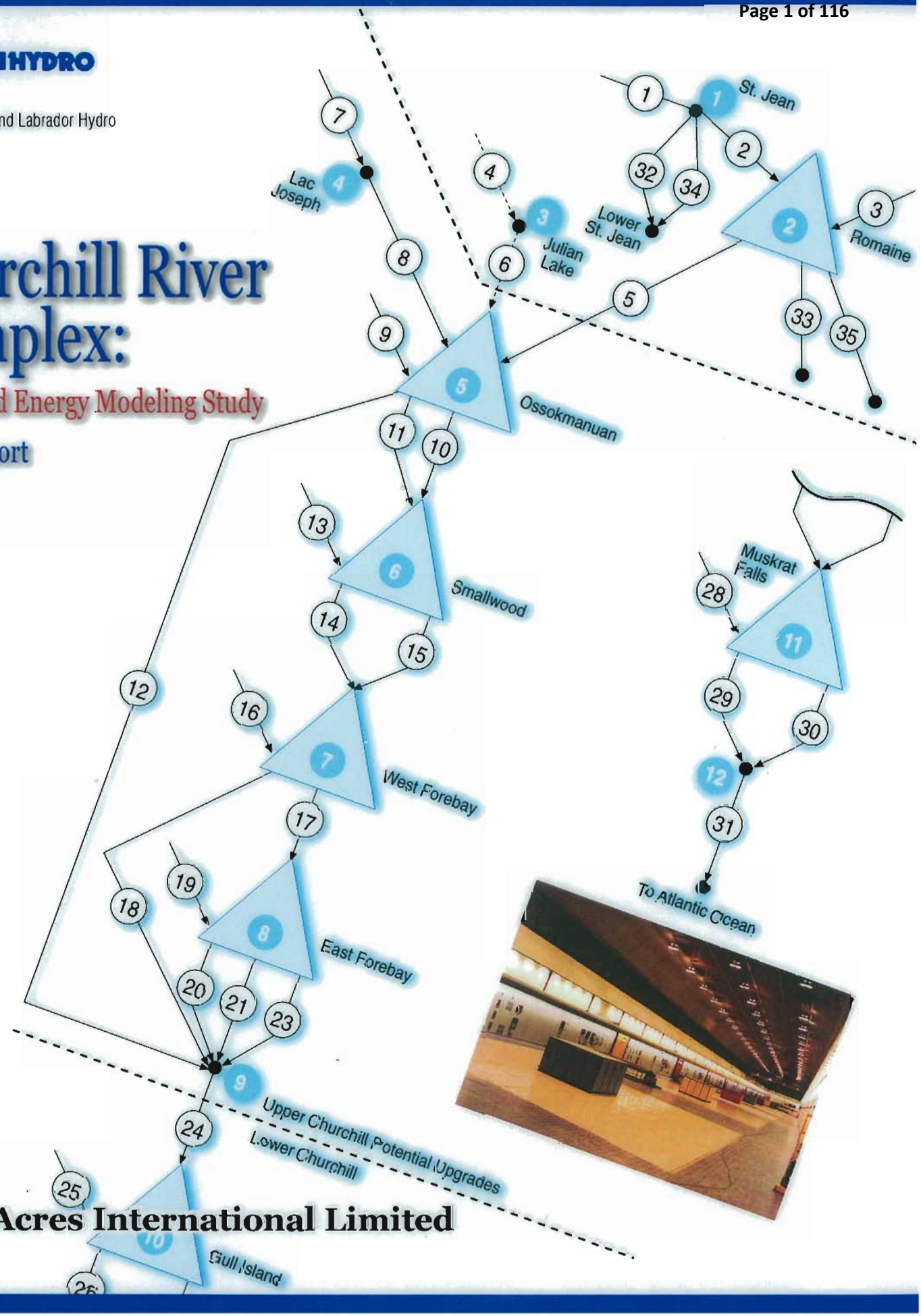
Newfoundland and Labrador Hydro

Churchill River Complex:

Power and Energy Modeling Study

Final Report

July 1998



Acres International Limited

Newfoundland and Labrador Hydro

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July 14, 1998
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Newfoundland and Labrador Hydro
P.O. Box 12400
Hydro Place, Columbus Drive
St. John's, Newfoundland A1B 4K7

Attention: Mr. M. Rana, Director
Generation Engineering and Telecontrol

Dear Sir:

Churchill River Complex Power and Energy Modeling Study

We are pleased to submit the final report of the Churchill River Complex Power and Energy Modeling Study. We have provided 12 copies of Volume 1 and six copies of Volumes 2 and 3 containing detailed output. The first copy of Volume 1 contains diskettes with electronic versions of the model setup and post-processor for your use.

The model as setup in this study is suitable for use in evaluating the proposed projects in the Churchill River Complex.

It has been a pleasure to work with you and your staff on this project and we look forward to continuing involvement with the Churchill River Complex studies.

Yours very truly,

S Rdt

SHR:sjc

for R.J. Gill, P.Eng.
Vice President, Atlantic Region

Enclosure

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Executive Summary

Executive Summary

This report documents the work carried out for Newfoundland and Labrador Hydro by Acres International Limited to develop a power and energy model of the Churchill River system. The model includes the existing and proposed projects in the Churchill River Complex. The Complex consists of

- the existing Churchill Falls hydroelectric station;
- a 1000 MW proposed extension to the Churchill Falls station;
- the proposed diversion of water from two rivers in Québec into the Churchill Falls system via the Atikonak River;
- a 2264 MW proposed hydroelectric station at Gull Island, on the Lower Churchill River; and
- a 824 MW proposed hydroelectric station at Muskrat Falls, on the Lower Churchill River.

Acres Reservoir Simulation Package (ARSP) was used as the basis for the model setup. The required output was average and firm energy from the total Complex for various combinations of projects. A post-processor was also developed to determine the energy available at the Québec-Labrador border, taking into account energy requirements to Labrador and to the Island of Newfoundland via a proposed transmission line infeed, and transmission losses to the border. Electronic copies of the model setups were provided to Newfoundland and Labrador Hydro.

The model setup required

- review of existing information,
- initial model setup,
- comparison of model results with recorded data and with previous estimates, and
- final model setup.

The estimated firm and average energy output from the proposed projects is summarized in Table S-1, together with the increment over the existing generation.

The energy for sale at the Québec-Labrador border is shown in Table S-2. These results apply to a particular combination of losses and loads agreed upon for the purposes of this study.

The model is recommended for Newfoundland and Labrador Hydro's use in further evaluation of projects in the Churchill River Complex.

Table S-1
Estimated Firm and Average Energy

Model Setups	Installed Capacity (MW)	Firm Energy (TWh/yr)	Incremental Firm Energy (TWh/yr)	Average Energy (TWh/yr)	Incremental Average Energy (TWh/yr)
Existing (CF1)	5600	31.37	--	34.50	--
CF1 + Gull	7864	42.16	10.79	46.28	11.78
CF1 + Gull + Muskrat	8688	46.24	14.87	50.69	16.19
Diversions + CF1 + CF2 (New CF)	6600	36.00	4.63	39.42	4.92
New CF + Gull	8864	47.91	16.54	52.42	17.92
New CF + Gull + Muskrat	9688	52.40	21.03	57.19	22.69
New CF + Gull + Lobstick	9024	48.80	17.43	53.50	19.00
New CF + Gull + Lobstick + Muskrat	9848	53.29	21.92	58.28	23.78

Table S-2
Energy for Sale at Québec-Labrador Border

Model Setup	Available Energy for Sale at Québec-Labrador Border	
	Total (TWh)	Incremental (TWh)
Existing (CF1)	31.18	--
CF1 + Gull	38.84	7.66
CF1 + Gull + Muskrat	43.10	11.92
Diversions + CF1 + CF2 (New CF)	36.02	4.84
New CF + Gull	44.88	13.70
New CF + Gull + Muskrat	49.49	18.31
New CF + Gull + Lobstick	45.91	14.73
New CF + Gull + Lobstick + Muskrat	50.53	19.35

Introduction

1 Introduction

In February, 1998 Newfoundland and Labrador Hydro (NLH) engaged Acres International Limited to develop a comprehensive power and energy model of the Churchill River system. Such a model would allow NLH to evaluate firm and average energy for a number of proposed developments on the river. This report documents the analyses required to develop the model and presents the results for the various developments.

1.1 Background

The Churchill Falls Hydroelectric Project was designed during the late 1960's and constructed between 1969 and 1974. It consists of an 11-unit underground powerhouse with a nominal installed capacity of 5,428.5 MW, two large storage reservoirs, two forebays and a number of water control structures. Potential developments on the Lower Churchill represent some of the largest untapped hydro power resources in North America. Proposed sites of energy generation on the Churchill River system include Gull Island, Muskrat Falls, and Lobstick water control structure. The proposed new developments also include additional capacity at the existing station, using diverted water from rivers in the province of Québec.

1.2 Objectives

The objectives of the study were

- to develop a comprehensive model based on ARSP (Acres Reservoir Simulation Package), capable of determining firm and average energy for the existing and proposed developments on the Churchill River;

- to provide a post-processor for determining the available energy for sale at the Québec-Labrador border taking into account Island infeed and Labrador loads and transmission losses to the border; and

- to provide NLH with electronic copies of final model setups of the power and energy model for use by NLH staff.

