Q. What is your name and why have you been asked to appear before the Board?

A. My name is Susan H. Richter. I am employed by SGE Acres Limited as a Senior Hydrotechnical Engineer. I have been asked to appear before the Board by Newfoundland and Labrador Hydro to respond to questions on the report entitled “Island Hydrology Review” prepared by SGE Acres under my direction. This report was submitted as part of Hydro’s Rate Application as Appendix JRH-2. It was prepared in 2002 at the request of Hydro in response to P.U. Order No. 7 (2002-2003).

Q. Please state your experience and qualifications for completing hydrology studies and determining the average energy production capability of hydroelectric developments.

A. I have been employed by Acres International since 1980 to perform various hydrotechnical studies for clients. In the Province of Newfoundland and Labrador I have carried out hydrology studies for the purposes of determining the energy production capability of hydroelectric developments for several clients including the following:

- Newfoundland Power
- Newfoundland and Labrador Hydro
- Fortis Inc.
- Abitibi Consolidated Inc.
- Star Lake Hydro Partnership
- Deer Lake Power

These are further described in my attached C.V. and Supplementary Experience list.

Q. Have the results of any of your studies been presented to the Board?

A. Yes, In 2000 Acres completed a study of the average energy capability of the hydroelectric facilities of Newfoundland Power. Newfoundland Power presented the results of that study to the Board in December 2000.

Q. Were the results of that work adopted by the Board?

A. I understand it is used in Newfoundland Power's Weather Normalization Reserve.

Q. What work was SGE Acres asked to do in the Island Hydrology Review?

A. The main work activities consisted of:

- A review of Hydro's data and methodology for estimating annual hydroelectric capability for production, forecasting and rate setting purposes;

- The determination and recommendation of the most appropriate length of record and methodology to develop the estimate; and

- Additional activities including addressing the possibility of trends and climate change, and providing an overview of practices in other jurisdictions.

Q. Please summarize the study's findings with respect to the appropriate length of record.

A. With respect to the length of hydrological record the longest reliable record is preferable. Hydro is fortunate to have records from 1950 onwards at each of the stations key to its purposes, providing a respectable record length of 52 years, increasing with time.

The sources on which the streamflow sequences are based are sound, with the exception of the early part of the Cat Arm sequence. The technological improvements in data collection from 1950 to the present have not affected accuracy and should not affect the selection of the length of record in this period.

SGE Acres recommends the use of the full historic record for all purposes including the estimate of hydraulic production for rate setting purposes. The only reason to curtail a record is for computer modeling purposes where a consistent length of record is necessary for all the facilities to be used in an integrated system model.

Q. In the study you completed a survey of the practices in other jurisdictions and of other utilities in determining the estimated energy production from their hydroelectric facilities. Please summarize your findings with respect

to the length of the hydrological record used by utilities in developing the estimate.

A. We contacted 25 utilities with 10 responding and 6 regulators with 3 responding. The length of record used varied from about 25 to over 70 years. All utilities indicated in their response that they use the longest possible record.

Only one of the responding regulators indicated they set how the estimate is to be performed. In that jurisdiction, about eight years ago, the regulator required the utility to use a 20-year record. However, following appeal it reversed its decision and the full hydrological record is now used.

The survey found that no utility curtailed a record for reasons other than to have a common period for a model or to assess and adjust recent periods for changes in water use.

Q. What were the findings with respect to the characteristics of Hydro's historic inflow sequences?

A. The Hydro records have some problems in regard to internal consistency, arising principally from changes in methods of flow derivation and internal basin water balance accounting. These deficiencies can and should be corrected. Aside from these minor internal inconsistencies, the sequences appear to be free of systematic and random errors.

Q. Did the study determine whether there were any trends due to climate change?

A. Examination of the streamflow records and Hydro inflow series on the Island does not reveal any definitive recent trends or changes attributable to climate change, nor is it possible at this point to predict the effects of climate change on future inflows. In any case, such changes are likely to occur slowly over a long period of time relative to the normal planning and rate setting horizons for hydropower systems.

Q. Do the internal consistency problems make the older data unsuitable for use in determining the project energy capability?

A. No, the problems are minor and can be corrected using standard methodologies. It was recommended that these inconsistencies be corrected. Hydro has accepted this recommendation and recently hired SGE Acres to carry out the corrections. This work is targeted for completion by the end of this year. However, in the interim because of the minor nature of the inconsistencies we recommend all data continue to be used.

Q. What were the findings with respect to the methodology used by Hydro to determine the expected average energy capability of its hydroelectric facilities?

