INFORMATION REQUEST RESPONSE

To: Manitoba Public Utilities Board Date: April 7, 2014

KP File: VA103-449/1-A.55

Needs For Alternatives To – **CAC/KP I-014 a, b, and c**

SUBJECT: Expertise of Knight Piésold Consulting

QUESTION:

a. Please set out the purported expertise of all authors to the report.
b. Please provide the expertise that each author is purported to bring to the report.
c. Please provide elements from each authors' curriculum vitae which demonstrate their purported expertise.

RESPONSE:

The answers to the three questions above are presented in the table below for conciseness and clarity. Only limited and relevant elements of each individuals experience are highlighted below. CVs Re-attached herein for relevant contributors.

Report Section Contributors (and Report Section Contributions)	Expertise Brought to Report	Element of CV Demonstrating Expertise
Sam Mottram (Q1, Q2, Q7, Q8, Q9, S3, S7, S8) Overall Review of both Reports)	Hydropower Engineering	20+ Years' Experience, M.Sc. Civil Eng., P.Eng. (BC, MB, ON, SK, YT), Canadian Hydropower Association, worked on numerous facilities from greenfield to construction to operation, has direct project involvement on more than 100 hydroelectric and large water infrastructure projects. Independent Engineer on a number of assignments.
	Capital Costs Estimates	Costing and optimization on numerous projects, projects financial analysis on numerous projects, i.e. 247 MW Kalungwishi, 1,500 MW Spirit of Ireland, 1,000 MW Fir Point, 400 MW Aguila, 150 MW Kwalsa & Upper Stave, 565 MW Alto Cachapoal, performed a review of 824 MW Muskrat Falls for Consumer Advocate of NL.
	O&M Cost	Worked on feasibility studies of numerous hydro projects as above, as well as refurbishment and redevelopment of older

		facilities.
	Project Management	Managing Principal at Knight Piésold, regular PM on KP Hydropower projects, regular Owner's Engineer assignments.
	Construction Management	PM for detailed design and construction supervision of: 150 MW Kwalsa and Upper Stave, 235 MW East Toba and Montrose, 247 MW Kalungwishi Hydroelectric Project, 25 MW New Post Creek Hydroelectric Project.
	Contracting	KP Principal, Tender Documents for 247 MW Kalungwishi Hydroelectric Project, 235 MW East Toba and Montrose Project, 150 MW Kwlasa and Upper Stave Project.
	Resource Planning	BC Hydro: Integrated Resource Plan and Options Assessment contributions (run of river hydro and pumped storage hydro)
Michael Roberson (Q1, Q2, Q3, Q6 to Q9, S1 to S8)	Hydropower Engineering	40+ Years' Experience, B.Sc. Civil Engineering, P.Eng. (BC) Canadian Dam Association, Waterpower / Hydrovision. Authored many dam safety reviews, worked on numerous facilities from greenfield to construction to operation. Designated Dam Safety Review Engineer.
	Capital Costs Estimates	Costing and optimization on numerous projects, projects financial analysis on numerous projects, i.e. 15 MW Culliton, 22 MW Tretheway, 15 MW Dasque, 120 MW Upper Lillooet, 100+ MW Cairns, performed a review of 824 MW Muskrat Falls for Consumer Advocate of NL.
	O&M Cost	PM for Budana and Soleniama Hydro condition assessment, BC Hydro Aberfeldie Hydro Redevelopment Project and numerous Feasibility Studies and Dam Safety Reviews.
	Project Management	Regular PM on KP Hydropower and Dam projects
	Construction Management	Construction supervision Campo Morado Mine, BC Hydro Aberfeldie Hydro, 235 MW East Toba and Montrose Hydro, 150 MW Kwlasa and Upper Stave Hydro
	Contracting	132 MW John Hart Redevelopment Project, Culliton Creek Hydro Tender Documents, Aberfeldie Hydro Tender Documents and Procurement, Rutherford Creek Hydro Tender Documents and Procurement,
	Quality Assurance	Quality Assurance Engineer 45 MW Kokish Hydro, 150 MW Kwalsa & Upper Stave Hydro, 235 MW East Toba & Montrose

		Hydro.
Boris Fichot (Q1 to Q9 and S1 to S3, S6 to S8)	Hydropower Engineering	12+ Years' Experience, B.Eng Civil, MSc in Water Resources Planning (Civil Eng), P.Eng. (BC), P.E. (AK, TX), worked on numerous facilities from greenfield to construction to operation. Project Identification of 100's of project sites (with Costing Component): country studies, several BC regional studies on ROR and Pumped storage (for BC Hydro). Project and design team coordination of 150 MW Kwasla and Upper Stave Hydro.
	Capital Costs Estimates	Costing and optimization on numerous hydro and wind projects. Prepared bottoms up cost estimates for numerous hydroelectric projects for pre-feasibility, feasibility, engineers estimates and due diligence (i.e. Sabanilla Hydro, Jamie Hydro, Box Canyon Hydro, Iqaluit Hydro, Mount Callon Pumped Storage Hydro, Betmai Hydro), performed a review of 824 MW Muskrat Falls for Consumer Advocate of NL.
	O&M Cost	Regularly prepare O&M costs as part of feasibility assessments or due diligence assessments as above.
	Project Management	Project Coordinator 120 MW Upper Toba Valley, 150 MW Kwlasa and Upper Stave Hydroelectric Projects.
	Construction Management	Design Coordinator, QA and Site Supervision for 150 MW Kwalsa and Upper Stave. Site Supervision for Construction of Kensington Gold Project, Design Coordinator, Prepared Earned Value Reports, Microsoft Project Scheduling.
	Contracting	132 MW John Hart Generating Station. RFP technical submission preparation. Conducted review of Tender Documents (150 MW Kwalsa & Upper Stave Hydro, 235 MW East Toba & Montrose Hydro, Jamie Hydro, Hartley Bay Hydro)
	Resource Planning	4 years with the Planning Group of the Lower Colorado River Authority.
	Wind, Natural Gas, Solar	Wind resource modelling (WASP and Wind Pro), authored 2 wind power feasibility studies (Pebble Wind Project and Roadhouse Wind Project) and a due diligence report (Roadhouse Wind Project), Nalcor resource options review, CanWEA member, Clean Energy BC Member

Michael Pullinger (Q4, Q5)	Renewable Energy Engineering	6+ Years as a Mechanical Engineer in renewable energy and building energy efficiency industries. Master of Science degree in Renewable Energy. Current President of the BC Sustainable Energy Association.
	Wind, Natural Gas, Solar	Wind Solutions for Mining, Atacama Large Scale Solar Array, Chinchillas Project, Lonsdale Quay Office, Cache Creek Landfill Gas Project.
	Capital and O&M Cost Estimates	Cache Creek Landfill Gas Facility, Misery Creek Hydro Project, Phantom Lake Hydro Project, Chinchillas Project, Atacama Large Scale Solar Array, Northwest Pumped Storage Hydro Project, Lonsdale Quay Office.
Additional Knight Piésold Specialists	Senior level review and input was provided by a number of other KP Specialists in the Geotechnical, Mechanical, Electrical and Structural Engineering Fields in support of the four key staff members mentioned above.	

Q1 - Stands for Question 1 of VA103-449-1 Rev 1 - Knight Piésold Expert Review Report
S2 - Stands for Question 2 of VA103-449-2 Rev 0 - Knight Piésold Expert Review Supplemental Report

SAMUEL R. MOTTRAM, P.ENG.

MANAGING PRINCIPAL – POWER SERVICES

SUMMARY

Mr. Sam Mottram has a master's degree in Civil Engineering with more than 20 years of experience in management, design and development of power and water related infrastructure projects around the world. He specializes in project concept development and optimization, including project identification, planning, environmental baseline studies, feasibility studies, contractual arrangements, permitting, impact assessments, risk assessments, design and financial viability. He has direct project involvement on more than 100 hydroelectric and large water infrastructure projects in North, Central and South America, Africa, Europe and SE Asia. His involvement in the mining sector includes water and wastewater management, transmission lines, access roads and power studies.

EDUCATION

- M.Sc.Eng. (Civil Engineering – Hydraulics), University of Natal, South Africa, 1993
- B.Sc. (Civil Engineering), University of Natal, South Africa, 1991

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

- Professional Engineer, British Columbia, Canada (Reg. No. 25642)
- Professional Engineer, South Africa (Reg. No. 960564)
- Professional Engineer, Yukon, Canada
- Professional Engineer, Saskatchewan, Canada (Reg. No. 20525)
- Professional Engineer, Ontario, Canada (Reg. No. 100170193)
- Professional Engineer, Manitoba, Canada (Reg. No 36712)

AFFILIATIONS

- Association of Professional Engineers and Geoscientists of British Columbia
- Association of Professional Engineers of Yukon
- Association of Professional Engineers and Geoscientists of Saskatchewan
- Association of Professional Engineers Ontario
- Association of Professional Engineers & Geoscientists of the Province of Manitoba
- Engineering Council of South Africa – Member
- Canadian Hydropower Association – Member
- Ocean Renewable Energy Group – Member

PROFESSIONAL EXPERIENCE

- **235 MW East Toba and Montrose Hydroelectric Project, BC, Canada** - Project Manager for the project identification, optimization, permitting, detailed design and construction supervision of a 235 MW Project. The project includes 147 MW East Toba (580 head, 30.7 m^3/s design flow) and 88 MW Montrose (467 m head, 22.8 m^3/s design flow) Projects, plus 70 km of access road, 11 major bridge structures and 150 km of a 230 kV transmission line ($650 million in 2010).