1.3 Approach

The initial planned approach was to take an existing power and energy model and the physical data and hydrology in this model and use it to set up the ARSP model. During the course of the work, it became evident that most of the data required confirmation and consultation with NLH. In addition, information on physical characteristics of some structures was available, which could be incorporated into the model. The activities undertaken in the study were therefore as follows.

- Review existing models and information related to the Churchill River system and proposed developments.
- Set up a power and energy model that matches the results of previous power and energy models, while documenting possible changes and concerns in model input values.
- Update the power and energy model to include all the physical characteristics of the Churchill River system and the most up-to-date data.
- Calibrate the updated model with recorded plant data.
- Meet with NLH to discuss progress and identify any concerns in the model setup and update the model based on NLH comments.
- Determine the preliminary firm and average energy for existing and proposed developments on the Churchill River system.
- Present and discuss preliminary results with NLH staff and make any changes to the model to reflect any concerns or questions from the presentation.
- Determine the firm and average energy for existing and proposed developments on the Churchill River system.
- Review the transmission layout for the Churchill River system and develop a post-processor for determining the available energy for sale at the Québec-Labrador border taking into account Island infeed and Labrador loads for existing and proposed developments.
- Tabulate the available energy for sale at the Québec-Labrador border.

- Document results.

A list of the information and sources is provided in Appendix A.

System Description

2 System Description

The Churchill River drains an area of 92,355 km^2, and flows from west to east from the Québec-Labrador border to Lake Melville, as shown on Figure 2.1. For the purpose of this study, the total drainage area of the Churchill River was taken above Muskrat Falls (just upstream of Goose Bay).

The Upper Churchill River basin includes drainage into Ossokmanuan Reservoir, Smallwood Reservoir, and local drainage to the forebays above Churchill Falls. This area provides flows for the existing Churchill Falls hydroelectric station. Additional flow for potential energy generation for the system is available from projects on the Lower Churchill River (below Churchill Falls) and from diverted water from Québec.

The following section summarizes the system characteristics of the Upper Churchill River, Lower Churchill River, and diverted basins from Québec.

2.1 Upper Churchill River

The Upper Churchill River drains a total area of 69,267 km^2 from the upper reaches of the Ossokmanuan Reservoir basin to the Churchill Falls Hydroelectric Station. The system is composed of two large storage reservoirs, two forebays and a number of water control structures as listed below and shown in Figure 2.2. The total nominal installed capacity of the system is 5,428.5 MW. The maximum continuous operating capacity available from the plant is 5,600 MW with a maximum historic peak of 5,765 MW. Reservoir and water control structures in the system are listed below.

Storage Reservoirs and Forebays
- Ossokmanuan Reservoir
- Smallwood Reservoir
- West Forebay
- East Forebay

Water Control Structures
- Ossokmanuan Control Structure (Spillway)
- Gabbro Control Structure
- Lobstick Control Structure
- Jacopie Spillway

- Whitefish Falls Control Structure
- East Forebay Spillway.

There are also two large lakes, Lac Joseph and Atikonak Lake, providing natural regulation above Ossokmanuan Reservoir. Lac Joseph flows uncontrolled from the west into Atikonak Lake which, in turn, flows uncontrolled to Ossokmanuan Reservoir. The water from the proposed diversions would flow into Atikonak Lake from the southeast.

2.2 Lower Churchill River

The drainage area of the Lower Churchill River includes the drainage area of the Upper Churchill River at 69,267 km^2 plus that of the Lower Churchill River above Muskrat Falls at 23,088 km^2.

The proposed hydroelectric developments on the Lower Churchill River are located at Gull Island and Muskrat Falls, approximately 80 km and 40 km upstream of Goose Bay, respectively. These would be essentially run-of-the-river developments, operated with essentially constant headpond levels. The proposed installed capacities of the generating stations are approximately 2,264 MW for Gull Island and approximately 824 MW for Muskrat Falls.

2.3 Churchill Falls Additional Capacity (CF2)

The proposed CF2 generation would come from an additional 1,000 MW at Churchill Falls, supplied by water diverted from two rivers, the St. Jean River and the Romaine River, in the province of Québec. These rivers which now flow south into the Gulf of St. Lawrence would be diverted into Atikonak Lake, and from there would flow into the Ossokmanuan Reservoir. The St. Jean River would be diverted through a diversion channel to the Romaine River. A storage reservoir would be constructed on the Romaine River, and flows would either be stored, spilled or diverted to the Upper Churchill River basin depending on energy demands. The flows diverted to the Churchill River basin would be regulated by a control structure located upstream of Atikonak Lake. No additional spillway capacity is planned in the Upper Churchill River; flood handling will be reviewed separately.

The diversion structures on the St. Jean and Romaine Rivers would include structures for release of fishery flows to the lower portion of the rivers.

The local and cumulative drainage areas for the Upper and Lower Churchill River and the diversions are summarized in Table 2.1.