A. Computer simulation of reservoir operation and power production from the hydroelectric system would be a more appropriate methodology than the

one presently used by Hydro to calculate the expected annual average energy from hydraulic resources. In particular, since spills are an important cause of lost energy, they should be considered in the estimate.

Q. Doesn't Hydro currently adjust its estimate for spills?

A. Yes, but it is only reflective of the more recent sequences. A simulation will provide a better estimate because it will determine the amount of spill that would occur for all historic sequences.

Q. Does Hydro have simulation models that can be used for estimating the average energy capability?

A. Hydro does have a number of models. However, they need to be assessed to determine whether they are suitable for providing the estimated annual energy capability. The model must be able to integrate all the plants including the Holyrood Thermal Plant to meet a common system load. A model that does not do this would not produce realistic results. Therefore the model must be properly set up for Hydro's circumstances.

Q. Were there other conclusions and recommendations from the study?

A. Yes, there were a number of recommendations outlined in the report on page 9-3. These relate to the energy production estimates for the small

hydroelectric plants and Paradise River, continued monitoring of climate change research and the interim use of the existing records.

Q. Are you familiar with Hydro's inflow experience since the last GRA in 2001?

A. Yes

Q. What has been the actual experience with respect to the 30-year average ending in 2000 and the full historic record ending in 2000?

A. Both 2001 and 2002 were below the 30-year average and the full historic record average. They were closer to the full historic record because it was not so influenced by the wet period of the 1990s.

Q. Does this conclude your direct evidence?

A. Yes.

Susan H. Richter

Ms. Richter is a Senior Hydrotechnical Engineer with over 20 years experience with Acres in hydrology, hydraulics and related fields, particularly in Atlantic Canada. Her work has included water management projects, power and energy analysis, economic analysis, optimization studies, hydraulic design of channels and structures, various water resources work in support of environmental assessment of mining and other projects, dam safety reviews, and flood and low flow analysis. The skills developed in these hydrotechnical assignments have led to work in other areas requiring analysis of variable data, such as wind energy, as well as joint work with fish biologists in relating the effects of changes in flow and levels to fish requirements.

Education

Memorial University of Newfoundland, St. John's, Newfoundland
- M.Eng., 1994
- B.Eng. Civil Engineering, 1980

University of British Columbia, Vancouver, British Columbia
- B.A. (Hons) English

Professional Associations

Association of Professional Engineers and Geoscientists of Newfoundland—Member
Canadian Society for Civil Engineering—Fellow
Women in Science and Engineering—Member
Canadian Dam Association—Member

Languages

English, French

Experience

Hydrotechnical Specialist/Project Manager
SGE Acres Limited—2002 to Present

1980–2002
Hydrotechnical Specialist/Project Manager
Acres International
General responsibilities include
- technical and administrative direction of hydrotechnical staff in Atlantic Canada
- provision of advice to clients with respect to development alternatives, project economics, power purchase negotiations, and environmental implications of civil and water resource projects
- project management, technical direction and senior review of water resource projects in Atlantic Canada
- professional affiliate providing professional advice to water resource engineering students and sessional lecturer teaching hydrology to senior civil engineering students at Memorial University.

Typical projects undertaken by the hydrotechnical group include

- dam safety studies, including statistical and deterministic flood estimation, flood handling studies, dam breach modeling and inundation mapping, preparation of emergency preparedness plans
- water management studies for hydroelectric systems, to maximize generation while recognizing and accommodating multiple uses of the water resource
- estimating baseline hydrology, planning data collection programs and predicting impacts of municipal and mining projects on water resources
- hydraulic studies related to design of new hydroelectric installations and rehabilitation of existing facilities.

Descriptions of project involvement are provided below.

Hydroelectric Feasibility Studies and Project Design

Responsible for hydrotechnical components of prefeasibility and feasibility studies and construction design for numerous hydropower developments both existing (upgrades) and proposed. Clients include major utilities, private developers, contractors, and paper companies. Major work items include estimating design floods, estimating power and energy, and providing hydraulic input to civil design.

Projects have included hydraulic design input for Newfoundland and Labrador Hydro's Granite Canal project, and studies for the proposed development of the hydroelectric potential of the Lower Churchill River in Labrador. A probable maximum flood study and an optimization study were undertaken for the proposed generating stations at Gull Island and Muskrat Falls.

Related work includes multireservoir simulation modeling to evaluate energy from existing and proposed hydropower developments, for various clients including Newfoundland and Labrador Hydro, Newfoundland Power, Nova Scotia Power Inc., Abitibi-Price Inc. and others. An example is a water management study for Newfoundland Power. The study involved reservoir simulation modeling of all 19 of Newfoundland Power's hydroelectric systems to determine long-term expected production and investigate opportunities for increased generation. Some of this information was required to satisfy regulatory requests.

