## HIGHLIGHTS OF EXPERIENCE

- Project management and performance of hydrogeological assessments and data interpretations
- Groundwater modelling (FeFlow and Modflow)
- Aquifer characterization of both physical and contaminant transport mechanisms

## KEY PROJECT EXPERIENCE

### Oil and Gas Facilities

Alberta

Has performed a geologic and hydrogeologic model to assess possible piping failure in a earthfill hydroelectric power dam. Using all available data including boreholes, material properties, historical information and water levels, piping and failure assessment was evaluated. Proposed a remedial cement-bentonite cut-off wall for groundwater isolation.



### **Oil and Gas Facilities**

Alberta

Has completed a groundwater monitoring and sampling program at an active sour gas plant in northern Alberta. Performance of hydrogeological field investigation, including aquifer slug tests, groundwater monitoring, well installation and development, groundwater and soil sampling in a sand and gravel porous media.

### **Oil and Gas Facilities**

Alberta

Has managed the compliance monitoring and the technical remedial activities for different compounds of concern and under different geologic settings. Responsible for the coordination of sub contractors, technical reporting and the budgetary status of the projects. Performance of hydrogeological field investigations, including aquifer pumping tests (step-rate, constant and recovery methods), groundwater monitoring (including low flow sampling), well development, groundwater and soil sampling and free product recovery testing for various compounds (PHC, NAPL, heavy metals) in both fractured bedrock and porous media, under both tight client deadlines and for sensitive public relations sites.

### **Groundwater Modelling**

Alberta

Developed a computer model for the interpretation of a salt impacted aquifer, tracing back to determine and assess the contaminant methods. The models primary influence was from surficial drainage but was under the possible effect of a local watercourse. The effects of rainwater dilution on the concentrations and the transport methods was investigated and interpreted. Model was calibrated to known water regimes and used for predictive analysis.

### **Phase II ESA's**

Alberta

Arranged and managed Phase II ESA's at operating gas plants or compressor stations to determine if oil field contaminants have migrated into the hydrogeological regime at/and near the various facilities. Responsible for the coordination of sub contractors, technical reporting and the budgetary status of the projects. Planning of field environmental assessments operations in conjunction with local operations to minimize interference.

### **Emergency Assessment**

Turner Valley, AB

The emergency observation of an excavation from a historical upstream oil and gas facility due to future development near a watercourse. Soil sampling for existing soil conditions, and managing public involvement within a sensitive location.

### **Groundwater Assessment**

Calgary, Alberta

Performance and management of a groundwater investigation at an abandoned landfill near downtown Calgary, AB. The assessment consisted of low flow groundwater sampling at numerous locations to manage groundwater/surface water interactions, and performing a data gap analysis in determining the lack of data for risk based management of the contaminants. Responsible for all budgetary aspects of the project, technical reporting and all client contact.

### **Phase II ESA**

Turner Valley, Alberta

Have been the project manager for a hydrogeological project for the assessment of a historical upstream oil and gas lease. The project has involved the assessment, interpretation, and management of a ~\$200,000 assessment with the installation of approx 40 monitoring wells, and numerous sampling events to determine locations of co-mingled hydrocarbon plumes and contaminant sources.

### **Groundwater Assessments**

Alberta

Participated in the writing of numerous hydrogeological reports for the assessments of engineered landfill containment areas, and the assessment of plume migrations at and near disposal sites. Have also participated in the intermediate review of hydrogeological reports in the assessments of upstream Oil-field activities. Participated in the sampling of monitoring wells at various upstream oil and gas locations, both reclaimed and active large scaled facilities.

### **Aquifer Testing**

Invermere, British Columbia

Responsible for the design, performance, and analysis of a 72 hour aquifer pumping test for a newly constructed public drinking water well supply. The project also included the collection of water samples for laboratory analysis, as well as using data





loggers, and various computer applications for the detailed analysis of the aquifer stress parameters.

### **Residential Development Assessment**

Calgary, Alberta

Managed the assessment of both surface water and groundwater potential impacts for proposed residential developments, within a sensitive neighborhood with public interaction. The projects have consisted of site visits, discussions with developers for proper construction methods and proposed discussion of alternate development plans. Installation of numerous groundwater monitoring wells to assess nearby potential contamination. Downstream assessments for hydrocarbon contaminant plumes.

### **Groundwater Modelling**

New Brunswick, Canada

Worked on the optimization of a production well pumping schedule, using a 3D finite-element transient computer model for the City of Fredericton, NB. The compilation of the FeFlow model consisted of 35 layers, aquitard removal under a watercourse, over 1400 boreholes with the model domain. Model was calibrated to a discreet multiple production well aquifer pumping test, with over 30 observation locations both on land and with the riverbed. The model was used to assess the length of time for water to travel from the watercourse to the production wells. As part of this project, a production well was rehabilitated to increased the specific yield in order to return to the system of groundwater extraction.

### **Aquifer Testing**

New Brunswick, Canada

Designed, performed, and analyzed multiple aquifer tests to determine the hydrologic parameters associated with the aquifers under different stresses. Performed step-test, 24 and 72 hours pumping tests. Analysis included the possible salt water intrusion interface and the collection of multiple data points via instrumented sites (electronic logging).

### **Geologic Modelling**

New Brunswick, Canada

Using approximately 175 boreholes from a potentially contaminated site, a 3-D model was completed to interpret the different geologic layers, to assist in the delineation of the site and the possible preferential pathways. For hydrocarbon contamination and various heavy metals.

### **Remediation Analysis**

New Brunswick, Canada

Supervised the drilling and collection of water and soil samples for confirmation of plume delineation at downstream service stations. Performed analysis to determine volume of free product, and planned next course of action to remediate the property to closure. Completed a free product survey, as part of the closure program.