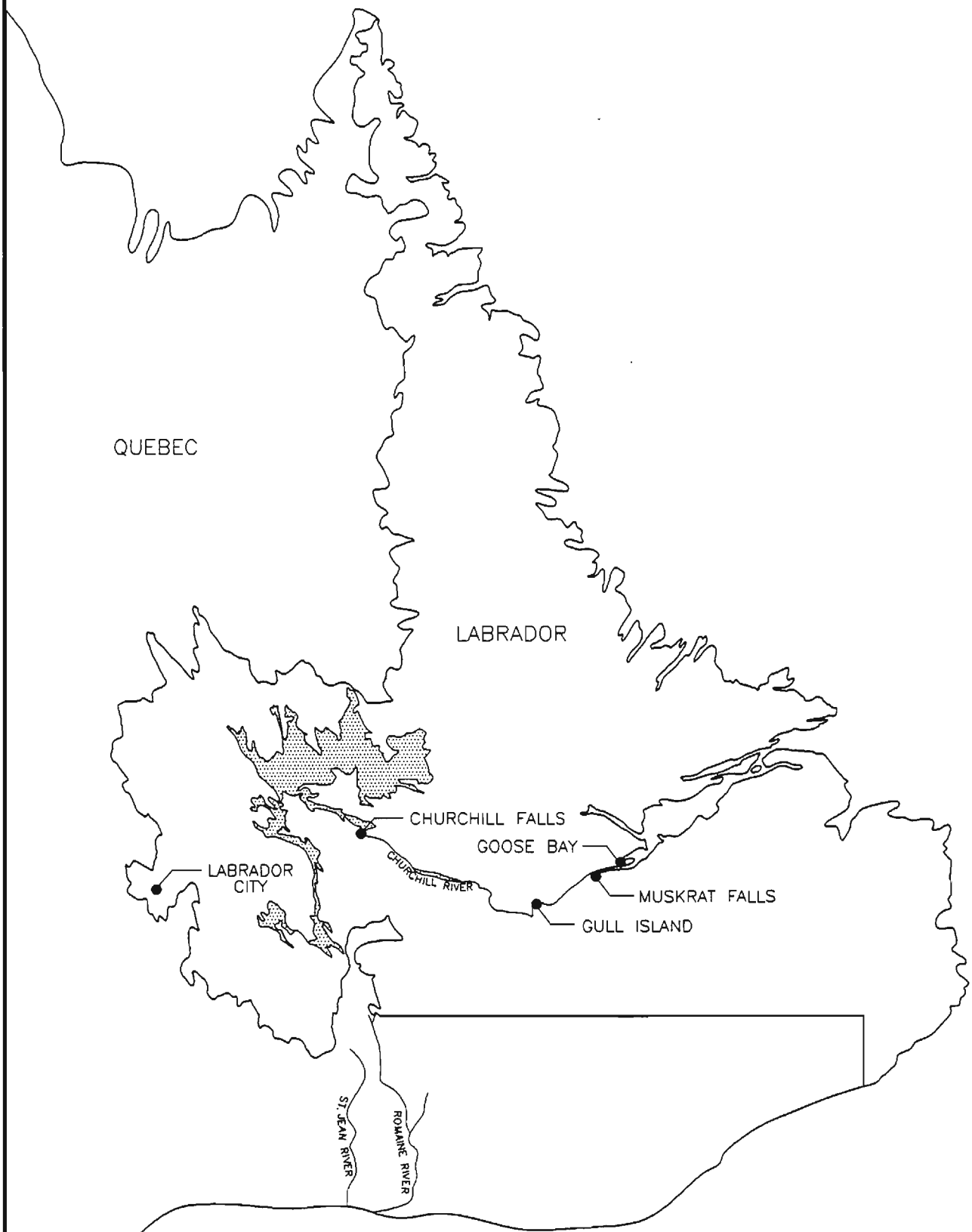

FIG. 2.1

NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
POWER AND ENERGY MODELING
PROJECT LOCATION

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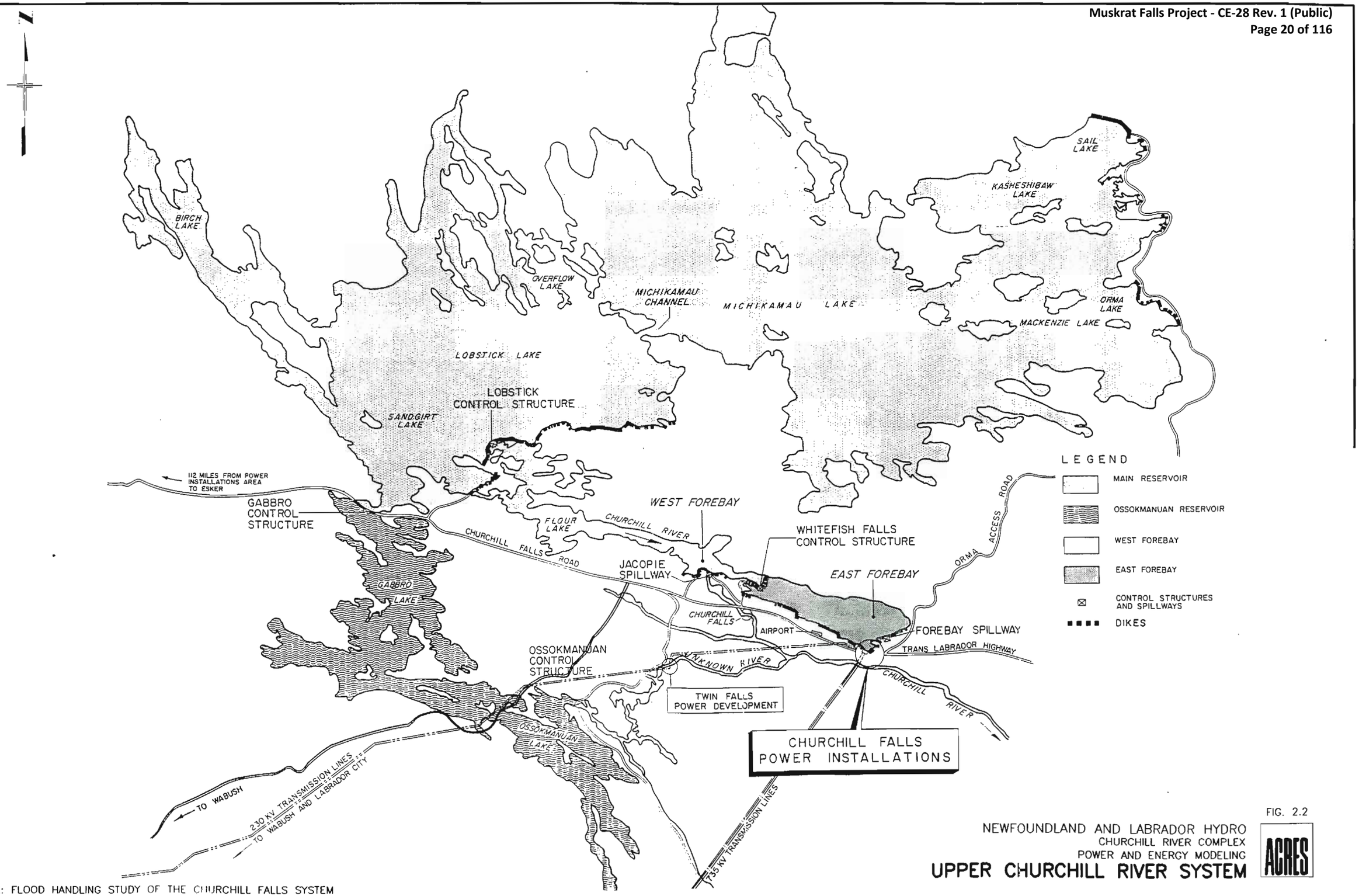

SOURCE: FLOOD HANDLING STUDY OF THE CHURCHILL FALLS SYSTEM

FIG. 2.2

NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
POWER AND ENERGY MODELING

UPPER CHURCHILL RIVER SYSTEM

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Table 2.1

Local and Cumulative Drainage Areas

Basin	Sub-Basin/ River	Local Drainage Area (km^2)	Cumulative Drainage Area (km^2)	
			Without Diversions	With Diversions
Diversions from the Province of Quebec	St. Jean River above diversion	1217	-	1217
	Romaine River above diversion	8402	-	9619
Upper Churchill	Lac Joseph	7070	7070	16689
	Ossokmanuan Reservoir	15362	22432	32051
	Smallwood Reservoir	45110	67542	77161
	West Forebay	1108	68650	78269
	East Forebay	617	69267	78886
Lower Churchill	Gull Island	19832	89099	98718
	Muskrat Falls	3256	92355	101974

Source: Churchill River Complex Energy Report (January 1991)
Hydro-Quebec Presentation Notes (February 1998)

Streamflow Sequences

3 Streamflow Sequences

In order to assess the power and energy benefits of the proposed alternatives, a monthly flow simulation model was set up to represent the Churchill River system. Representative inflow sequences for each of the sub-basins in the system were required as input data for the simulation model. Based on available data, inflow sequences for 54 years were developed. The three main sub-basins requiring inflow sequences are as follows.

(1) Upper Churchill River
- Lac Joseph local inflows.
- Ossokmanuan Reservoir local inflows (including Atikonak Lake).
- Smallwood Reservoir local inflows.
- West Forebay local inflows.
- East Forebay local inflows.

(2) Lower Churchill River
- Gull Island local inflows.
- Muskrat Falls local inflows.

(3) Diversions
- St. Jean River local inflows (above diversions).
- Romaine River local inflows (above diversions).

3.1 Data Sources

The data sources used for developing the streamflow sequences were as follows.

- *Gull Island Power Development: Review of Engineering and Capital Cost Estimate Final Report, Volume 2: Detailed Calculation of Energy Simulation* (October 1997).

- *Churchill Falls Inflows Harmonization of Hydro-Québec and CF(L)Co Data Bases* (October 1997).

- Partial Diversions of Upper St. Jean and Romaine Rivers: Preliminary Studies - Hydro-Québec Presentation Notes (February 1998).

- A Development Scenario for the Upper Churchill Watershed - Hydro-Québec Presentation Notes (September 1997).

Using these sources, inflow sequences were developed for each of the sub-basins as discussed in the following section.

3.2 Inflows

During the initial stages of the study, inflow sequences from the Gull Island Power Development Report (October 1997) were used directly for both Upper and Lower Churchill River sub-basins. During meetings with NLH and correspondence with Churchill Falls (Labrador) Corporation CF(L)Co staff, it was agreed that the Harmonization Report (October 1997) inflows should be used, where available, in developing inflow sequences.

The Harmonization Report (October 1997) included flows for the Upper Churchill River for the period 1976 to 1996 only. Therefore, the Gull Island Power Development Report (October 1997) hydrology was used for the years before 1976. For the Lower Churchill River basin, the hydrology from the Gull Island Power Development Report (October 1997) only was used because the Harmonization Report (October 1997) did not include any information on this basin.

For the diversions, the only flow information provided was average inflow above the diversion for St. Jean and Romaine Rivers from the two sets of Hydro-Québec Presentation Notes (September 1997 and February 1998). The average inflow for St. Jean and Romaine Rivers was stated as 29 m^3/s and 186 m^3/s, respectively, giving a total diverted inflow of 215 m^3/s. The approach used to develop an inflow sequence for these two rivers was to prorate the local inflows to Ossokmanuan Reservoir based on the ratio of average inflows. In general, this assumes that the diversion inflows follow the same pattern as the Ossokmanuan Reservoir inflows.

The sources of the inflow sequences are summarized in the table below.

Sub-basins	Inflow Sequence
Upper Churchill - Lac Joseph - Ossokmanuan Reservoir - Smallwood Reservoir - West Forebay - East Forebay	1943-1975 [1] ; 1976-1996 [2] 1996 - 1997 [1]
Lower Churchill - Gull Island - Muskrat Falls	1943-1997 [1]
Diversions - St. Jean River - Romaine River	1943-1997 Ossokmanuan local inflows prorated based on average local inflows

[1] Gull Island Power Development Report (October 1997)
[2] Harmonization Report (October 1997)

The inflow sequences for each of the sub-basins used for the final model setups and results are provided in Appendix B.

When the mean annual runoff (MAR) for the Upper Churchill basin was compared with the MAR for the Lower Churchill basin for the period of record (length of inflow sequence), it was noticed that the MAR for Smallwood was about 5 percent higher than for Gull Island. In general, given the general climate and topography, it might have been expected that the Lower Churchill MAR would be higher than the Upper Churchill MAR.

As a comparison, the MAR for the overlapping period of record January 1985 to December 1995 was determined for hydrometric stations in or adjacent to the Lower Churchill River. The results, as presented in Table 3.1, showed that the MAR's for the gauged basins are higher than the MAR of the Lower Churchill River. This suggests that the reference streamflow sequence used for the Lower Churchill River may be underestimating flow.

This comparison is provided for information only, since it was not in the scope of work of this study to update the hydrology. This question may be addressed separately.

Table 3.1

Mean Annual Runoff (MAR) for Churchill River and Adjacent Hydrometric Stations

Basin	Drainage Area (km^2)	Average Flow Jan 85-Dec 95 (m^3/s)	MAR (mm)
Smallwood local Inflow*	45,110	795.0	556
Gull Island local Inflow*	19,832	335.0	533
Minipi River Below Minipi Lake	2,330	51.5	698
Naskaupi River Below Naskaupi Lake	4,480	79.6	561
Little Mecatina River Above Lac Fourmont	4,540	83.6	581
Churchill River Above Upper Muskrat Falls**	92,500	1651.0	563

*Flows were taken from Gull Island Power Development Report (October 1997). Others are Environment Canada Hydrometric Stations.

**1989 is missing from this record, but it is just slightly above average. MAR could be expected to be a few millimetres higher.