- **BC Hydro: Integrated Resource Plan and Options Assessment, BC, Canada** – Specialist input into BC Hydro's Integrated Resource Plan, including identification and options assessment. This included pricing input into resource options such as run of river hydro and pumped storage hydro.

- **247 MW Kalungwishi Hydroelectric Project, Zambia –** Specialist Hydropower Engineer for a 247 MW Hydroelectric Project, including concept development, optimization, preliminary design, specifications and tender documentation. The project includes two hydro projects (151 MW and 96 MW), dams, intake structures, canals, penstocks, powerhouses, 600 km of 330 kV transmission line, access roads, bridges, construction camps, substations and interconnection.

- **BC Hydro Pumped Storage Potential Assessment BC, Canada** – Project Manager for the pumped storage assessment of potential 500 MW to 1,000 MW pumped storage sites in the Lower Mainland and Vancouver Island areas. This included the development of a GIS bases project identification and evaluation tool. More than 200 sites were identified and assessed, including both fresh and salt water sites.

- **Newfoundland Generation Expansion Options, NL, Canada** – Project Manager for specialist independent consultant input into Nalcor's proposed generation expansion options, which include the 824 MW Muskrat Falls Hydroelectric Project and a 1,100 km long 900 MW HVDC transmission line. Knight Piésold Ltd. was hired by the Consumer Advocate of Newfoundland and Labrador to review and comment on the generation expansion alternatives as well as the information presented by Nalcor to the Board. This included the comparison of the Muskrat Falls development (Off-Island hydro solution) to an On-Island generation expansion solution that included wind, small hydro and thermal (500 MW Holyrood upgrades plus 170 MW CCGT).

- **150 MW Kwalsa and Upper Stave Hydroelectric Projects, BC, Canada** - Project Manager for project optimization, detailed design and construction supervision. The project includes six run-of-river developments, interconnecting 138 kV transmission lines, access roads and a 138 kV to 360 kV substation ($500 million in 2007). The six run-of-river projects have the following basic characteristics:
  - Douglas Creek Project – 27 MW, 307 m head, 11 m3/s design flow
  - Fire Creek Project – 23 MW, 300 m head, 9.5 m3/s design flow
  - Lamont Creek – 27 MW, 404 m head, 8.7 m3/s design flow
  - Stokke Creek – 22 MW, 314 m head, 8.4 m3/s design flow
  - Tipella Creek - 18 MW, 295 m head, 7.2 m3/s design flow, and
  - Upper Stave Project – 33 MW, 101 m head, 43.8 m3/s design flow.

- **1,368 MW Ingula (Braamhoek) Pumped Storage Project, South Africa** - Specialist Hydropower Engineer for a 1,368 MW Pumped Storage Project, including project optimization and hydraulics. The project includes a Concrete Faced Rockfill Dam (CFRD) for the upper reservoir, a Roller Compacted Concrete (RCC) for the lower reservoir, tunnels, an underground powerhouse, and 4 x 342 MW pump turbines (450 m head and 370 m^3/s design flow).

- **Iqaluit Hydroelectric Power Projects, (Qulliq Energy Corporation), NU, Canada** - Project Manager for project identification, feasibility studies, hydrology and geotechnical studies, and permitting assistance. Fourteen potential hydroelectric sites assessed for diesel replacement for the town of Iqaluit. Tasks included review of power and energy demand forecasts, costing, scheduling, financial analysis and comparison and recommendations relative to preferred energy mix (i.e. Diesel, Thermal, Hydro, Wind, etc).

- **1,500 MW Spirit of Ireland Saltwater Pumped Storage Project, Ireland** - Specialist Hydropower Engineer for a proposed 1,500 MW Pumped Storage Project, including project optimization, concept development and preliminary design. The project includes Concrete Faced Rockfill Dams (CFRD) for upper reservoirs, intake towers, penstocks and powerhouses, transmission and interconnection, sea water canal, and breakwater protection.

- **1,000 MW Fir Point Pumped Storage Project, BC, Canada** - Specialist Hydropower Engineer for a proposed 1,000 MW Pumped Storage Project, including project identification, optimization and layouts. The proposed project includes a new Roller Compacted Concrete (RCC) for the upper reservoir, existing lower lake, surface mounted penstocks, surge facilities and powerhouse, and 4 x 250 MW pump turbines (720 m head and 170 m3/s design flow).

- **800 MW Mount Callon Pumped Storage Hydro Project, Ireland** - Specialist Hydropower Engineer for a proposed 800 MW Pumped Storage Project, including project optimization, concept development and preliminary design. The project includes Concrete Faced Rockfill Dams (CFRD) for the upper and lower reservoirs, intake towers, penstocks and powerhouses, transmission, and interconnection options.

- **1,100 MW Bute Hydroelectric Project, BC, Canada** - Specialist Hydropower Engineer and Project Manager for a 1,100 MW combined output from 17 run-of-river hydroelectric projects, including project identification, preliminary design, optimization, hydrology and stream gauging. The project includes 17 run-of-river hydroelectric projects, ranging in size from 30 MW to 140 MW, intakes, weirs, penstocks, tunnels, 450 km of a 500 kV and a 230 kV transmission line, access roads, bridges, barge facilities, construction camps, air strips, substations, and interconnection options.

- **16 MW Pallca Hydroelectric Project, Peru** – Owner's Engineer for a proposed 16 MW run-of-river hydroelectric project in the Andean mountains, with an intake elevation above 4,000 m.a.s.l. Scope of work included project optimization, preliminary design, design basis report and tender documents, engineer's cost estimate, and interconnection options.

- **20 MW Carhuac Hydroelectric Project, Peru** – Owner's Engineer for a proposed 20 MW run-of-river hydroelectric project in the Andean mountains. Scope of work included project optimization, preliminary design, design basis report and tender documents, engineer's cost estimate, and interconnection options.

- **400 MW Aguila Hydroelectric Project, Peru** – Project Optimization and Preliminary Engineering for a proposed 400 MW hydroelectric project in the Andean mountains with a 9.5 m diameter tunnel that is 8,700 m long, underground powerhouse, 42 m high concrete gravity dam, gated spillways, desanding basins, and an underground powerhouse. Assisted Sinohydro with their preparations for a complete EPC (Design Build) bid for this $700 million (2011) project.

- **140 MW Upper Toba Hydroelectric Project, BC, Canada** - Specialist Hydropower Engineer and Project Manager for a 140 MW combined output from three run-of-river hydroelectric projects, including project identification, preliminary design, optimization, hydrology and stream gauging. The project included three run-of-river hydroelectric projects, ranging in size from 30 MW to 60 MW, intakes, weirs, penstocks, a 230 kV transmission line, access roads, bridges, barge facilities, construction camps, substations, and interconnection options.

- **30 MW Baffinland Iron Mines Hydropower and Windpower Assessments, Canadian Arctic, NU, Canada -** Project Manager for the project identification of a 30 MW Separation Lake Hydro scheme and a 30 MW Mary River wind farm, which involved feasibility studies, geotechnical investigations, wind monitoring towers, and stream gauges.

- **15 MW Box Canyon Hydroelectric Project, BC, Canada** – Project Manager for the detailed design and construction supervision of a 16 MW run-of-river hydroelectric project. The project includes three main intakes and seven tributary intakes, with interconnection pipelines and penstocks to a surface powerhouse with Pelton turbine and generator sets.

- **30 MW Sabanilla Hydroelectric Project, Ecuador** - Project Manager for the project optimization, hydraulic model studies, design and tender documentation. This 30 MW run-of-river project was originally designed to supply power to a copper mine under development. The project is now being developed by an independent power producer that will sell energy directly into the national grid under a 15 year power purchase agreement.

- **30 MW Pusuno Hydroelectric Project, Ecuador** - Project Manager for the hydraulic transient analysis studies for the proposed 30 MW Pusuno Hydroelectric Project.

- **500 MW Alto Cachapoal Hydroelectric Projects, Chile** - Project Manager for the project optimization, preliminary design and detailed feasibility studies for a cascade of run-of-river hydroelectric project with a total installed capacity of about 500 MW.

- **90 MW Chacayes Hydroelectric Projects, Chile** - Project Manager for the project optimization, preliminary design and costing for the 90 MW Chacayes Hydroelectric Project. The project includes a run of river intake, gated concrete diversion weir, daily off channel storage, canal, tunnel, penstock and powerhouse.

- **18 MW Nzoro River Hydroelectric Project, DRC** - Project Manager for the project identification, preliminary design and feasibility studies for an 18 MW run-of-river development on the Nzoro River to supply power to the Moto Gold mine.

- **9 MW McNair Creek Hydroelectric Project, BC, Canada** - Project Manager for the detailed design and construction supervision of a 9 MW run-of-river hydroelectric project on McNair Creek that included concrete weir, intake structure, high-pressure penstock (340 m head, 3.6 m3/s design flow), powerhouse, Pelton turbines, transmission and interconnection ($12 million in 2004).

- **7 MW Las Truchas Hydroelectric Project, Mexico** - Project Manager for project optimization, preliminary design and detailed feasibility studies for a 7 MW storage project, which included a Roller Compacted Concrete (RCC) dam tunnel and high pressure surface mounted penstock.