Flood Handling and Dam Safety Assessments

Provided specialist direction and advice for dam safety studies, including flood and dam break studies, and preparation of emergency preparedness plans to various clients including

- Newfoundland Power
- Nova Scotia Power Inc.
- Star Lake Hydro Partnership
- Abitibi-Price Inc.
- City of Edmundston

- Deer Lake Power
- Newfoundland and Labrador Hydro
- other private clients.

The flood handling aspects of these studies have frequently led to upgrades, for example in the Bay d'Espoir system. Operating procedures were also evaluated, for example at Churchill Falls.

Water Resources/Environmental/Municipal Projects

Investigated and recommended solutions for internal and external storm drainage systems at a large shopping mall. Work included design of improved conveyance of a river under the parking lot.

Advised on hydrological baseline data collection program for a proposed mine/mill site near Voisey's Bay, Labrador; analyzed data and provided flow estimates as required for infrastructure and for environmental assessment.

Participated in a 3-year instream flow needs assessment study, a joint project of the Department of Fisheries and Oceans, the provincial Department of Environment and Labour, and Newfoundland and Labrador Hydro.

Provided detailed assessments of water quantity and quality, documented water uses and conflicts, analyzed supply and demand for all communities, and made water management recommendations to the Water Resources Division of the Department of Environment and Lands, Government of Newfoundland and Labrador, for the Eastern Avalon Peninsula, the Western Avalon Peninsula, Humber Valley and Northern Peninsula, and Burin Peninsula and Fortune Bay.

Evaluated various fisheries release requirements from a reservoir for Nova Scotia Power Incorporated.

Reviewed water supply and demand for the Hibernia project site, with consideration of the effect of withdrawals on low flows for aquatic life.

Examined the hydrology and hydraulics of a series of ponds in the Bay d'Espoir system to determine the cause of an apparent inadequacy in compensation flow releases; recommended possible remedial measures.

Other Projects

Analyzed an ice problem in a conveyance canal in the Wreck Cove reservoir system, Nova Scotia. Recommended operating and structural solutions for canal capacity improvement.

Selected promising sites for wind turbine/water pump combination, as an alternative to dam/canal diversions, in a study of interbasin water transfer using wind pumps. In a follow-up study, provided detailed estimates of

amount of water pumped, considering variable wind and flow regimes, for CEA.

Assessed the school bus transportation programs in two regions of Newfoundland.

Assessed feasibility of wood fuel conversion projects; investigated feasibility of using biomass-fired boilers in a thermal power station; prepared technical booklets and slide shows on wind, micro-hydro, wood and solar energy in Newfoundland.

1981
Hydraulic Design Engineer
Airport drainage study, St. John's Airport, Newfoundland. Carried out hydrological analyses, model studies and field program for stormwater management.

Hydrology and power planning studies at various locations, including Newfoundland, Ethiopia, and Tanzania.

Ice studies, New Brunswick. Simulated ice jam processes.

1980
Junior Hydraulic Engineer
Backwater analysis and ice simulation studies, Nelson River, Manitoba; hydraulic/hydrologic studies for projects in Ethiopia and Tanzania; investigation of methods of crossing a ship track in Arctic ice.

1976–1979
Undergraduate Cooperative Work Terms (Various Employers)
Monitoring of hydraulic structures; pump tests; analysis of wave motion and wave forces from wave tank data; structural design and inspection; ground truthing for airborne radar remote sensing of offshore ice; analysis of meteorological data and reduction of aerial infrared imagery.

Professional Awards
1980—Association of Professional Engineers of Newfoundland Award for Excellence
1993—David Dunsiger Award for Excellence in Graduate Studies
1994—University Medal for Excellence in Graduate Studies, Memorial University of Newfoundland
1998—Fellow of the Canadian Society of Civil Engineers

Technical Publications

Multiusers in a Multireservoir System
CDA Annual Conference, Victoria, British Columbia, September 2002. (Coauthor)

Relationships of Flow and Basin Variables on the Island of Newfoundland, Canada
CWRA Annual Conference, Fredericton, NB, June 1995. (Coauthor)

Design and Construction of a Fuse Plug Spillway as a Flood Handling Mechanism
Joint CANCOLD/Canadian Dam Safety Association Conference, St. John's, NF, September 1993. (Coauthor)

Facility Design: Hydrology
First Small Hydro Generation Workshop, St. John's, NF, March 1993.