Churchill River Model Setup

4 Churchill River Model Setup

This section of the report gives a detailed description of the model setup of the Churchill River system. The ARSP model was used to evaluate the existing and proposed energy generation. ARSP uses a simplified network of channels, reservoirs, nodes (connecting points for channels), structures, and power stations to represent a water system. A detailed description of the ARSP program is provided in Appendix C.

The following section describes the model setup, the physical data used in the model, and the calibration of the model.

4.1 Model Representation

In general, the model for the Churchill River system takes monthly inflows and uses the water to first satisfy fishery demands (where required) and then to generate energy, based on various physical and operational constraints. The portion of the inflow not used for energy generation is either stored or spilled.

The input data required to set up the model include

- representative inflow sequences;
- reservoir characteristics;
- power station characteristics;
- structure data; and
- operational data.

The representative inflow sequences have been described in Section 3. The remaining input data are discussed in the following sections. A model schematic of the Churchill River system, including both existing and potential generation facilities and diversions, is presented in Figure 4.1.

The approach to setting up the model was as follows.

- Review existing information.
- Set up power and energy model using input data from previous study.
- Match previous power and energy results.
- Update model to include all physical characteristics of system.
- Calibrate model to existing data.

- Discuss results with NLH staff.
- Update model input based on calibration results and comments from NLH staff.
- Determine preliminary firm and average energy for Churchill River system.
- Present and discuss results with NLH.
- Update model based on discussions with NLH.

4.2 Comparison with Previous Energy Results

The most recent previous estimates of the existing and potential energy generation of the Churchill River system are summarized in the Gull Island Power Development Report (October 1997). This report estimated the existing energy of the Churchill Falls facility and the potential energy generation if Gull Island and Muskrat Falls were added to the system. The three cases investigated were

- Churchill Falls existing;
- Churchill Falls existing plus Gull Island; and
- Churchill Falls existing plus Gull Island plus Muskrat Falls.

The appendices to the report provided echoes of the input data used to estimate the power and energy. This information was input to ARSP and reworked where required to match the input requirements of ARSP. The ARSP model of the three cases was then run using the same input parameters, and the results were compared.

Table 4.1 shows that both models, when using similar input data and run for the same firm energy, produce similar results, as expected. The slight difference in the energy values can be attributed to the different manner in which the two models handle the power plant characteristics.

In developing the ARSP model and reviewing the input variables, it became evident that additional information could be usefully incorporated in this study. Ossokmanuan control structure was added, structure discharge curves were specified for all structures, and the East and West Forebays were modeled separately.

Modeling all structures and structure curves is more important when the diversions are included to ensure that no structure is limiting or acting as a control in the system.

4.3 Physical Data for Model Calibration

The physical data used for the model calibration and subsequent model setups of potential energy generation were derived from the following sources.

- CF(L)Co correspondence, storage curves (November 1996), structure curves, and recorded site data (May 1985 to April 1997).
- Gull Island Power Development Report - Volumes 1 and 2 (October 1997).
- Churchill River Complex Energy Studies Final Report - Volume 1 (January 1991).
- Flood Handling Study of the Churchill Falls System (March 1989).
- Hydro-Québec Presentation Notes (September 1997 and February 1998).

In general, CF(L)Co data were used for input values to the model. In the case where there were no CF(L)Co data on file, the Gull Island Power Development Report - Volumes 1 and 2 (October 1997), Flood Handling Study Report (March 1989), and Churchill River Complex Energy Report (January 1991) were used to derive the required input values.

4.3.1 Reservoir Characteristics

As previously noted, the existing Churchill River system consists of two storage reservoirs and two forebays. These include Ossokmanuan and Smallwood Reservoirs, and West and East Forebays. CF(L)Co has developed and updated storage curves for the reservoirs and forebays; the most recent curves are presented in Appendix D. These curves were used to represent the storage in the model. Key reservoir elevations, such as full supply level, dead storage level, and surcharge level, were taken from both CF(L)Co data and the Flood Handling Study Report (March 1989).

Smallwood Reservoir consists of three reservoirs - Hook Bay, Orma Lake, and Lobstick. At low levels, the reservoir is separated into three separate reservoirs connected by channels. For the purpose of modeling, the Smallwood Reservoir was modeled as one reservoir, but the storage curve accounted for reduced storage at low levels. The difference in levels due to the hydraulic connections was not modeled. It would be possible to model the three reservoirs separately if the channel characteristics were known for the channels connecting the reservoirs.

For the run-of-the-river projects at Gull Island and Muskrat Falls, it was assumed that the reservoirs remain at a constant level on a monthly time step. For the purpose of this study, the information on storage curves and reservoir levels was taken from the Gull Island Power Development Report (October 1997) and the Churchill River Complex Energy Report (January 1991), and this data was used in the current modeling.

The only information available for the diversions was Hydro-Québec Presentation Notes (September 1997 and February 1998). Storage is provided at the Romaine River diversion only.

Key reservoir features, storage curves, and reservoir levels are presented in Tables 4.2 and 4.3 for the Upper and Lower Churchill River system and the diversions.

4.3.2 Power Station Characteristics

Power station characteristics were required for the following stations.

- Churchill Falls Existing Station.
- Lobstick Structure Proposed Power Station.
- Proposed Additional Capacity at Churchill Falls Station.
- Gull Island Proposed Station.
- Muskrat Falls Proposed Station.

Power station characteristics for Churchill Falls, Gull Island and Muskrat Falls were taken from the Gull Island Power Development Report (October 1997).

Characteristics for the proposed Lobstick station were taken from the Churchill River Complex Energy Report (January 1991) and were used with minor adjustments.

Power plant characteristics for CF2 were derived from Hydro-Québec presentation notes (February 1998) and information on the existing station.

Plant characteristics used in the final setup of ARSP are presented in Table 4.4. Table 4.5 presents the tailwater curves for each station. As shown in this table, the tailwater curves for Churchill Falls (and CF2) and Gull Island differ depending on the development of downstream power stations. In general,

Churchill Falls tailwater is affected by the development of Gull Island, and Gull Island tailwater is affected by the development of Muskrat Falls.

In addition to these plant characteristics, the model also requires the available capacity of the stations (availability curve) and the demand pattern for the system.

These two items are discussed below.

Availability Curve

Due to higher water temperatures in the river, the availability of the power stations is reduced in the summer. The availability curve used in previous work suggested that the available capacity varied from a maximum of 5,460 MW to a minimum of 4,833 MW. CF(L)Co staff noted, however, that the maximum continuous summer availability of the plant is 5,100 MW and the maximum continuous winter availability of the plant is 5,600 MW. Although one or two units would generally be down in the summer for scheduled maintenance, if water were available in the summer that would otherwise be spilled, CF(L)Co would postpone the maintenance. Using this information from CF(L)Co, an availability curve was developed in consultation with NLH. This curve assumes 5,600 MW is available in winter (December to April) and 5,100 MW in summer (June to October). Availability in November and May was taken as 5,350 MW, the average of winter and summer availability.

This same pattern of availability was used for each of the proposed new systems, except for CF2. For these units, it was assumed that the availability throughout the year would be 100 percent, except in April. It was assumed that each unit would be down for 2 weeks maintenance in April, and availability would then be 50 percent.

The availability curves used in this study and the Gull Island Power Development Report (October, 1997) are presented in Figure 4.2.

Demand Pattern

Energy loads on the existing and potential system originate from four points. These include

- Labrador;
- station site services and Twin Falls loads;

- Québec; and
- HVDC infeed to the island.

Demand patterns, as provided by NLH (Appendix E) for year 2008, were reviewed and compared with demand patterns used in the Gull Island Power Development Report (October 1997). This comparison showed that the demand pattern provided by NLH when combined with Hydro-Québec loads was similar to the pattern used for previous work. Therefore, the demand pattern used in the Gull Island Power Development Report (October 1997) was used for this study. The resulting monthly demand factors, defined as the ratio of the energy demand during the month to the total annual energy demand are presented in Table 4.6. These are shown as ratios of both GWh and MWc.

4.3.3 Structure Data

Structure curves (stage/discharge curves) were required for the following water control structures.

Upper Churchill
- Ossokmanuan Control Structure (Spillway)
- Gabbro Control Structure
- Lobstick Control Structure
- Whitefish Control Structure
- Jacopie Control Structure
- East Forebay Spillway

Lower Churchill
- Gull Island Spillway
- Muskrat Falls Spillway

Diversions from Québec
- Romaine Spillway
- Atikonak Control Structure

For the Upper Churchill Falls development, structure curves and tables were provided by CF(L)Co for the main water control structures at Gabbro, Lobstick and Whitefish (Appendix F). For the remaining structures in the system, curves were taken from the Flood Handling Study (March 1989).

For the Lower Churchill developments, the data were taken from the Gull Island Power Development Study (October 1997). This study did not incorporate structure curves and assumed any flow not used to generate power would be spilled. This assumes that the spillway capacity would be adequately designed to pass any flows above the maximum power flow. For the purpose of this study, this assumption was taken to be adequate and to have no effect on the determination of energy generation. As can be seen in Table 4.7, a large arbitrary spillway capacity was given for Gull Island and Muskrat Falls to ensure that spillway capacity would not be limiting.

For the diversions, the data available was limited to the presentation notes. The maximum spill capacity of the Romaine structure provided in these notes was used as the maximum capacity of the Romaine spillway. This number on a monthly time step would not be exceeded; therefore, the spillway capacity was assumed to be adequate for the spill structure. A control structure located at Atikonak Lake would regulate the flow from the diversions to Ossokmanuan Reservoir.