- **Due Diligence Reviews of Hydroelectric Projects, BC, Canada**
  - Independent Engineer's Role, Canada
    - 4 MW Mears Hydroelectric Project
    - 4 MW South Sutton Hydroelectric Project
    - 4 MW Marion HEP and other confidential IPP Projects in British Columbia, and
    - 7 MW Fitzsimmons Creek Hydroelectric Project.

- **30 MW Sabanilla Hydroelectric Project, Ecuador** - Independent Engineer's Role, including project optimization of a 30 MW hydroelectric facility, intake design and physical modelling of a 3 m high inflatable rubber weir and vortex desander, transmission line, and interconnection.

- **30 MW Douglas Creek Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for the preliminary design of a 30.1 MW run-of-river hydroelectric project on Douglas Creek that included a rubber weir, intake

structure, low-pressure conduit, tunnel, high-pressure penstock (408 m head, 9.3 m3/s design flow), powerhouse, Pelton turbines, transmission and interconnection.

- **20 MW Fire Creek Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for the preliminary design of the 20.5 MW run-of-river hydroelectric project on Fire Creek that included rubber weir, intake structure, low-pressure conduit, high-pressure penstock (304 m head, 8.5 m3/s design flow), powerhouse, Pelton turbines, transmission and interconnection.

- **60 MW Ulindi II Hydroelectric Project, DRC** – Project identification, optimization and feasibility assessment and design of a 60 MW hydroelectric facility that will project 95% of the power requirements for Banro's mining operations in the DRC. This project will result in significant cost savings to Banro in terms of energy costs when compared to onsite diesel generation.

- **28 MW Big Silver Creek Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for the preliminary design of a 28.1 MW run-of-river hydroelectric project on Big Silver Creek that included a rubber weir, intake structure, 4 m dia. TBM tunnel (115 m head, 31 m3/s design flow), powerhouse, Francis turbines, Howel-Bunger valves, transmission, and interconnection.

- **24 MW Stokke Creek Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for the preliminary design of a 24 MW run-of-river hydroelectric project on Stokke Creek that included a rubber weir, intake structure, Tyrolean weirs, low-pressure conduit, high-pressure penstock (620 m head, 4.9 m3/s design flow), powerhouse, Pelton turbines, transmission, and interconnection.

- **32 MW Ure Creek Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for the preliminary design of a 32.4 MW run-of-river hydroelectric project on Ure Creek. Project Manager for the preparation of an Environmental Socio-economic Report (ESR).

- **Rutherford Whitewater Kayaking Facility, BC, Canada** - Project Manager and Design Engineer for the preliminary design of a whitewater kayaking channel directly downstream of the Rutherford Creek Hydroelectric Project.

- **3 MW Big Qualicum River Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for the desktop assessment of a potential for the Department of Fisheries and Oceans (DFO) to develop a hydropower generating facility within their present fisheries enhancement facilities on the Big Qualicum River (1 MW to 3.6 MW with head varying from 20 m to 60 m).

- **5.5 MW Saskatoon Weir Hydro and Whitewater Park Development, SK, Canada** – Project Manager and Hydro Specialist for the concept development and feasibility studies of a 5.5 MW run-of-river hydroelectric facility with a 2.5 m head and 240 m^3/s design flow, incorporating Pit or Bulb type turbines and an adjacent Whitewater Park and Kayaking Channel.

- **Green Energy Projects, BC, Canada** - Project Manager and Design Engineer for pre-feasibility level studies of 12 run-of-river hydroelectric projects in the Lillooet River Valley and Gold Bridge areas. The projects ranged in size from 10 MW to 50 MW.

- **10 MW Mayo B Hydroelectric Project, YT, Canada** – Project Manager for the penstock detailed design and construction supervision, including dealing with frozen ground, permafrost and innovative soil restrained penstock design, thus eliminating the requirement for expensive concrete anchor blocks.

- **Windpower Prospects, BC, Canada** - Preliminary wind resource assessments of potential wind power sites throughout BC, Canada.

- **33 MW Miller Creek Hydroelectric Project, BC, Canada** - Design Engineer for a 33 MW ($35 million in 2001) 760 m head run-of-river hydroelectric project. Proposal, preliminary and tender design, investigations, specifications, costing, reporting, detailed design and construction supervision.

- **50 MW Mamquam Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for the detailed design and construction supervision of spillway refurbishment and powerhouse cooling water intake ducts.

- **50 MW Rutherford Creek Hydroelectric Project, BC, Canada** - Design Engineer for a 50 MW ($70 million in 2002) run-of-river hydroelectric project, including preliminary and tender design, investigations, costing and reporting. This project includes a 3m high inflatable rubber dam, run of river intake, vortex desander, 9,000 m long penstock, surface powerhouse and a man-made white water kayaking facility integrated into the powerhouse tailrace outlet structure.

- **2.5 MW Tom Mackay Creek Hydroelectric Project, BC, Canada** - Project Manager and Design Engineer for a proposed 2.5 MW ($9 million in 1999) hydroelectric project, including preliminary design, hydrology and energy generation modelling, costing, financial analysis and reporting.

- **6 MW Moresby Lake Hydroelectric Project, BC, Canada** - Design Engineer for the proposed upgrading of a 6 MW Moresby Lake Hydroelectric Project located at the Queen Charlotte Islands, including hydrology and energy generation modelling, operation and flood routing simulations, and financial analysis.

- **Cuisson Creek Hydrology Model, BC, Canada** - Project Manager for a watershed modelling of Cuisson Creek.

- **Land Application Disposal (LAD) System, Montana, USA** - Design Manager and Design Engineer for the Land Application Disposal System of wastewater disposal alternatives for the East Boulder Mine. Included alternatives for snow making, atomizing sprays/evaporators and centre pivot irrigation systems.

- **12 MW Bougouriba Hydroelectric Project, Burkina Faso** - Design Manager and Design Engineer for a proposed 12 MW (US$ 105 million in 1997) Bougouriba Hydroelectric Project. The proposed project included two 6 MW Francis units in a surface powerhouse, 2600 m long 30 m high earth embankment dam, gated and free overspill spillway, infrastructure, housing, access roads, M&E, substations, and 420 km of 225 kV transmission lines.

- **6 MW Sotuba II Hydroelectric Project, Mali** - Project Manager and Design Engineer for a 6 MW (US$ 30 million in 1998) Sotuba II Hydroelectric Project, which included a 6 MW powerhouse, 3000 m long 75 m wide earth lined canal with 240 m3/s capacity, restoration of a 2500 m long barrage on Niger River, intake weir, screens, water hyacinth diversions, and M&E.

- **10 MW Mubuku 3 Hydroelectric Project, Uganda** - Design Engineer for a 10 MW run-of-river Mubuku 3 Hydroelectric Project (US$ 25 million in 1996) that included a 10 MW powerhouse, 3,000 m steel penstock, 5,000 m long trapezoidal concrete lined canal, reject weirs, siphon pipes, desilting works, Tyrolean intake weir, substations, powerlines, and infrastructure.

- **40 MW Rio General Hydro Project, Costa Rica** – Due diligence review of an existing 40.5 MW hydroelectric facility that incorporates a run of river intake and diversion weir, desanding facility, canal, inverted siphon pipeline, off-channel

daily peaking storage facility, high pressure steel penstock, surface powerhouse with two vertical axis Francis turbines, tailrace and 230 kV substation and transmission line.

- **45 MW Kokish River Hydroelectric Project, Canada** – Project manager for the detailed design and construction supervision of a 45 MW hydroelectric project that included the World's largest Coanda Screen intake, diversion weir, fish ladder for salmon and Steelhead migration passed the intake, 9,300m long 3 m diameter penstock, surface powerhouse, four vertical axis 6-jet Pelton turbines, 138 kV substation and transmission lines.

- **24 MW Betmai Hydroelectric Project, Sierra Leone** – Project manager for the proposed 24 MW hydroelectric facility that will provide power to Cluff Gold's mining operations in Sierra Leone. Project identification, optimization and feasibility design and assessment. The project will result in significant energy cost savings for the mine site when compared to on site diesel.

- **6 MW Cache Creek Landfill Gas Power Project** – Project Principal for the 6 MW Landfill Gas Project for Wastech, where the biogas collected from Metro Vancouver Cache Creek Landfill Site is collected and used to generate power. Services includes civil, mechanical and electrical engineering, equipment tendering and evaluation and transmission and interconnection to the BC Hydro grid.

- **1.8 MW Capilano Energy Recovery System, Canada** – Project Principal for the 1.8 MW Hydroelectric facility that was built to recover energy from Metro Vancouver's bulk water supply system.

- **Midmar Water Treatment Works, South Africa** - Assistant Resident Engineer for a 250 Ml/d Midmar Water Treatment Works (US$10 million in 1995), which included super pulsator clarifiers, rapid gravity V-filters, chemical dosing buildings, clearwells, chlorination and ammoniation tanks and buildings, roads, and administration buildings.

- **Masilo Sewerage Treatment Works, South Africa** - Design Engineer for the 3.5 Ml/d Masilo Sewerage Treatment Works (US$ 3 million in 1994) that included incoming sewer, Pista grit removal traps, recycling pump station, buildings, biological reactors, settling tanks, chlorination building and contact tank, outlet works, and sludge drying beds.