Flood Risk Reevaluation by Newfoundland and Labrador Hydro
Canadian Electrical Association, Engineering and Operations Division Transactions, Vol. 30, Part 2, 1991. (Coauthor)

Use of a Multireservoir Simulation Model for Evaluating Developments in the Bay d'Espoir System
CSCE Annual Conference and Ninth Hydrotechnical Conference, pp 523-543, St. John's, NF, June 1989. (Coauthor)

Hydrological and Freeboard Considerations in Dam Safety
Seminar on Maintenance of Dikes and Dams. Toronto, Ontario, October 1987.

Use of Wind Maximization Factor in the Estimation of Probable Maximum Precipitation
CSCE/CWRA Atlantic Region Hydrotechnical Conference, June 1986. (Coauthor)

Optimal Long Range Generation Investment Planning Model of Mixed Hydro/Thermal Systems
CEA Conference, March 1982. (Coauthor)

Susan H. Richter – Supplementary Experience

1993-2003 **Specific projects requiring development or assessment of long term flow series, modelling, and energy estimates:**

	Client	Description
2003	Newfoundland Power	Rose Blanche Modifications to Increase Energy
2002-2003	Newfoundland and Labrador Hydro	Island Hydrology Review
2002-2003	Town of Clarenville	Clarenville Water Supply
2000-2003	Aur Resources/Jacques Whitford Environment Limited	Estimate of Expected Flows with and without Mine
2002-2003	Golder Associates	Voisey's Bay Hydrologic Data Collection and Analysis
2002-2003	Newfoundland Labrador Hydro	Labrador Hydro Project Studies
2001-2003	Fortis Inc.	Exploits River Stations - Energy Production
2001	Lower Churchill Review	Review of Hydrology and Modelling Results
2001	Newfoundland Power	Port Union Watershed Resource Assessment
2001	Deer Lake Power	ARSP and SSARR Model Training
2000	Abitibi Consolidated Inc	Exploits River: Flow Sequence and Model Development, Energy Estimates (several projects)
2000	Newfoundland Power	Water Management Study
2000	Newfoundland and Labrador Hydro	Model Development to Review Snook's Arm and Venam's Bight Operating Policies
1999-2000	Newfoundland Power	Water Management Study, Horsechops
1999-2000	Newfoundland and Labrador Hydro	Lower Churchill Water Management Studies
1999-2001	Nova Scotia Power Inc.	Sheet Harbour Development Study
1993-2000	Star Lake Hydro Partnership	Development of Flow Sequences, Power and Energy Estimates, Assessment of Alternatives
1999	Deer Lake Power	Rule Curve Study
1999	Siemens Westinghouse	Power and Energy Estimates
1999	Newfoundland and Labrador Hydro	Model Development for Power and Energy Planning
1998-1999	Newfoundland and Labrador Hydro	Churchill River Complex Optimization Study

SGE Acres

	Client	Description
1998-1999	Nova Scotia Power Inc.	Development of Flow Sequences for Energy Estimates at all Stations
1997	Voisey's Bay Nickel Company	Assessment of Water Supply for Smelter/Refinery
1997	St. Mary's Bay Hydro Corp.	NW Arm Brook Hydro
1996	Algonquin Power Corporation	Power and Energy Analysis
1996	Digdeguash Hatchery, N.B.	Water Usage Management
1996	Newfoundland and Labrador Hydro	Bay d'Espoir Energy Model Update
1995-1996	City of Edmundston, N.B.	Green River Basin Energy Estimates
1995-2000	Voisey's Bay Nickel	Design of Hydrology Program, Preparation of Flow Sequences, Modelling
1994-1995	Canadian Water Resource Group	Water Export Study – Gisborne Lake
1994-1995	Department of Environment and Lands	Water Resources Study of Southwestern Newfoundland
1994	Department of Fisheries and Oceans	Development of Flow Duration Curves
1994	Delcan Crop	Exploits River Hydrologic Analysis
1993-1994	Newfoundland and Labrador Hydro	Paradise River Regulation Structure
1993-1996	NBIP Forest Products Inc.	Charlo River Dam – New Brunswick
1993-2000	Abitibi-Price Inc.	Feasibility Study of Star Lake Hydroelectric Development
1993-1995	Abitibi-Price Inc.	Exploits River Water Management Study – Phase I
1993	Genergy Inc.	Garia Bay – Project Definition Update
1992-1993	NODECO	Little Mosquito Pond – Supply/Demand Review
1992-1993	Paris & Associates	Torrent River – Site 1C – Feasibility Study
1992-1993	Paris & Associates	Torrent River – Site 4 – Power and Energy Studies
1992-1993	Department of Environment and Lands	Water Resources Study – Burin Peninsula and Fortune Bay
1992-1993	Abitibi-Price Inc.	Power and Energy Study for Greenwoods Project
1992-1993	Frontier Hydro	SW River Hydroelectric Development Feasibility Study