Table 4.7 summarizes the structure curves used in the model for all the structures in the existing and proposed systems.

4.3.4 System Operation

The model maximizes firm energy production using the power plant characteristics as defined. However, to ensure maximum energy conversion at Churchill Falls, the new units are assumed to be loaded before the existing units. Also, when fishery demands are imposed on the system, as is required for the diversion, these demands are met before energy generation.

The definition of firm energy used for this study is the maximum average energy that can be produced during the most severe dry sequence of the hydrological record. The dry sequence begins after the last period when secondary energy was generated and ends when the reservoirs are just empty.

After fishery and power generation demands are satisfied, the remaining water in the system is either stored in the reservoirs, depending on operational rule curves, or spilled if all reservoirs are at maximum operating level and the plant is at maximum output.

The rule curve for Smallwood Reservoir was taken from the Gull Island Power Development Report (1997). For Ossokmanuan Reservoir and the forebays, rule curves were developed from actual water levels provided by CF(L)Co. The management rule curves of each of the reservoirs is described below.

- **Ossokmanuan Reservoir**
  Reservoir drawdown begins in mid-February to allow for spring runoff. During spring runoff, the reservoir is allowed to fill. Excess water in Ossokmanuan Reservoir is passed to Smallwood Reservoir. If there is no storage available downstream, or if there is insufficient capacity at Gabbro, or if the plant is at maximum output, the excess water is spilled.

- **Smallwood Reservoir**
  Smallwood Reservoir is operated to meet firm demand. If the reservoir is at the rule curve, excess water is used to generate secondary energy, up to the maximum plant output. Any additional water is spilled at Jacopie.

- **West Forebay**
  During winter, the levels in the West Forebay are kept high and constant to maintain ice cover; otherwise, ice jamming could occur upstream of the Whitefish Falls control structure. During summer, the levels are kept low to allow for storage of excess flow.

- **East Forebay**
  The East Forebay level is allowed to fluctuate depending on energy demands. There are no specific operational constraints on the East Forebay, except that full supply level is not exceeded.

Since the Lower Churchill developments are run-of-the-river, reservoir management is more straightforward than at the Upper Churchill development. Gull Island and Muskrat Falls headpond levels are kept constant (on a monthly time step) and any flow above maximum power flow is spilled.

The Romaine reservoir was assumed to be operated to provide water for firm energy if the Upper Churchill reservoirs are below their rule curves, water was also released to bring them to their rule curves. Water will also be released to generate secondary energy. If water levels in Romaine and St. Jean reservoirs are above the maximum allowable levels, and the Upper Churchill reservoirs are at

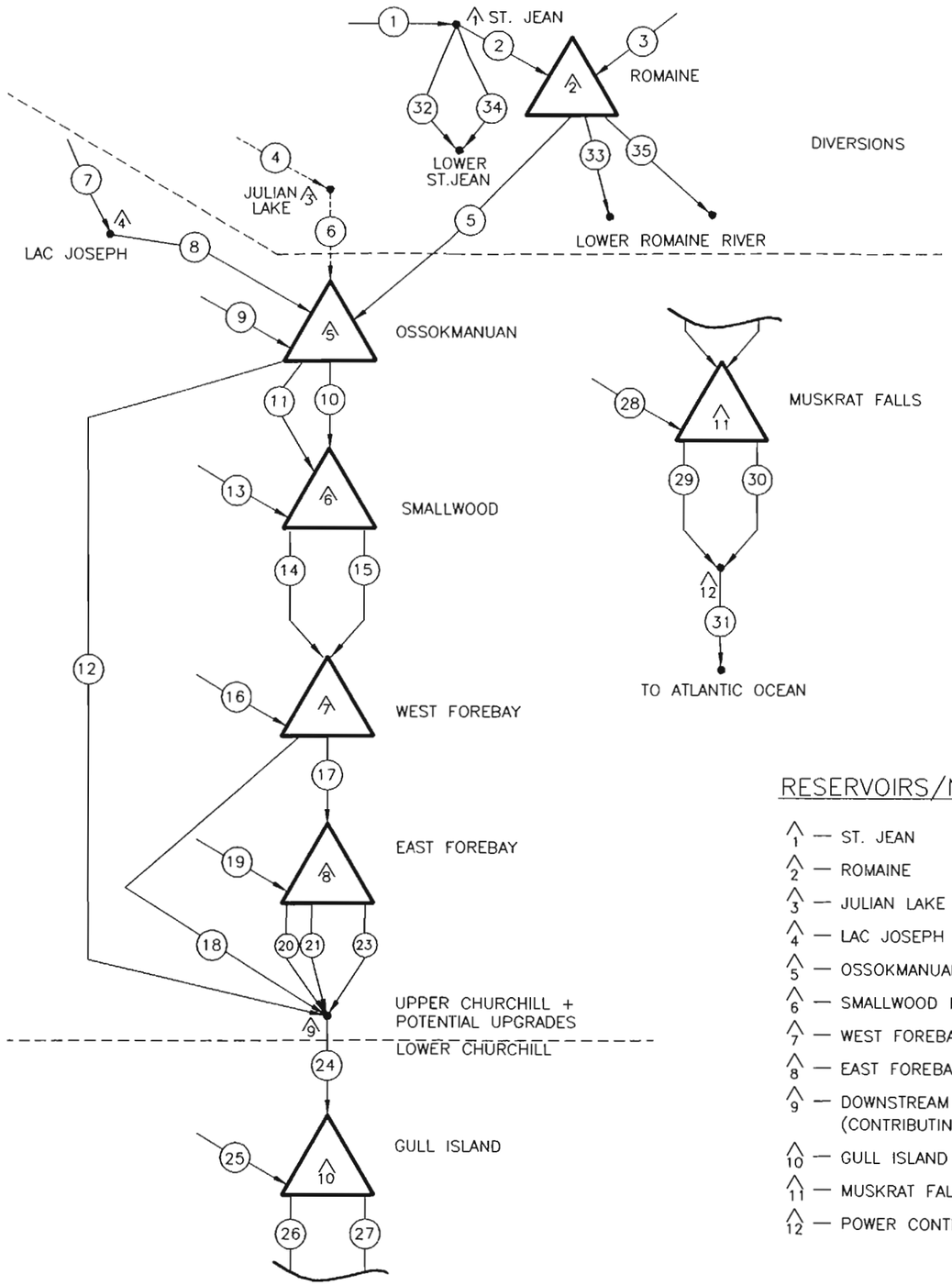
or above their rule curves, and the plant is generating at maximum output, excess flows from the Romaine and St. Jean reservoirs will be spilled.

For the fishery releases, ten percent of the mean local inflow to St. Jean and Romaine Rivers above the diversions is passed downstream. This demand must be met before any system demands or constraints are imposed. Table 4.8 summarizes the monthly fishery releases assumed for both the St. Jean and Romaine Rivers.

4.4 Model Calibration with Existing Data 1995-1997

In order to ensure that all the above physical characteristics represent the existing system, historical data were used to calibrate the model. For the period May 1995 to April 1997, the model was run to match the recorded power flow. Simulated water levels and generation were reviewed to ensure that the model accurately estimated operation and flow releases.

The initial model run slightly over-estimated the power generation of the system, and the plant efficiency in the model was reduced by 1.5 percent (the difference in historical and simulated energy). With this change in input data, results agreed with recorded data. This model setup of the existing Churchill Falls plant was used in all further runs for existing and proposed developments.



RESERVOIRS/NODES

- ^1 — ST. JEAN
- ^2 — ROMAINE
- ^3 — JULIAN LAKE
- ^4 — LAC JOSEPH
- ^5 — OSSOKMANUAN RESERVOIR
- ^6 — SMALLWOOD RESERVOIR
- ^7 — WEST FOREBAY
- ^8 — EAST FOREBAY
- ^9 — DOWNSTREAM OF CHURCHILL FALLS STATION (CONTRIBUTING TO TAILWATER LEVELS)
- ^10 — GULL ISLAND
- ^11 — MUSKRAT FALLS
- ^12 — POWER CONTROL NODE

CHANNELS

- (1) — ST. JEAN LOCAL INFLOW
- (2) — DIVERSION CHANNEL ST. JEAN TO ROMAINE
- (3) — ROMAINE LOCAL INFLOW
- (4) — JULIAN LOCAL INFLOW
- (5) — REGULATED FLOW ROMAINE TO OSSOKMANUAN
- (6) — GENERAL FLOW JULIAN TO OSSOKMANUAN
- (7) — LAC JOSEPH LOCAL INFLOW
- (8) — GENERAL FLOW LAC JOSEPH TO OSSOKMANUAN
- (9) — OSSOKMANUAN LOCAL INFLOW
- (10) — GABBRO CONTROL STRUCTURE
- (11) — FLOW OVER GABBRO CONTROL STRUCTURE
- (12) — OSSKMANUAN CONTROL STRUCTURE
- (13) — SMALLWOOD LOCAL INFLOW
- (14) — LOBSTICK CONTROL STRUCTURE
- (15) — LOBSTICK POWER FLOW
- (16) — WEST FOREBAY LOCAL INFLOW
- (17) — WHITEFISH FALLS CONTROL STRUCTURE
- (18) — JACOPIE SPILLWAY
- (19) — EAST FOREBAY LOCAL INFLOW
- (20) — CHURCHILL FALLS POWER FLOW
- (21) — CF2 STATION POWER FLOW
- (23) — EAST FOREBAY SPILL
- (24) — GENERAL FLOW CF STATION TO GULL ISLAND
- (25) — GULL ISLAND LOCAL INFLOW
- (26) — GULL ISLAND POWER FLOW
- (27) — GULL ISLAND SPILL
- (28) — MUSKRAT FALLS LOCAL INFLOW
- (29) — MUSKRAT FALLS POWER FLOW
- (30) — MUSKRAT FALLS SPILL
- (31) — POWER CONTROL CHANNEL
- (32) — ST. JEAN FISHERY RELEASE
- (33) — SPILL TO LOWER ROMAINE
- (34) — SPILL TO LOWER ST. JEAN
- (35) — ROMAINE FISHERY RELEASE

NOTE: JULIAN LAKE INCLUDED IN MODEL FOR POTENTIAL DEVELOPMENTS, NOT USED IN CURRENT MODEL SIMULATIONS.