- **Other Design Experience, Theunissen Pipeline**, **South Africa** – Theoretical analysis of problem pipeline, site investigations, pressure tappings, survey, analysis, and reporting.
  - Novo Water Transfer Scheme – Hydrological modelling, preliminary design of river off-take, pump station, rising main, gravity pipelines, canals and reporting, and
  - Farm storage dams including rockfill, concrete gravity and earth embankments.

WORK HISTORY

- Knight Piésold Ltd. (Vancouver, Canada), Managing Principal – Power Services, 2012 - Present
- Knight Piésold Ltd. (Vancouver, Canada), Specialist Engineer, 2001 - 2012
- Knight Piésold Ltd. (Vancouver, Canada), Project Engineer, 1999 - 2001
- Ninham Shand Consulting Engineers, (Johannesburg, South Africa) Senior Engineer, 1996 - 1999
- Ninham Shand Consulting Engineers, (Johannesburg, South Africa) Engineer, 1994 - 1996
- University of Natal, (South Africa) Research Thesis, 1992 - 1993

PUBLICATIONS AND PRESENTATIONS

Mottram, Samuel R, “Energy Dissipation and Aeration on Stepped Spillways” (1993) - M.Sc Eng Thesis, University of Natal, South Africa, December 1993.

Mottram, Samuel R, Pegram, GGS, Officer, AK, “Hydraulics of Skimming Flow on Modelled Stepped Spillways” (1999) - American Society of Civil Engineers, ASCE, Hydraulics Publication, May 1999.

Mottram, Samuel R.; Haile, Jeremy P.; Cathcart, Jaime C. “Technical and Design Innovations in run of River Projects” (2009) – International Water Power and Dam Construction. March 2009.

Mottram, Samuel R.; Hughes, Brian; Sims, Nancy: “Run-of-River Hydroelectric Projects – Intake Design Considerations Based on Physical Hydraulic Model Study Results” (2009).

Mottram, Samuel R.; Haile, Jeremy P.: Small Hydro – Challenges and Latest Innovations (2010).

Mottram, Samuel R. “Overview of the Ingula Pumped Storage Project”. Clean Energy BC Conference 2010.

Mottram, Samuel R. “Intake and Desander Designs – Cost Effective Solutions for Small Hydro”. Small Hydro International Conference 2011.

Mottram, Samuel R. “Overview of the 1368 MW Ingula Pumped Storage Hydroelectric Project in South Africa and a proposed 1,500 MW Saltwater Pumped Storage Project in Ireland”. Hydrovision 2011.

Mottram, S.R. and Scherman, E.J. “The Design of 8 Run-of-River Hydroelectric Projects Constructed and Commissioned in British Columbia over the Last Three Years”. Canadian Dam Association Conference 2011.

Mottram, Samuel R. and Brodie, Chris. “South Saskatchewan River Weir - Hydropower and Whitewater Park Development”. Canadian Dam Association Conference 2012.

Mottram, S.R. and Scherman, E.J. “Design Innovations and Lessons Learnt from the Design of 8 Run-of-River Hydroelectric Projects recently Constructed and Commissioned in British Columbia”. Hydrovision 2012.

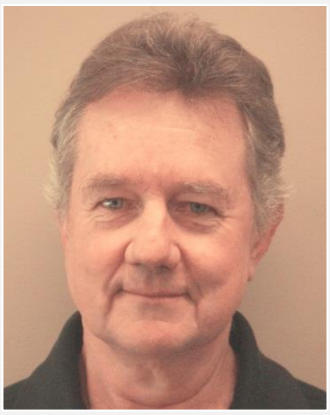
Mottram, Sam and Smyth, Greg. “Renewable Energy Solutions for Mining Projects around the World”. Clean Energy BC Annual Conference 2012.

Mottram, Sam “Hydropower for Remote Mining Projects around the World”. Hydrovision International Conference, Denver, 2013.

Mottram, Sam. “Wonderful and Wacky Energy Storage Concepts” Clean Energy BC Annual Conference 2013.

MIKE J. ROBERTSON, P. ENG.

SPECIALIST ENGINEER & PROJECT MANAGER



SUMMARY

Mr. Mike Robertson is a Civil Engineer with over 40 years of professional experience, primarily in the water resources, hydroelectric power and mining sectors. He has been extensively involved in all aspects of dams and bulk water supply schemes for urban and irrigation use. He also has extensive experience in dam safety inspections and evaluations, water resources planning and feasibility studies, run-of-river and pumped storage hydroelectric schemes, mining developments and projects for upgrading urban infrastructure. His career has included time spent with consultants in London, UK; with the Ministry of Water Development in Zimbabwe (including a year with the US Bureau of Reclamation Dams Branch in Denver, Colorado, USA); with consultants in South Africa; and with consultants in Vancouver, Canada. He has worked on projects in the United Kingdom, United States of America, Canada, Mexico, Chile, Suriname, Zimbabwe, South Africa, Tanzania, Madagascar, Ethiopia, Kenya, the Democratic Republic of the Congo, Liberia, Egypt and Iraq.

EDUCATION

- B.Sc., Civil Engineering (Honours), University of Bristol, UK, 1970

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

- Professional Engineer, British Columbia, Canada, #23784
- Former professional registration in UK, South Africa and Zimbabwe
- Approved Professional Engineer for Dam Safety Inspections, South Africa
- Approved Engineer for Dams and Large Dams, Zimbabwe

AFFILIATIONS

- Canadian Dam Association, Member
- Institution of Civil Engineers, UK; South African Institution of Civil Engineers and Zimbabwe/Rhodesian Institution of Engineers – Past Member

TRAINING (SHORT COURSES, WORKSHOPS, SEMINARS AND SYMPOSIA)

- Run-of-River Hydro, Independent Power Producers of BC Short Course (Presenter), 2009
- Conferences and Seminars – Waterpower/Hydrovision (including Paper Presenter, Session Moderator and Technical Papers Committee/Session Chair), Clean Energy BC (Independent Power Producers of BC), Association of Power Producers Ontario, Canadian Dam Association
- Cold Regions Engineering Short Course, 2006
- Swiftwater, Avalanche and Confined Space Training
- Construction Management Programme, University of Stellenbosch, South Africa, 1993
- Certificate in Management Practice, Rhodes University, South Africa, 1989
- One year Work/Study Programme on Design of Dams with the United States Bureau of Reclamation, Denver, Colorado, USA, 1980

PROFESSIONAL EXPERIENCE

Arrow Lakes Generating Station Dam Safety Review, BC, Canada - Designated Dam Safety Review Engineer for periodic dam safety review of CFRD embankment 185 MW hydropower dam and associated structures. For Columbia Power Corporation.

Keeyask and Conawapa Hydroelectric Projects, Manitoba, Canada – Project Manager for review of Manitoba Hydro proposals for the design and construction of the 695 MW Keeyask and 1,485 MW Conawapa Dams. For Manitoba Public Utilities Board.

Pocaterra and Interlakes Dam Safety Review, Alberta, Canada - Designated Dam Safety Review Engineer for periodic dam safety review of two earth/rock embankment hydropower dams – Pocaterra and Interlakes Dams. For TransAlta Generation Partnership.

Kootenay River Dam Safety Reviews, BC, Canada – Designated Dam Safety Review Engineer for periodic dam safety review of four concrete hydropower dams in cascade on Kootenay River - Corra Linn, Upper and Lower Bonnington and South Slocan Dams. For FortisBC Inc.

Corra Linn Dam Breach Inundation Study, BC, Canada – Project Manager for study into consequences of cascade failure of five dams on the Kootenay River, BC should Corra Linn Dam fail. For FortisBC Inc.

John Hart Hydroelectric Project, BC, Canada - Project Manager for design elements of bid proposal for 130 MW replacement of power generating facility at existing BC Hydro Dam. For Graham Construction (part of P3 format bid).

Lower Mamquam and Moresby Lake Hydroelectric Projects, BC, Canada - Designated Dam Safety Review Engineer for periodic Dam Safety Reviews of intake structures. For Atlantic Power Preferred Equity Ltd.

Rosebel Hydropower Study, Suriname - Project Manager for desk top assessment of feasibility of using hydroelectric power for development of proposed Rosebel Mine (~25-60 MW). For IAMGOLD Corporation.

New Liberty Hydropower Study, Liberia - Project Manager for study into feasibility of using hydroelectric power of various rivers for development of proposed New Liberty Mine (~6 MW). For Aureus Mining Inc.

Kokish River Hydroelectric Project, BC, Canada - Responsible for monitoring overall Quality Assurance for design, and construction supervision under EPC Contract. For Peter Kiewit Sons Co.

Culliton Hydroelectric Project, BC, Canada – Project Manager for detail design, contract procurement and construction of 16 MW run-of-river hydroelectric project. For Culliton Creek Power LP (division of Veresen Inc.).

Tretheway Creek Hydroelectric Project, BC, Canada - Project Manager for preliminary design of 15 MW run-of-river hydroelectric project. For Innergex Renewable Energy.

Dasque and Middle Cluster Hydroelectric Projects, BC, Canada – Owners Review Engineer for detail design and construction of 12 MW Dasque and 8 MW Middle run-of-river hydroelectric projects. For Swift Power LP (now Veresen Inc.)

Newfoundland Two Generation Alternatives Project, NL, Canada – Part of team reviewing plans to provide future power to Newfoundland from either the proposed Muskrat Falls Hydroelectric Project in Labrador or from a combination of On-Island alternatives. For the Consumer Advocate for Newfoundland and Labrador, Canada.