### **Environmental Impact Study**

Florida, USA

Performing the hydrology and surface water quality impacts to the proposed Ona mines project. Project includes site-specific and basin-wide impacts. This project also includes ecological and biological studies, as well as cumulative impacts for the proposed project. Participated in the public involvement process and the associated meetings with a multi disciplinary team, as well as other consultants. Prepared documents reflecting the environmental impact due to the development and assessed the potential impacts of the proposed mining methods and usage of surface water as a transport mechanism for the resource.

### **Environmental Resource Permitting**

Florida, USA

Prepared civil engineering plans for a power plant project in Hardee County. Prepared drainage studies and surface water modeling for multiple drainage areas and hydraulic systems. These studies consist of hydrologic study, surface water modeling, and hydraulics design and construction modifications. Also designed discharge control structures, culverts, and specification for various construction components.

### **Water Quantity Budgets**

Florida, USA

Performed surface water modeling to determine the impact of the evaporative and thermal losses resulting from the pumping at a rate of approximately 625,000 m<sup>3</sup>/day of the effluent from the process water in the generation of power into a spray field.

### **Environmental Assessments**

Florida, USA

Analyzed the surface water quality, determined the appropriate course of action with regards to the site development options. Comparison of the site-specific quality with the ambient background concentrations. Assessed the risk based on the detected levels of metals in the soil and the surficial groundwater. Requested a no further action from the



county with regards to the site and the encountered petroleum contamination.

### **Alternative Water Supply Analysis**

Florida, USA

Analyzed the sources of water to be utilized at a power plant generating facility. The options evaluated included; surface water, groundwater, reclaimed water, development of public well fields, aquifer storage and recovery systems

### **Hydrological Assessment**

New Brunswick, Canada

Hydrological study of a partially closed landfill to determine the onsite leachate treatment options. Included the installations of piezometers, stream gauging, water/leachate sampling, data analysis, and report evaluation. The project assessed the site surface water balance and the quality of the water leaving the site, compared the evaluation to the regulatory requirements.

### **Spruce Lake Landfill**

New Brunswick, Canada

Provided engineering evaluation and modifications of the plans and specifications for the closure of the landfill site. Also prepared cost estimates and subcontractors bids for construction and materials. Responsible for the payment quantities and the supervision of the day to day operations at the site.

### **Remediation Supervision**

New Brunswick, Canada

Project site manager for the excavation, removal and treatment of 1,500 m<sup>3</sup> of contaminated soil and recycling treatment. The project included work plans and specifications, sampling plans, field screening and confirmatory sampling procedure, quantity surveying, backfilling, and compaction.



**RYAN LENNIE**

**Environmental Technician**

## **EDUCATION**

Water Resources Engineering Technology Diploma, Saskatchewan Institute of Applied Science and Technology (SIASST Palliser), December 2009

## **CERTIFICATIONS**

H<sub>2</sub>S Alive  
Marine Emergency Duties A2  
Standard First Aid – Level C CPR/AED

## **PROFESSIONAL HISTORY**

*IEG Consultants Ltd.*  
Environmental Technician, January 2010 - Present

*A&A Technical Services, Diavik Diamond Mine*  
Skilled Labourer, 2008

Ryan graduated with a diploma in Water Resources Engineering Technology. This program has equipped him with solid technical skills in surveying, drafting, computer applications and modeling, soil and concrete testing, water chemistry, hydraulics, surface and groundwater hydrology, atmospheric and hydrometric data collection and analysis, irrigation, water and wastewater treatment, river engineering, municipal infrastructure, environmental engineering and project management.

Ryan brings a variety of other skills such as leadership, communication, time management, and an understanding of safety procedures developed through previous work experience.

Ryan is a bright, young Inuvialuit Beneficiary. Through his employment with IEG, he is building on his environmental experience, interest, education and training.

## **HIGHLIGHTS OF EXPERIENCE**

- Environmental Technician, 2008 ISR DEW Line landfill monitoring
- Logistics boat operator for DEW Line Phase III ESA.

## **KEY PROJECT EXPERIENCE**

### **2008 ISR Post Construction DEW Line Landfill Monitoring**

*Northwest Territories*

Served as an environmental technologist for IEG in August 2008. He was an important member of IEG's DEW Line landfill monitoring field team. His duties included sampling of groundwater from monitoring wells, recording of field parameters, collection of soil samples, sample handling and packaging, decontamination of field equipment, calibration of field equipment, and detailed note taking.





**2009 Post Construction Landfill Monitoring  
BAR-E intermediate DEW Line Site**

*Northwest Territories*

As part of IEG's assessment team, collected soil, groundwater and leachate samples; recorded field parameters, filled in chain of custody forms, packaged and shipped samples; and, assisted in surveying benchmarks and survey pins to measure the landfill cap stability.

**Johnson Point Hydrocarbon Soil  
Remediation**

*Banks Island, Northwest Territories*

Served as a field technician during excavation, treatment and confirmatory testing of impacted soils at a former exploration base camp. Helped guide equipment operators during excavation and aeration of impacted soils, estimated soil volumes, analysed samples with a PID and PetroFlag and sent samples to an analytical laboratory for analysis.

**Camp Farewell Hydrocarbon Soil  
Remediation**

*Mackenzie Delta, Northwest Territories*

Served as a field technician during excavation, treatment and confirmatory testing of impacted soils at a former oil and gas exploration base camp. Collected soil and surface water samples, assisted with pumping out a sewage lagoon in compliance with NWT Water Board regulations, surveying and sending samples to an analytical laboratory for analysis.