FIG 4.1

NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
POWER AND ENERGY MODELING

MODEL SCHEMATIC – CHURCHILL RIVER SYSTEM

ACRES

Month	Availability	
	Previous Study	ARSP Model
May	5118.4	5350.0
Jun	4922.4	5100.0
Jul	4866.4	5100.0
Aug	4832.8	5100.0
Sep	4866.4	5100.0
Oct	5012.0	5100.0
Nov	5163.2	5350.0
Dec	5437.6	5600.0
Jan	5460.0	5600.0
Feb	5437.6	5600.0
Mar	5213.6	5600.0
Apr	5180.0	5600.0

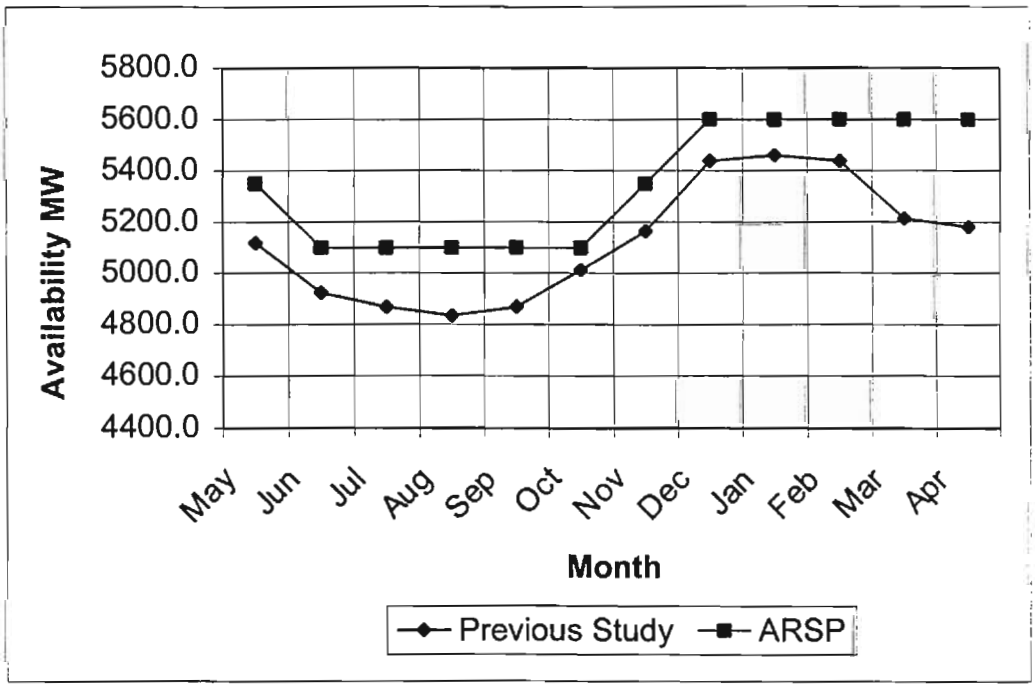


FIG. 4.2

NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
POWER AND ENERGY MODELING
AVAILABILITY CURVE

ACRES

Table 4.1

Comparison with Previous Energy Results

Case	Average Annual Energy		
	Previous Model (TWh/yr)	ARSP Model (TWh/yr)	Percent Difference (%)
1) Match Existing Churchill Falls			
-Churchill Falls	33.74	33.82	0.2
2) Match Existing Churchill Falls + Gull			
-Churchill Falls	33.56	33.59	0.1
-Gull Island	11.85	11.84	-0.1
-Total	45.41	45.43	0.0
3) Match Existing Churchill Falls + Gull + Muskrat			
-Churchill Falls	33.53	33.36	-0.5
-Gull Island	11.62	11.78	1.4
-Muskrat Falls	4.82	4.75	-1.4
-Total	49.97	49.89	-0.2

vs 50.40 ALI% reg study

Note:

- Previous average annual energies were taken from the Gull Island Power Development Study (October 1997).

Table 4.2

Key Reservoir Features

Basin	Reservoir/ Forebay	Full Supply Level (m)	Low Supply Level (m)	Live Storage Volume (*10^6 m^3)
Diversions from the Province of Quebec	Romaine River Diversion Headpond	500.00	497.00	4000
Upper Churchill	Ossokmanuan Reservoir	479.15	475.03	2835
	Smallwood Reservoir	472.74	464.05	28946
	West Forebay	452.93	451.00	141
	East Forebay	448.51	447.60	121
Lower Churchill	*Gull Island Reservoir	125.00	122.00	550
	*Muskrat Falls Reservoir	39.00	39.00	0

Sources: Gull Island Power Development Report (October 1997)
CF(L)Co. Storage Curves (November 1996)
Hydro-Quebec Presentation Notes (February 1998)
Flood Handling Study Report (March 1989)

Table 4.3

Reservoir Storage Curves

Ossokmanuan Reservoir

Elev. (m)	Storage (*10^6 m^3)
475.03	0
476.00	586
478.00	1923
478.75	2490
479.00	2701
479.50	3176
479.99	3734

Source: CF(L)Co. (November 1996)

Smallwood Reservoir

Elev. (m)	Storage (*10^6 m^3)
464.05	0
467.10	2618
469.00	10375
470.50	17185
471.50	22135
472.50	27551
473.04	30756

Source: CF(L)Co. (November 1996)

West Forebay

Elev. (m)	Storage (*10^6 m^3)
445.00	0
445.50	7
446.00	13
447.00	31
448.00	54
449.00	83
450.00	120
451.00	167
452.00	231
452.93	309
452.99	315

Source: CF(L)Co. (November 1996)

East Forebay

Elev. (m)	Storage (*10^6 m^3)
443.80	0
445.00	124
447.10	370
448.70	580
448.99	621

Source: CF(L)Co. (November 1996)

Gull Island

Elev. (m)	Storage (*10^6 m^3)
119.00	3200
122.00	3750
125.00	4300

Muskrat Falls

Elev. (m)	Storage (*10^6 m^3)
39.00	0
39.50	0

Source: Gull Island Power Development Report (October 1997)

Romaine Headpond

Elev. (m)	Storage (*10^6 m^3)
497.00	0
500.00	4000

Source: Hydro-Quebec presentation Notes (February 1998)

Table 4.4

Power Plant Characteristics

Power Plant Characteristics	Stations				
	Lobstick	Churchill Falls	Churchill Falls New	Gull Island	Muskrat Falls
Installed Capacity (MW)	160	5600	1000	2264	824
Maximum Flow (m^3/s)	2020	1996	390	3055	2806
Best Efficiency Flow (m^3/s)	1618	1760	354	2752	2610
Efficiency @ Max Flow (%)	83.2	89.7	92.2	90.6	88.6
Efficiency @ Best Flow (%)	87.6	90.8	NR	92.2	90.9
Design Net Head (m)	9.7	312.4	312.4	85.6	34.4
Head Loss (m)	0.18	0.00	0.00	1.39	1.09

NR - Not Required (Unit Base loaded); See Section 4.3.2 for Sources of information

Table 4.5

Tailwater Curves

Lobstick Station		Churchill Falls and CF2 without Gull		Churchill Falls and CF2 with Gull	
Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)
458.42	0	124.10	0	125.00	0
459.24	283	124.60	400	125.30	400
459.73	566	124.80	600	125.50	600
460.14	850	125.10	800	125.80	800
460.50	1133	125.50	1000	126.10	1000
460.82	1416	125.90	1200	126.40	1200
461.11	1700	126.70	1600	127.10	1600
461.38	1982	127.50	2000	127.80	2000
461.62	2265	129.10	2800	129.10	2800
462.09	2832				
463.69	5653				

Gull Island without Muskrat Falls		Gull Island with Muskrat Falls		Muskrat Falls	
Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)
35.90	0	39.00	0	1.90	0
36.50	500	39.01	283	1.98	566
36.90	1000	39.03	566	3.44	2515
37.30	1500	39.07	850	3.80	3000
37.60	2000	39.09	1133		
37.90	2500	39.19	1699		
38.20	3000	39.32	2265		
38.80	4000	39.48	2832		
39.30	5000	40.37	5663		
39.80	6000				

Sources: Gull Island Power Development Report (October 1997)
and Churchill River Complex Energy Report (January 1991)

Table 4.6

Monthly Demand Fraction

Month	Demand Fraction	
	MW/MWc	GWh/GWh/yr
May	0.9073	0.0771
Jun.	0.8816	0.0725
Jul.	0.8767	0.0745
Aug.	0.8861	0.0753
Sep.	0.8828	0.0726
Oct.	0.9320	0.0792
Nov.	1.0458	0.0860
Dec.	1.1450	0.0973
Jan	1.2027	0.1022
Feb.	1.1687	0.0897
Mar	1.0838	0.0921
Apr.	0.9910	0.0815

Source: Gull Island Power Development Report (October 1997)

Note:

- ARSP model requires demand fraction with respect to power (MW/MWc). Therefore, numbers provided in Gull Island Power Development Report (GWh/GWh/yr) were converted.