Fitzsimmons Hydroelectric Project, BC, Canada – Project Manager for investigation of cause of poor performance of Coanda effect intake screens. For contractor Ledcor CMI.

Upper Lillooet Hydroelectric Project, BC, Canada – Project Manager for cluster of three run-of-river hydroelectric facilities bid into BC Hydro 2008 Call for Power – Upper Lillooet, Boulder and North, combined 120 MW capacity. For Creek Power Inc (Innergex Renewable Energy). Subsequently joined Walsh Group team for EPC bid.

Pocaterra Penstock Replacement Project, AB, Canada – Project Manager for the replacement of the 55 year old 11 ft diameter woodstave penstock at the Pocaterra Generating Station, including assessment of alternative material types, alignments and buried vs. surface condition, and contract procurement and construction supervision. For TransAlta Generation Partnership.

Budana and Soleniama Hydroelectric Projects, DRC – Project Manager for condition assessment and studies into the feasibility of using hydroelectric power from the old existing and largely non-functional Budana and Soleniama Hydroelectric Projects on the Shari River for the reopening of the old Mongbwalu Mine (~12 MW). For AngloGold Ashanti, South Africa.

Upper Pelly Hydroelectric Project, YT, Canada – Project Manager for studies into the feasibility of using hydroelectric power from the Pelly River for the development of the proposed Selwyn Zinc Mine (~20 MW). For Selwyn Resources.

Various Potential Run-of-River Hydroelectric Projects, BC, Canada – Project Manager for studies of various proposed run-of-river hydroelectric projects, including Log, Kookipi, Rainy, Bear, Kwoiek, American, Emory, Ruby, Garnet. Technical assistance with others, including Kinskuch, Beaver. For various clients.

Cairns Hydroelectric Projects, BC, Canada – Project Manager responsible for (pre)feasibility studies into seven run-of-river hydroelectric projects submitted in response to BC Hydro Call for Clean Power 2008 (range 10 to 35 MW). For Cloudworks Energy / Peter Kiewit Sons Co.

Bute Inlet Hydroelectric Projects, BC, Canada – Responsible for concept design reviews of components of 17 run-of-river hydroelectric projects submitted in response to BC Hydro Call for Clean Power 2008 (range 20 to 115 MW). For Plutonic Power Corporation / Peter Kiewit Sons Co.

East Toba Montrose & Kwalsa Upper Stave Hydroelectric Projects, BC, Canada – Responsible for monitoring overall Quality Assurance for design, procurement and construction aspects of eight hydroelectric run-of-river projects presently under construction or recently completed under EPC Contracts. For Peter Kiewit Sons Co.

Campo Morado G9 Development, Mexico – Overall Project Manager for ongoing development of 1,500 to 2,000 tpd poly-metallic mine (mainly Zn, Cu, Pb), including design engineering and construction supervision by various Canadian and US consultants. For Farallon Resources Ltd., Canada.

Twangiza-Namoya Mine, DRC – Project Manager for studies into the feasibility of using hydroelectric power for the proposed development of several adjacent gold mines (26.5 MW for 5 Mt/a process plant). For Banro Corporation, Canada.

Nzoro Hydroelectric Project, DRC – Project Manager for studies into the feasibility of using hydroelectric power from the Nzoro River for the development of the proposed Moto Gold Mine (20 MW for 4.5 Mt/a process plant). For Lycopodium / Moto Gold Mines, Australia.

Box Canyon and Marty Creek Hydroelectric Project, BC, Canada – Project Manager for feasibility studies of proposed run-of-river hydroelectric project, including assistance with preparation of submissions in response to BC Hydro Call for Clean Power 2008. For Sound / Elemental Energy.

Aberfeldie Redevelopment Project, BC, Canada – Project Manager for the optimization, detailed design and construction supervision of the redevelopment to 24 MW of the 1922 existing 5 MW facility, including alteration to the intakes from the Aberfeldie Dam and replacement of all other run-of-river components. For BC Hydro.

Alto Cachapoal Hydroelectric Projects, Chile – Optimization of the development potential of the whole catchment, involving three or four separate projects with a combined capacity in the order of 600 MW. For Pacific Hydro Chile S.A.

Rutherford Creek Hydroelectric Project, BC, Canada – Project Manager for all stages of 50 MW run-of-river hydropower development from feasibility and environmental studies, through preliminary design and tendering and EPC contract negotiations to final design and construction supervision. For Rutherford Creek Power Ltd. / Peter Kiewit Sons Co.

Rosia Montana Gold Project, Romania – Project Manager for geotechnical aspects of feasibility study including tailings disposal facility, open pit slopes, waste dumps and plant site for 20 Mt/a mine. For Gabriel Resources.

Geita Gold Project, Tanzania – Resident Engineer for geotechnical aspects of construction, including tailings disposal facility, water storage / diversion dam and river diversion channel for 6 Mt/a mine. For Ashanti Goldfields / Anglo-American Corporation.

Dam Safety Program, BC, Canada – Manager of a 4-year Dam Safety Strategic Alliance for various Deficiency Investigations (principally 80 m high, 675 Mva Seven Mile Hydroelectric Dam), Comprehensive Inspections and Reviews (Dam Safety Reviews), OMS Manuals and assistance with investigation of sinkholes at 183 m high Bennett Dam. For and with BC Hydro.

Ambatovy Nickel Mine, Madagascar – Responsible for initial appreciation on site of power and water requirements and availability, for feasibility study. For Phelps Dodge / H. A. Simons.

Seven Sisters Dam and Generating Station, MB, Canada – Overall reviewer for Dam Safety Review of 20 m high concrete gravity dam and 150 MW powerstation. For Manitoba Hydro.

St. Lawrence and Madawaska River Dams, ON, Canada – Lead Senior Engineer for risk assessment component of Dam Safety Reviews of 9 dams (FMEA). For Ontario Hydro.

Hogsback Pumped Storage Scheme, South Africa – Project Manager for a reconnaissance study for 1000 MW scheme including 45 m high embankment and rollcrete dams. For South African Government (Ciskei).

Lower Fish River Irrigation Scheme, South Africa – Project Manager for a bulk water supply to 1,500 ha scheme. For South African Government (Ciskei).

Ciskei Dam Safety Programme, South Africa – Project Manager for an establishment and execution of programme including identification, classification, inspection, evaluation and reporting of all dams in Ciskei with identified safety risk. 12 large dams, 20 medium and 21 small. Production and supervision of number of remedial works contracts. For South African Government (Ciskei).

Inanda Dam, Natal, South Africa – Produced a Dam Safety Inspection Report on 65 m high composite gravity concrete / earth fill dam with an 11,700 m^3/s Safety Evaluation Flood. For and with Department of Water Affairs Dam Safety Inspectorate, South Africa.

Dimbaza Upgrade Project and Urban Management Programme, South Africa – Project Manager for a number of projects to upgrade urban infrastructure and develop new residential areas, and project leader and technical member of consortium to train and empower local government. For South African Government (Ciskei) and Development Bank of Southern Africa.

Luvuvhu River Dam Feasibility Study, Queenstown Regional Water Supply Feasibility Study and Amatole Water Resource System Analysis, South Africa – Project Manager on behalf of own company in separate consortia of consultants. For South African Government.

Gibb Africa Water Division, Africa – After incorporation of local consultancy HKS into international Law Gibb Group, responsible for technical leadership, including technical audits of offices in Kenya, Ethiopia and Uganda and close liaison with Gibb UK. Involved in preparation of submissions for components of Lesotho Highlands Project, for Maguga Dam, Swaziland and projects elsewhere in Africa. (For HKS LAW GIBB).

Sandile Pipeline and Other Works, South Africa – Resident Engineer for various pipelines and reservoir construction contracts, including 7 km, 0.5 to 1.0 m diameter Sandile Pipeline. For South African Government (Ciskei).

Independent Consultant, Zimbabwe – Planning, design and construction supervision of dams and irrigation bulk water supplies. For various private clients.

Major Dams And Bulk Water Supply Works, Ministry Of Water Development, Zimbabwe – Chief Design Engineer Designs Branch, Head Office responsible for the design and construction supervision of various projects including **Raising of Chiredzi Canal** (to 7.6 m3/s capacity), **Kamativi Dam** (30 m high doubled curved arch, including ADSAS design at USBR), **Raising of Sebakwe Dam** (concrete buttress, from 39 m to 45 m high), **Smallbridge Dam** (32 m high embankment). Period included one-year work/study programme with USBR Engineering and Research Centre Dams Branch, Denver, Colorado, USA, learning hands-on and performing productive work on secondment from Ministry. Included detail embankment design for 30 m high earthfill **Lone Tree Dam, USA**; spillway aeration for 216 m high concrete gravity arch **Glen Canyon Dam, USA**; outlet works for 48 m high earthfill **McGee Creek Dam, USA**; stress analysis of 61 m high concrete arch **Gibson Dam, USA**; and uplift and seepage studies for concrete **Esna Barrage, Egypt**. Period also included separate two week USBR **International Seminar on Management of Large Water Systems for Irrigation** at Denver, Colorado and Fresno, California, USA. For Zimbabwe Government / USBR.