Table 4.7

Structure Discharge Curves

Gabbro Control Structure		Lobstick Control Structure		Whitefish Control Structure	
Elev. (m)	Discharge (m^3/s)	Elev. (m)	Discharge (m^3/s)	Elev. (m)	Discharge (m^3/s)
472.90	0.00	457.20	0.00	448.00	0.00
473.35	169.90	463.30	2124.00	448.50	1077.00
473.96	339.80	466.34	3330.00	449.00	1518.00
474.88	566.30	469.39	4604.00	449.60	1905.00
476.40	1076.00	470.92	5326.00	451.10	2601.00
477.32	1415.80	472.44	6133.00	451.40	2718.00
478.54	1868.90	472.74	6329.00	451.70	2826.00
479.76	2491.90	473.96	7127.00	452.00	2937.00
				452.30	3045.00
				452.60	3153.00
				452.90	3258.00
				453.50	3459.00

Source: CF(L)Co.

Table 4.7 (con't)

Structure Discharge Curves

Flow Over Gabbro Control Structure*

Elev. (m)	Discharge (m^3/s)
472.90	0.0
479.76	0.0
479.91	5.9
480.06	16.8
480.36	47.5
480.67	87.3
480.97	134.5
481.28	160.5

Ossokmanuan Control Structure*

Elev. (m)	Discharge (m^3/s)
474.20	0.0
475.50	311.0
476.30	623.0
477.00	962.0
477.80	1472.0
478.50	2066.0
479.15	2348.0
480.50	3679.0

Jacopie Spillway*

Elev. (m)	Discharge (m^3/s)
440.90	0.0
445.00	1764.0
446.50	2307.0
448.10	2904.0
449.60	3557.0
451.10	4269.0
452.63	5045.0
454.15	5888.0
455.00	6359.4

Gull Island Spillway**

Elev. (m)	Discharge (m^3/s)
115.00	10000.0
125.00	10000.0

Muskrat Falls Spillway**

Elev. (m)	Discharge (m^3/s)
35.00	10000.0
45.00	10000.0

Romaine Spillway***

Elev. (m)	Discharge (m^3/s)
485.30	2410.0
520.00	2410.0

East Forebay Spillway*

Elev. (m)	Discharge (m^3/s)
436.47	0.0
438.90	169.9
440.40	396.4
441.96	736.2
443.50	1189.3
445.00	1699.0
446.50	2265.4
448.06	2718.4
448.67	2973.3
449.28	3199.8

Atikonak Control Structure***

Elev. (m)	Discharge (m^3/s)
490.00	0.0
497.00	335.0
500.00	680.0

Source: *Flood Handling Study (March 1989)
**Gull Island Power Development Report (October 1997)
***Hydro-Quebec Presentation Notes (February 1998)

Table 4.8

Monthly Fishery Releases

Month	Monthly Fishery Release (m^3/s)	
	St. Jean River	Romaine River
May	4.6	29.4
Jun.	8.8	56.7
Jul.	4.8	30.6
Aug.	3.1	20.1
Sep.	2.8	18.1
Oct.	3.0	19.3
Nov.	2.3	14.8
Dec.	1.6	10.1
Jan.	1.1	7.0
Feb.	0.8	4.9
Mar.	0.8	4.9
Apr.	1.1	6.7
Average	2.9	18.6

Note:
- Fishery release equal to 10 percent mean monthly flow

Model Results

5 Model Results

This section of the report presents the firm and average energy results of each model run for the existing and potential Churchill River developments. Detailed input and output for each of the model setups are provided in Volumes 2 and 3 as follows.

- **Volume 2:**
  ARSP model input and output, including summary of system production and energy distribution, and available energy for sale at Québec-Labrador border for Run 1 to Run 4.

- **Volume 3:**
  ARSP model input and output, including summary of system production and energy distribution, and available energy for sale at Québec-Labrador border for Run 5 to Run 8.

5.1 Required Model Setups

The following model setups defined by NLH were required for this study.

- Churchill Falls Existing (CF1) (Run 1)
- CF1 plus Gull Island (Run 2)
- CF1 plus Gull Island plus Muskrat Falls (Run 3)
- CF1 plus New Units at Churchill Falls (CF2) plus Diversions (New CF) (Run 4)
- New CF plus Gull Island (Run 5)
- New CF plus Gull Island plus Muskrat Falls (Run 6)
- New CF plus Gull Island plus Lobstick (Run 7)
- New CF plus Gull Island plus Lobstick plus Muskrat Falls (Run 8)

5.2 Results of Churchill River System Modeling

Table 5.1 summarizes the incremental average and firm energy for Runs 1 to 8. Model results for Runs 1 to 3 are summarized in Table 5.2 and model results for Runs 4 to 8 are summarized in Table 5.3.

5.3 Comparison with Previous Results

Table 5.4 compares the ARSP model results with previous energy results. There is good agreement between the total energy results of this model and the previous work. The differences are due to the inclusion of additional data provided by and agreed upon with NLH and CF(L)Co, as well as harmonized inflows.

5.4 Sensitivities

The following sensitivity runs were carried out to determine the effect of varying the following variables on energy output.

- Three additional installed capacities at Muskrat Falls.
- Maximizing firm energy.
- Maximizing average annual energy.
- No fishery release from Romaine.
- Reduced period of record for inflow sequences.
- Diversion inflow sequence.
- Romaine storage curve and Atikonak Lake control structure.

Each of these is discussed below and the results of the analysis are summarized in Table 5.5, which also shows the base case results.

Muskrat Falls Installed Capacity

In the original model runs which included Muskrat Falls, it was noticed that the spill from the plant was significantly larger than from Gull Island. The Muskrat Falls installed capacity was increased and the corresponding energy determined. For this sensitivity, the case including CF1, Gull Island, and Muskrat Falls (Run 3) was used for comparison. For the largest installed capacity, (950 MW) the average energy increased by approximately 0.2 percent over the base case.

Maximizing Firm Energy

In order to maximize the firm energy of the existing system, each reservoir was kept at full supply level. Although this is not the normal operation of the system and would result in increased spill, it indicates the upper limit of firm energy available from the system. This was performed for only the existing Churchill River case (Run 1). The maximum firm energy of the system is approximately one percent higher over the base case firm energy.

Maximizing Average Annual Energy

To maximize average annual energy, no firm energy requirement was imposed. The reservoirs in the system were kept low. This rule ensures that storage is not used to protect firm, and spill is minimized. The result indicates the upper limit of average annual energy available for the existing system. This was performed for only the existing Churchill River case (Run 1). The maximum average annual energy of the system is approximately 0.3 percent higher over the base case average annual energy.

No Fishery Release from Romaine

To indicate the energy lost through the release of water to the Lower Romaine for fish, the model was run assuming no release of water to the Lower Romaine River. For this sensitivity, the case including CF1 and CF2 and the diversions (Run 4) was used for comparison. This resulted in the average annual energy being approximately one percent higher than the base case.

Reduced Period of Record for Inflow Sequences

To determine the difference in energy of shortening the inflow sequence to start the same year that the hydrometric station located at Muskrat Falls on the Churchill River began recording continuous flow, the inflow sequences were reduced from 54 years to 43 years. A review of the hydrometric station data indicated that the gauge started recording continuous flow in 1954. Therefore, the model inflow sequence was changed to begin in May 1954. For this sensitivity, the case including CF1, Gull Island, and Muskrat Falls (Run 3) was used for comparison. This increased the average annual energy by approximately one percent over the base case.

Diversion Inflow Sequence

As previously discussed in Section 3.2, for the diversions from Québec the Ossokmanuan inflow sequence was prorated based on average flow. Hydro-Québec provided an inflow sequence which included local inflow from St. Jean

and Romaine, and included fisheries releases. For this sensitivity, the case including CF1 and CF2, and the diversions (Run 4) was used for comparison. The average annual energy was increased by approximately 0.2 percent over the base case.

Romaine Storage Curve and Atikonak Lake Control Structure

Hydro-Québec provided the Romaine headpond storage curve and Atikonak Lake, which were values not available during model setup and runs. To determine the effect of these changes on the results, the case including CF1, CF2, and the diversions (Run 4) was used for comparison. The average annual energy was decreased by approximately 0.1 percent over the base case.