Major Dams And Bulk Water Supply Works, Ministry Of Water Development, Zimbabwe – Design Engineer to Deputy Chief Design Engineer Designs Branch, Head Office feasibility studies, preliminary and detail designs and construction supervision of various major dams and bulk irrigation water supply works throughout Zimbabwe. Included 45,000 ha **Chisumbanje Irrigation Scheme**, 27 m high **Amapongokwe Dam**, 1,500 ha **Middle Sabi Irrigation Scheme**, 90 m high **Condo Dam**, and various dams for City of Mutare. Detailed design for and two years as Assistant

Resident Engineer on **Siya Dam** (56 m high embankment), primarily responsible for concrete works (300 m^3/s tunneled drop inlet spillway and outlet works). Resident Engineer for final six months. For Zimbabwe Government.

Sir M. Macdonald And Partners, London, UK – Detail design for **East Gharraf**, **Badra** and **Mandali Irrigation Schemes**, Iraq and **Clachnaharry Sewage Scheme**, Inverness. Assistance with feasibility report **Paphos Irrigation Scheme**, Cyprus. For various clients.

WORK HISTORY

- Knight Piésold Ltd., (Vancouver, BC) Canada, Resident Engineer then Specialist Engineer / Senior Project Manager, 1999 - present
- Klohn-Crippen Consultants Ltd., (Vancouver, BC) Canada, Senior Project Manager, 1996 - 1999
- Hill Kaplan Scott Law Gibb (Pty) Ltd., South Africa, Senior Engineer to Director, 1986 - 1996
- Hill Kaplan Scott, Inc., South Africa, Resident Engineer, 1985 - 1986
- Independent Consultant, Zimbabwe, 1984
- Ministry of Water Development, Zimbabwe, Chief Design Engineer, 1980 - 1983
- Ministry of Water Development, Zimbabwe, Design and Assistant Resident Engineer, 1973 - 1979
- Sir M. MacDonald and Partners, London, Design Engineer, 1971 - 1972

PUBLICATIONS AND PRESENTATIONS

M. Robertson, “Eight River Crossings on 6.8 km long Sandile Dam Pipeline”, 1988, SA Construction World, South Africa.

M. Robertson and R. Witthuhn, “Community Involvement in Housing Development: Lessons from Dimbaza”, 1993, 21st IAHS World Housing Congress, Cape Town, South Africa.

M. Robertson, “The Ciskei Dam Safety Programme: A Pragmatic Approach to Dam Safety Assessments and Improvements”, 1994, International Commission on Large Dams, 18th Congress, Durban, South Africa.

M. McCann and M. Robertson, “Estimating Loss of Life Due to Dam Failure: Pitfalls, Fallacies and Recommendations”, 1999, Annual Conference of (US) Association of Dam Safety Officials, St. Louis, Missouri, USA.

N. Reid, C. Marti, B. Hughes and M. Robertson, “Rutherford Creek Hydroelectric Project: Sediment Exclusion at Main Intake”, 2003, 16th Canadian Society of Civil Engineers Hydrotechnical Conference, Burlington, Ontario, Canada.

M. Robertson, “The Use of Weholite Large Diameter HDPE Pipe for the Low Pressure Conduit of the Rutherford Creek Hydroelectric Project”, 2004, Large Diameter Polyethylene (KWH) Pipe Symposium, 2004, Toronto, Ontario, Canada.

M. Robertson, P. Wearmouth and R. Blanchet, “Rutherford Creek Hydroelectric Project – An Example of the Synergy That Can Be Obtained When Owner, Engineer And Contractor Work Together Using An EPC Contract Format”, 2005, Waterpower XIV Conference, Austin, Texas, USA.

M. Robertson, “The Use of Weholite Plastic Pipe for Low Pressure Conduits in Hydroelectric Schemes”, 2005, Plastic Pipe Institute Seminar, 2005, Vancouver, BC, Canada.

M. Robertson, “Aberfeldie Redevelopment Project”, International Water Power and Dam Construction Small Hydro Conference, April 2009, Vancouver, Canada.

M. Robertson, “Redeveloping Aberfeldie”, International Water Power and Dam Construction, July 2009.

M. Robertson and G. McDonnell, “Run-of-River Hydro”, Independent Power Producers of British Columbia Short Course, November 2009, Vancouver, Canada.

M. Robertson and N. Atkins, “Design of Intakes, Waterways and Powerhouses”, Contributing Lecturer to British Columbia Institute of Technology Course on Run-of-River Hydro Power, May 2010, Vancouver, Canada.

M. Robertson, “Design of Waterways and Powerhouses”, Contributing Lecturer to British Columbia Institute of Technology Course on Run-of-River Hydro Power, April 2011, Vancouver, Canada.

M. Robertson, R. Drury and E. Scherman, “The Pocaterra Penstock Replacement Project: Replacement of an Aging Surface Woodstave Penstock with a new Buried Steel Penstock”, HydroVision Conference, 2013, Denver, Colorado, USA

BORIS FICHOT, P.ENG., P.E.

SENIOR ENGINEER

SUMMARY

Mr. Boris Fichot holds a bachelor's and a master's degree in Civil Engineering with a specialization in water resources planning and management. He has been involved in the successful identification, staking, permitting, bidding, and detailed design and construction of a number of run-of-river hydroelectric projects. He is involved in wind resource screening assessments, hydropower due diligence studies, and mine water management. Before moving to Canada, he worked as a water resources planner for the Lower Colorado River Authority in Texas, where he was involved in water resources modelling, risk analysis, systems operations, system optimization, water management policy and public process.

EDUCATION

- Graduate Studies in Civil Engineering, University of British Columbia, Canada, 2000
- M.Sc. Water Resources Planning and Management - Civil Engineering, Colorado State University, USA, 1999
- B.Eng. Civil Engineering and Applied Mechanics, McGill University, Canada, 1998

REGISTRATION/CERTIFICATIONS

- Professional Engineer, British Columbia, Canada (APEGBC#30575)
- Professional Civil Engineer, Alaska, USA (Inactive, CE#12405)
- Professional Engineer, Texas, USA (Inactive, TBPE#93528)

AFFILIATIONS

- Clean Energy BC, Member through Dragonfly Hydropower Corporation
- Kitimat Chamber of Commerce, Member through Dragonfly Hydropower Corporation
- Canadian Wind Energy Association (CANWEA), Corporate Member through Knight Piésold Ltd.
- American Society of Civil Engineers (ASCE), Member
- Environmental & Water Resources Institute of ASCE (EWRI), Member

TRAINING

- Run-of-River Hydropower, BCIT, Instructor, 2010 through 2013
- Knight Piésold Renewable Energy Seminar, Presenter, 2008, 2011
- Optimization of Hydropower Operations Workshop Waterpower XVI, July 2009
- Microsoft Project 2003 by On-Track Computer Training), March 2008
- WindPRO Training Course by EAPC), June 2007
- Cold Regions Engineering Course by the University of Washington, November 2006
- Emergency First Aid – Industry (#1-15PMVQ) by St. John Ambulance, August 2009
- Leadership Training Course by LCRA, June 2004
- Riverware Training Course by Cadswes, April 2004

Boris Fichot, P.Eng., P.E.
Senior Engineer

PROFESSIONAL EXPERIENCE

- **824 MW Muskrat Falls and Labrador Island Link, NL, Canada** – As Expert Reviewer for the Consumer Advocate of Newfoundland and Labrador, reviewed documents prepared by Nalcor and the Public Utilities Board on Muskrat Falls being the least cost option for the supply of power to Newfoundland and provided independent input to the Consumer Advocate.
- **132 MW John Hart Generating Station Replacement Project, BC, Canada** – RFP technical submission preparation with Knight Piésold Ltd. for the Elk Falls Energy Partners.
- **30 MW Sabanilla Hydroelectric Project, Ecuador** – Conducted a Due Diligence study on energy production and project economics.
- **22 MW Jaime Creek Project, BC, Canada** – Conducted a Due Diligence study, elevated construction progress, energy, hydrology, performed optimization of plant capacity, reviewed detailed design and tender.
- **15 MW Box Canyon, BC, Canada** – As Design Coordinator, coordinated and participated in engineering design, optimization, cost estimating, and conducted project management and project design scheduling.
- **20 MW Zeballos Lake Hydroelectric Project, BC, Canada** – Conducted a Due Diligence study on energy production.
- **15 MW Iqaluit Hydro, Nunavut, Canada** – Completed a high-level regional study of potential hydroelectric resources to supply the Iqaluit and potential mining developments. Prepared reservoir energy models.
- **1 MW Hartley Bay Hydroelectric Project, BC, Canada** – Conducted a Due Diligence Study on Project Feasibility for INAC. Conducted review of Tender Documents and Bids for the Hartley Bay Band.
- **24 MW Betmai Hydroelectric Facility, Sierra Leone** – Prepared Feasibility Study including facility design layouts, cost estimates, energy estimates, and project overall financial valuation.
- **Sechelt FN Territory Study, BC, Canada** – Completed a detailed study of the run-of-river potential in the Sechelt FN traditional territory.
- **150 MW Kwalsa and Upper Stave Project, BC, Canada** – As Design Coordinator, coordinated and participated in engineering design, prepared earned value reports, and conducted project management and project design scheduling.
- **10 MW Homestake Project, BC, Canada** – prepared alternatives assessment for mine power supply alternatives including transmission line alignments, a regional look at all hydropower facility option, and estimated development cost.
- **4 MW Brucejack Creek, BC, Canada** – Prepared Mine PA section pertaining to a hydroelectric supply to the mine, including facility layouts, energy estimates and capital cost.
- **120 MW Upper Toba Valley Hydroelectric Project, BC, Canada** – As Project Coordinator, conducted project management and scheduling, reviewed and coordinated facility layout and design, evaluated project feasibility, prepared Clean Power Call bid material, and participated in project permitting.

- **La Joie Project, BC, Canada** – identified and analyzed alternatives to remediate Dam Safety deficiencies in a manner that will not preclude future potential plant modernization and power generation expansion opportunities at the La Joie facility.

- **Kitsault Project, BC, Canada** – Evaluated the mine water management options and integrated a 9 MW hydroelectric project option in the feasibility study.

- **Roadhouse Wind Power Project, ON, Canada** – Wind Power Due Diligence Study, prepared energy estimates and project layout for a private developer.

- **60 MW Cascade Creek Hydroelectric Project, Alaska, USA** – Conducted a Due Diligence Study on Project Feasibility for investors.

- **Pebble, Alaska, USA** – Prepared a Wind Power Screening Assessment for the proposed Pebble Mine. Identified run-of-river hydropower options.

- **1,100 MW Bute Inlet Project, BC, Canada** – Conducted project identification, project optimization, land and water license application submissions, hydrology and energy studies, cost estimations, preliminary project design, and project permitting.

- **Dhalaks Creek and Seven Other Projects in the Kitimat Area, BC, Canada** – Responsible for project identification, land and water license application submissions, hydrology and energy studies, cost estimations, preliminary project design, and project permitting.

- **60 MW Meager, Salal, and South Creek in the Lillooet, BC, Canada** – Responsible for project identification, land and water license application submissions, hydrology and energy studies, preliminary project design, and project permitting.

- **Kensington Gold Project, Alaska, USA** – Provided onsite construction supervision and sediment control design and consulting services during the construction of this gold mine north of Juneau, AK.

- Prepared BCHydro tender submissions for the **East Toba River and Montrose Creek Project, Canada** (a 235 MW run-of-river project), the **Rainy River Project, Canada** (a 15 MW run-of-river project), the **Emory Creek Project, Canada** (a 6.5 MW run-of-river project), and the **Log and Kookipi Creeks, Canada** (a 20 MW run-of-river project).

- **Lower Colorado River Authority (LCRA) Water Management Plan, Austin, Texas, USA** – Evaluated and modelled impacts of water resources management plans, conducted analysis of water resources management policy options, and drafted technical reports. Developed water resources planning models, such as water allocation, water rights, hydraulic, stochastic and environmental models, and optimization tools. Presented the results of analyses in briefings, meetings, and documentation to a variety of internal and external parties.

- **Texas Senate Bill 1 Long Range Water Management Plan, Texas, USA** – Modeled and presented water resources management options.

- **Canadian International Development Agency (CIDA), Beijing, China** – Conducted research in China for the Beijing-Tianjin 3x4 Water Resources Management Project. Topics of research included: institutional analysis of Chinese environmental governance, assessment of Beijing's hydrological and environmental situation, and policy analysis of Chinese environmental policies related to water quality management.

- **Dept. of Civil Engineering, University of British Columbia, BC, Canada** – Researched topics in relation to the development of indicators of environmental health particularly for water resources.
- **Canadian Journal of Civil Engineering, BC, Canada** – Performed technical translations of journal articles.
- **Dept. of Civil Engineering, McGill University, QC, Canada** – Conducted research in environmental fluid mechanics through image analysis for correlative purposes.
- **SNC–Lavalin, Kuala Lumpur, Malaysia** – Planned and managed daily tasks for foremen. Established a system of inventory control for shipping and installation of linear induction modules (a primary rail component).

WORK HISTORY

- Knight Piésold Ltd., Vancouver, BC, Canada, Specialist Consultant, 2012 - Present
- Dragonfly Hydropower Corporation, Owner/Director, 2012 - Present
- Dragonfly Hydropower Consulting Ltd., Principal, 2012 - Present
- Knight Piésold Ltd., Vancouver, BC, Canada, Senior Engineer, 2009 - 2012
- Knight Piésold Ltd. Vancouver, BC, Canada, Project Engineer, 2006 – 2008
- Lower Colorado River Authority, Austin, Texas, USA, Engineering Associate, 2001 – 2004
- Canadian International Development Agency, Beijing, China, Researcher, 2000 – 2001
- SNC-Lavalin, Kuala Lumpur, Malaysia, Engineering Assistant, 1997

PUBLICATIONS AND PRESENTATIONS

Brown R., Fichot B., and Kabir N., “Accounting on the Lower Colorado”, RiverWare User Group Meeting 2004, February 2004

Brown R., Fichot B., Kabir N., “Innovations in LCRA’s Water Supply Modeling”, Texas Section - ASCE Spring 2005, April 2005, Austin, Texas.

Fichot, B., “Finding Indicators to Evaluate Beijing-Tianjin Wastewater Discharge Policies”, CIDA and Center for Human Settlement, 2000. http://www.chs.ubc.ca/china/index.html

Fichot B. and Hou E., “Beijing-Tianjin Watershed Report Card”, CIDA and Center for Human Settlement, 2000. http://www.chs.ubc.ca/china/index.html

Fichot B., “Deriving an Inflow and Outflow Fuzzy Rule Base System”, M.Sc. Technical Paper, August 1999.

MICHAEL G. PULLINGER, M.Sc., P.ENG.

PROJECT ENGINEER

SUMMARY

Mr. Pullinger has over six years of experience as a mechanical engineer in the power generation and commercial building industries. Michael has broad experience with project development, generating equipment, mechanical systems and numerical modelling. Mr. Pullinger is committed to the clean energy industry, holding a Master's degree in Renewable Energy and currently serving as President of the BC Sustainable Energy Association. He has experience working with hydropower, biogas, solar, wind and thermal energy projects located in Australia, Canada, Argentina, Chile, China, Costa Rica, Democratic Republic of the Congo, Peru, and USA.

EDUCATION

- M.Sc. (Renewable Energy), Murdoch University, Australia, 2011
- B.E. (Mechanical Engineering), University of Tasmania, Australia, 2006
- B.Sc. (Geography and Environmental Studies), University of Tasmania, Australia, 2006

REGISTRATION, CERTIFICATIONS AND AFFILIATIONS

- Professional Engineer, APEGBC
- President, BC Sustainable Energy Association
- Chartered Professional Engineer, Engineers Australia
- National Professional Engineers Register, Australia
- American Society of Heating, Refrigerating and Air-Conditioning Engineers

PROFESSIONAL EXPERIENCE

Generating Equipment

- **Capilano Energy Recovery Facility, BC, Canada** – Preparation of Installation Specifications for a 1.8 MW generating unit for energy recovery purposes at a municipal water supply facility. Quality Assurance (QA) during turbine and generator manufacture including Factory Acceptance Test (FAT) witnessing, non-conformance and deficiency assessments, and documentation reviews. Includes horizontal axis Francis turbine (approx. 30 m head), synchronous generator, rotating brushless excitation system, flywheel and hydraulic actuated brake, hydraulically actuated turbine inlet (butterfly) valve, medium voltage switchgear, PLC control system and transformer.

- **Cache Creek Landfill Gas Project, BC, Canada** – Technical specifications for supply of Generating Equipment and Gas Treatment equipment, including 3 x 1.6 MW spark ignited, turbocharged landfill gas fired engines, 4.16 kV synchronous generators, medium voltage switchgear, generating unit enclosures, gas compressors and gas chilling/dehydration equipment. Responsible for engineering project management, preparation of mechanical portions of the specifications, technology review, cost estimates, and assessment of secondary treatment technologies for possible siloxane, H_2S and halogenated compound removal.

- **Skookum Creek Hydroelectric Project, BC, Canada** – QA for generating equipment supply contract consisting of 2x 15 MW turbine/generator units, including supplier documentation and submittal reviews.

- **Box Canyon Hydroelectric Project, BC, Canada** – Review of tender bids for 17 MW "water to wire" equipment supply and installation package, including 1x vertical axis Pelton turbine (517 m head) and generator, 15 kV switchgear, turbine inlet valve, hydraulic pressure system, and protection and control equipment.

- **Kokish River Hydroelectric Project, BC, Canada** – Site QA for mechanical and electrical systems at 45 MW, (238 m head) run of river facility including 4x vertical axis Pelton turbines and generators, switchyard, MCCs, PLC installation and ancillary mechanical systems.

- **Mongbwalu Hydropower Project, Democratic Republic of the Congo** – Preliminary turbine selections for two low head (10 m) mini-hydropower plants. Each of the five turbines will be S-type Kaplan turbines, rated at 780 kW for the Soleniama I plant, and 940 kW for the Soleniama II plant.

Project Development

- **Misery Creek Hydroelectric Project, BC, Canada** – Prefeasibility study of a potential 15 MW run-of-river hydroelectric project (approximately 390 m head) in the Sunshine Coast region of British Columbia. Included site investigation, preliminary design, cost estimating, energy modelling, assessment of intake locations and transmission line routes, and preparation of work plan for Feasibility Study of project.

- **Manitoba Power Development Plan, MB, Canada** – Part of independent expert panel for Public Utilities Board's review of Manitoba Hydro's development plan ("Needs For and Alternatives To"). Responsible for assessment of capital costs, operation and maintenance costs and development plans for wind, natural gas and solar PV facilities in the province.

- **Rio General Hydroelectric Project, Costa Rica** – Due diligence review of 40 MW run-of-river hydroelectric project in the Caribbean region of Costa Rica. Assessment included site review of facility, assessment of mechanical and electrical equipment specifications, spare parts and maintenance history, review of regional hydrology and assessment of suitability for expansion of project. Project undertaken for client who were submitting a bid for purchase of facility, and included co-ordination with client, operators and current owners, often in Spanish.

- **Phantom Lake Project, BC, Canada** – Preliminary assessment of potential 15 MW hydropower project, including site review, preliminary design and cost estimates. Project involves approximately 490 m of head in difficult terrain.

- **Chinchillas Project, Argentina** - Preliminary assessment of supply options for 8 MW for a proposed silver/lead/zinc mine in Jujuy region of Argentina. Included preliminary capital cost estimates for alternative supply options including thermal power plant using natural gas delivered by new 30 km pipeline, and 66 km long 33 kV transmission line.

- **Wind Solutions for Mining, North America** – Assessment of potential off-grid mining projects that could be served by small to medium wind projects. Over 30 potential power sites identified ranging 0.5-350 MW.

- **Atacama Large Scale Solar Array Pumped Storage Project, Chile** – Preliminary assessment, concept design and cost estimate of a 350 MW saltwater pumped storage facility in a coastal desert region. Assessment undertaken as part of a bid for an Electricity Purchase Agreement in conjunction with a 600 MWp solar photovoltaic system for base load power supply to a new mining facility.

- **North Coast Pumped Storage Assessment, BC, Canada** – Screening assessment of potential pumped storage sites in the North Coast region of British Columbia, Canada. The key objectives included identification of potential

sites for pumped storage development with installed capacities of either 500 or 1000 MW and a storage potential for 16 hrs or 48 hrs at maximum generation output. Included development and modification of a GIS screening tool, and assessment and ranking of the 25 identified sites based on capital costs.

- **Northwest Pumped Storage Project, BC, Canada** – Project identification and initial evaluation, project scope assessment, preliminary site inspection and preliminary engineering. Assessed project layout options, including dam height, capacity, storage duration, transmission line, access and preliminary assessment of environmental and social impacts. Produced cost estimates, preliminary designs and development schedule for project, updated based on preliminary site review co-ordinated with engineering and environmental consultants.

- **South Coast Pumped Storage Assessment, BC, Canada** – Screening of potential sites using GIS, elimination of sites which are on salmon bearing lakes, or near drinking water supplies and existing water power licences. Determined length and cost of transmission lines and access for each site, and ranked site to provide a list of most cost effective sites of up to 1000 MW on Vancouver Island and the Lower Mainland.

- **Lonsdale Quay Office, BC, Canada** – Conceptual design for 85 kW solar thermal hot-water heating system for the ICBC head office in North Vancouver. Included system layout and integration, energy and capital cost estimates and preliminary financial modelling and analysis.

- **Northwest Dental, Burnie, TAS, Australia** – Owner's project manager for fast-tracked design and construction of a seven surgery dental centre. Responsible for co-ordinating the design team, managing the budget and schedule, procuring equipment and contractors, and overseeing construction.

Mechanical Systems

- **Blackwater Gold Project, BC, Canada** – Feasibility level design of freshwater pump stations and temperature and flow control systems for proposed gold mine.

- **John Hart Generating Facility Replacement Project, BC, Canada** – Tender design of auxiliary mechanical systems for 140 MW generating station replacement project, including HVAC, compressed air, drainage and dewatering, raw water, domestic water and wastewater systems.

- **Mamquam River Generating Facility, BC, Canada** – Design, construction support and testing of a new ventilation system serving a 400 m underground tunnel at a 50 MW hydroelectric facility.

- **East Toba Hydroelectric Facility, BC, Canada** – Design of replacement raw water and pressure reducing system for fire suppression and domestic water supply at 147 MW hydroelectric facility, with 580 m gross head.

- **Kokish River Hydroelectric Project, BC, Canada** – Technical specifications for supply of mechanical systems and components including intake hydraulic pressure units (HPU), intake gates and 60 tonne overhead bridge crane.

- **Minerals Testing Laboratory, Burnaby, BC, Canada** – Design of compressed gas systems for air, nitrogen, argon, hydrogen, helium, acetylene, propane, ammonia, oxygen and vacuum, and toxic and acidic waste drainage systems.

- **Hall Beach Community Centre, NU, Canada** – Detailed design of a fuel oil (diesel) supply and distribution system for heating boiler and emergency generator system. Included arctic climate requirements.

- **Westport Facility, Vancouver, BC, Canada** – Design of diesel and high pressure (20 MPa) natural gas piping and distribution systems, HVAC systems, and compressed air systems for natural gas engine testing facility

- **Kwinana Grain Terminal, WA, Australia** – Condition assessment of dust control systems at a 2 million tpa grain export facility. Included detailed testing and analysis of seven large dust extraction systems.

- **Mining Area C, WA, Australia** – Field engineer for commissioning of four dust control systems at a large iron ore mine including air balancing, control system testing and fan troubleshooting.

- **Alberni St. Offices, Vancouver, BC, Canada** – Detailed design of new 450 kW mechanical cooling system. Tendering and construction administration for the mechanical portion of the contract, including vapour-compression chillers, heat exchangers, refrigeration safety systems, piping and cooling tower.

- **Aspen Office, Perth, Australia** – Detailed design of 1.2 MW mechanical system (HVAC) for a 9,000m^2, five storey office building. System designed to meet GreenStar rating of 5 stars and leading energy efficiency standards.

- **Perth Airport, Australia** – Detailed design of ventilation systems for domestic airport expansion project.

Numerical Modelling

- **Tretheway Creek Hydroelectric Project, BC, Canada** – Computational Fluid Dynamics (CFD) assessment of the intake and headpond of a 23 MW hydroelectric facility to assess the effectiveness of a run of river intake sluicing system. Determined 3D flow patterns and bed shear stresses to infer bed sediment mobility and ability of sluice system design to mobilise sediment to downstream fish spawning habitat.

- **Mamquam River Hydroelectric Project, BC, Canada** – Hydraulic transient analysis for a 50 MW run of river hydroelectric facility. Assessed transient pressure conditions in ~3 km long tunnel and penstock on emergency closure of turbine wicket gates, synchronous bypass valves and turbine inlet valves.

- **Upper Lillooet Hydroelectric Facility, BC, Canada** – Computational Fluid Dynamics (CFD) assessment of the intake and headpond of a 77 MW hydroelectric facility, to inform the feasibility level design of the facility. Examined the flow under alternate arrangements of the intake opening orientations, as well as location of a debris protection berm. Identified designs that would improve flow uniformity and reduce head-loss through the intake openings.

- **Ingula Pumped Storage Project, South Africa** – Hydraulic transient analysis for a 1,334 MW pumped-storage system with four reversible Francis pump-turbines of 333 MW each. Conducted analysis on scheme (currently under construction) to compare with analysis undertaken during initial project design and to evaluate performance of software and analysis techniques for pumped-storage schemes. Undertaken for Masters Dissertation.

- **Aberfeldie Hydropower Project, BC, Canada** – Hydraulic transient analysis for 24 MW hydropower system with three 8 MW Francis turbines. Analysis undertaken to compare with data obtained during field commissioning for evaluation of transient analysis software and techniques. Undertaken for Masters Dissertation.

- **City Square, Perth, WA, Australia** – Energy modelling and performance specifications for 9.4 MW heating, ventilation and cooling systems for a new 48-story office tower. System designed to meet NABERS Office Energy rating.

- **KBRB Laboratories, QLD, Australia** – CFD investigation of air-pollution dispersal from an industrial laboratory.

- **Melbourne Subway Station, VIC, Australia** – CFD investigation of an air relief shaft for an underground train station.

- **Albany Entertainment Centre, WA, Australia** – CFD investigation of wind flow around proposed building.

WORK HISTORY

- Knight Piésold Ltd., Vancouver, BC, Canada, Project Engineer, 2011 - Present
- FWD Systems Design Ltd., North Vancouver, BC, Canada, Project Manager/Mechanical Designer, 2010 - 2011
- Northwest Dental, Burnie, TAS, Australia., Cattley Street Dental Centre – Project Manager, 2009
- Connell Wagner, Perth, WA, Australia., Mechanical Engineer, 2007 - 2008

PUBLICATIONS AND PRESENTATIONS

Pullinger, M, V. Martin and M. Robertson (2013). *Preliminary Optimization of a Run of River Intake and Headpond Design Using Computational Fluid Dynamics (CFD) Techniques.* HydroVision International, Denver, Colorado, USA.

Pullinger, M.G. (2011). *Evaluating hydraulic transient analysis techniques in pumped storage hydropower systems.* Master of Science in Renewable Energy Dissertation. Murdoch University.

Johnson, C.J., M. Hurley, E. Rapaport, and M. Pullinger, (2011). Using expert knowledge effectively: lessons from species distribution models for wildlife conservation and management. In *Expert knowledge and its application in landscape ecology*; A.H. Pereira, C.A. Drew and C.J. Johnson eds. Springer.

Pullinger, M.G., and C.J. Johnson, (2010). *Maintaining or restoring connectivity of modified landscapes: evaluating the least-cost path model with multiple sources of ecological information.* Landscape Ecology, **25:** 1547-1560.

Pullinger, M.G., and J.E. Sargison. (2007). *Using CFD to improve the design of a circulating water channel*. 16th Australasian Fluid Mechanics Conference, Gold Coast, Australia.