Table 5.1

Incremental Average and Firm Energy Above Existing Case (Run 1)

Model Setups	Installed Capacity (MW)	Firm Energy (TWh/yr)	Average Energy (TWh/yr)	Incremental Firm Energy (TWh/yr)	Incremental Avg Energy (TWh/yr)
Existing (CF1) (Run 1)	5600	31.37	34.50	-	-
CF1 + Gull (Run 2)	7864	42.16	46.28	10.79	11.78
CF1 + Gull + Muskrat (Run 3)	8688	46.24	50.69	14.87	16.19
Diversions + CF1 + CF2 (New CF) (Run 4)	6600	36.00	39.42	4.63	4.92
New CF + Gull (Run 5)	8864	47.91	52.42	16.54	17.92
New CF + Gull +Muskrat (Run 6)	9688	52.40	57.19	21.03	22.69
New CF + Gull + Lobstick (Run 7)	9024	48.80	53.50	17.43	19.00
New CF + Gull + Lobstick + Muskrat (Run 8)	9848	53.29	58.28	21.92	23.78

Table 5.2

Model Results - Run 1 to Run 3

Model Setups	Installed Capacity (MW)	Firm Energy (TWh/yr)	Average Energy (TWh/yr)	Incremental Avg Energy (TWh/yr)	Spill (m^3/s)	Incremental Spill (m^3/s)	Energy Eqv. of Spill (GWh/yr)
Existing (CF1) (Run1)							
-CF1	5600	31.37	34.50	-	15.8	-	397.2
CF1 + Gull (Run2)							
-CF1	5600		34.30	-0.19	21.8	6.0	546.9
-Gull Island	2264		11.98	-	14.7	-	100.1
-Total	7864	42.16	46.28	11.78	36.5	20.7	647.0
CF1 + Gull + Muskrat (Run3)							
-CF1	5600		34.24	-0.07	24.4	2.5	610.5
-Gull Island	2264		11.54	-0.44	13.4	-1.2	88.3
-Muskrat Falls	824		4.91	-	31.9	-	86.8
-Total	8688	46.24	50.69	16.19	69.7	53.8	785.6

Note:
- For total average energy, incremental average energy is the difference over the existing case (Run 1).
- For individual plant energy, incremental average energy is the difference over the previous run.
- Incremental spill is calculated the same as incremental average energy.
- Energy generation is energy at bus before losses and load demands.

Table 5.3

Model Results - Run 4 to Run 8

Model Setups	Installed Capacity (MW)	Firm Energy (TWh/yr)	Average Energy (TWh/yr)	Incremental Avg Energy (TWh/yr)	Spill (m^3/s)	Incremental Spill (m^3/s)	Energy Eqv. of Spill (GWh/yr)
Diversions + CF1 + CF2 (New CF)							
(Run 4) -CF1	5600		31.02	-	16.5	-	413.2
-CF2	1000		8.40	-	-	-	-
-Total	6600	36.00	39.42	-	16.5	-	413.2
New CF + Gull (Run 5)							
-CF1	5600		30.81	-0.21	13.3	-3.2	332.7
-CF2	1000		8.40	0.00	-	0.0	-
-Gull Island	2264		13.21	-	14.9	-	101.6
-Total	8864	47.91	52.42	13.00	28.2	11.7	434.2
New CF + Gull +Muskrat (Run6)							
-CF1	5600		30.71	-0.10	13.8	0.5	346.3
-CF2	1000		8.40	0.00	-	0.0	-
-Gull Island	2264		12.72	-0.49	12.9	-2.0	84.9
-Muskrat Falls	824		5.36	-	39.5	-	107.4
-Total	9688	52.40	57.19	17.77	66.3	49.8	538.6
New CF + Gull + Lobstick (Run 7)							
-Lobstick	160		1.09	-	78.6	-	58.6
-CF1	5600		30.80	0.09	13.4	-0.4	335.2
-CF2	1000		8.40	0.00	-	0.0	-
-Gull Island	2264		13.21	0.49	15.1	2.1	102.7
-Total	9024	48.80	53.50	14.08	107.1	90.6	496.5
New CF + Gull +Lobstick+Muskrat (Run 8)							
-Lobstick	160		1.09	0.00	81.1	2.5	60.6
-CF1	5600		30.71	-0.09	13.8	0.4	345.8
-CF2	1000		8.40	0.00	-	0.0	-
-Gull Island	2264		12.72	-0.49	12.9	-2.1	84.9
-Muskrat Falls	824		5.36	-	39.8	-	108.2
-Total	9848	53.29	58.28	18.86	147.7	131.2	599.6

Note: - Notes as per Table 5.2, exceptions follow.
- For total average energy, incremental average energy is the difference over Run 4.
- Energy generation is energy at bus before losses and load demands.

Tab5_3.WK4
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Table 5.4

Comparison of Model Results

Model Setups	1997 Estimated Energy (TWh/yr)	1998 Estimated Energy (TWh/yr)	Percent Difference (%)
Existing (CF1) (Run 1)			
-CF1	33.74 *	34.50	2.3
CF1 + Gull (Run 2)			
-CF1	33.56 *	34.30	2.2
-Gull Island	11.85 *	11.98	1.1
-Total	45.41 *	46.28	1.9
CF1 + Gull + Muskrat (Run 3)			
-CF1	33.53 *	34.24	2.1
-Gull Island	11.62 *	11.54	-0.6
-Muskrat Falls	4.82 *	4.91	1.8
-Total	49.97 *	50.69	1.4
Diversions + CF1 + CF2 (New CF) (Run 4)			
-CF1	-	31.02	-
-CF2	-	8.40	-
-Total	38.83 **	39.42	1.5
New CF + Gull (Run 5)			
-CF1+CF2	38.76 **	39.21	1.2
-Gull Island	12.92 **	13.21	2.2
- Total	51.68 **	52.42	1.4

* Gull Island Power Development Report (October 1997)
** Hydro-Quebec Presentation Notes (February 1998)

Table 5.5

Results of Sensitivities

Sensitivity	Installed Capacity (MW)	Firm Energy (TWh/yr)	Average Annual Energy		Difference in Energy (TWh/yr)
			Sensitivity (TWh/yr)	*Base Case (TWh/yr)	
Sensitivity to Muskrat IC					
-CF1	5600		34.24	34.24	0.00
-Gull Island	2264		11.54	11.54	0.00
-Muskrat Falls	830		4.91	4.91	0.00
-Total	8694	46.24	50.69	50.69	0.00
Sensitivity to Muskrat IC					
-CF1	5600		34.24	34.24	0.00
-Gull Island	2264		11.54	11.54	0.00
-Muskrat Falls	850		4.92	4.91	0.01
-Total	8714	46.24	50.71	50.69	0.02
Sensitivity to Muskrat IC					
-CF1	5600		34.29	34.24	0.05
-Gull Island	2264		11.55	11.54	0.01
-Muskrat Falls	950		4.96	4.91	0.05
-Total	8814	46.24	50.80	50.69	0.11
Sensitivity to Average Annual Energy					
-CF1	5600	-	34.61	34.50	0.11
Maximize Average Annual Energy					
Sensitivity to Firm Energy					
-CF1	5600	31.69	33.72	34.50	-0.78
Maximize Firm Energy					
Sensitivity to Romaine Fishery Release					
-CF1	5600		31.44	31.02	0.42
-CF2	1000		8.40	8.40	0.00
- Total	6600	36.50	39.84	39.42	0.42
Sensitivity to Length of Inf. Sequence					
-CF1	5600		34.60	34.24	0.36
-Gull Island	2264		11.67	11.54	0.13
-Muskrat Falls	824		4.96	4.91	0.05
-Total	8688	46.24	51.23	50.69	0.54
Sensitivity to Diversion Inf. Sequence					
-CF1	5600		31.08	31.02	0.06
-CF2	1000		8.4	8.40	0.00
- Total	6600	35.64	39.48	39.42	0.06
Sensitivity to Romaine Storage and Atikonak Lake Structure Curve					
-CF1	5600		30.99	31.02	-0.03
-CF2	1000		8.4	8.40	0.00
- Total	6600	35.94	39.39	39.42	-0.03

* Base Case results refer to model setups Run 1 to Run 8.

Energy Available for Sale at Québec-Labrador Border

6 Energy Available for Sale at Québec-Labrador Border

Energy generated at the existing and proposed Churchill River developments, once losses and demands including infeed are removed, will be transmitted to the province of Québec for sale to energy markets. In order to determine the amount of energy available, a post-processor was developed to carry out the required calculations using the ARSP output. Appendix G presents the detailed calculations for Run 1. Summary of system production and energy distribution, and results for the energy available for sale at the Québec-Labrador border for all runs are provided in Volumes 2 and 3 of this report.

6.1 Transmission Layout

The transmission layout presented in Figure 6.1 was assumed for the Churchill River system, as provided by NLH. Information on line and generator losses used to determine the available energy for sale at the Québec-Labrador border were provided by NLH (Appendix H). This table was updated in discussions with NLH to take account of variations in installed capacities and maximum loads at the bus. These loss numbers and transmission line losses are summarized in Table 6.1.

The procedure used to calculate energy available at the Québec-Labrador border is as follows.

1) Calculate the total system energy using ARSP.

2) Calculate net total system energy by removing the generator transformer losses from total system energy.

3) Subtract infeed to the Island (except for Run 1 and Run 4), Labrador loads, and station services/Twin Falls loads (Twinco Block) from the net total system energy to determine the energy available for sale at the Québec-Labrador border at the sending end. The Labrador and Island loads used in the calculations are presented in Appendix E.

4) Determine the energy available for sale at the Québec-Labrador border by subtracting the line losses from the energy available at the sending end.

It was noticed that the maximum load at 230 kV values are exceeded for the energy available at the Québec-Labrador border at the sending end for some months in some runs. This has to do with the calculation of maximum load at the bus. This affects the loss at maximum load. It was determined that the adjustment in losses at maximum load would not affect the results.

6.2 Energy at Québec-Labrador Border

Values of average annual and monthly energy available for sale at the Québec-Labrador border (TWh) are presented in Table 6.2. Total and incremental average energy available for sale at the Québec-Labrador border (TWh) is presented in Table 6.3.

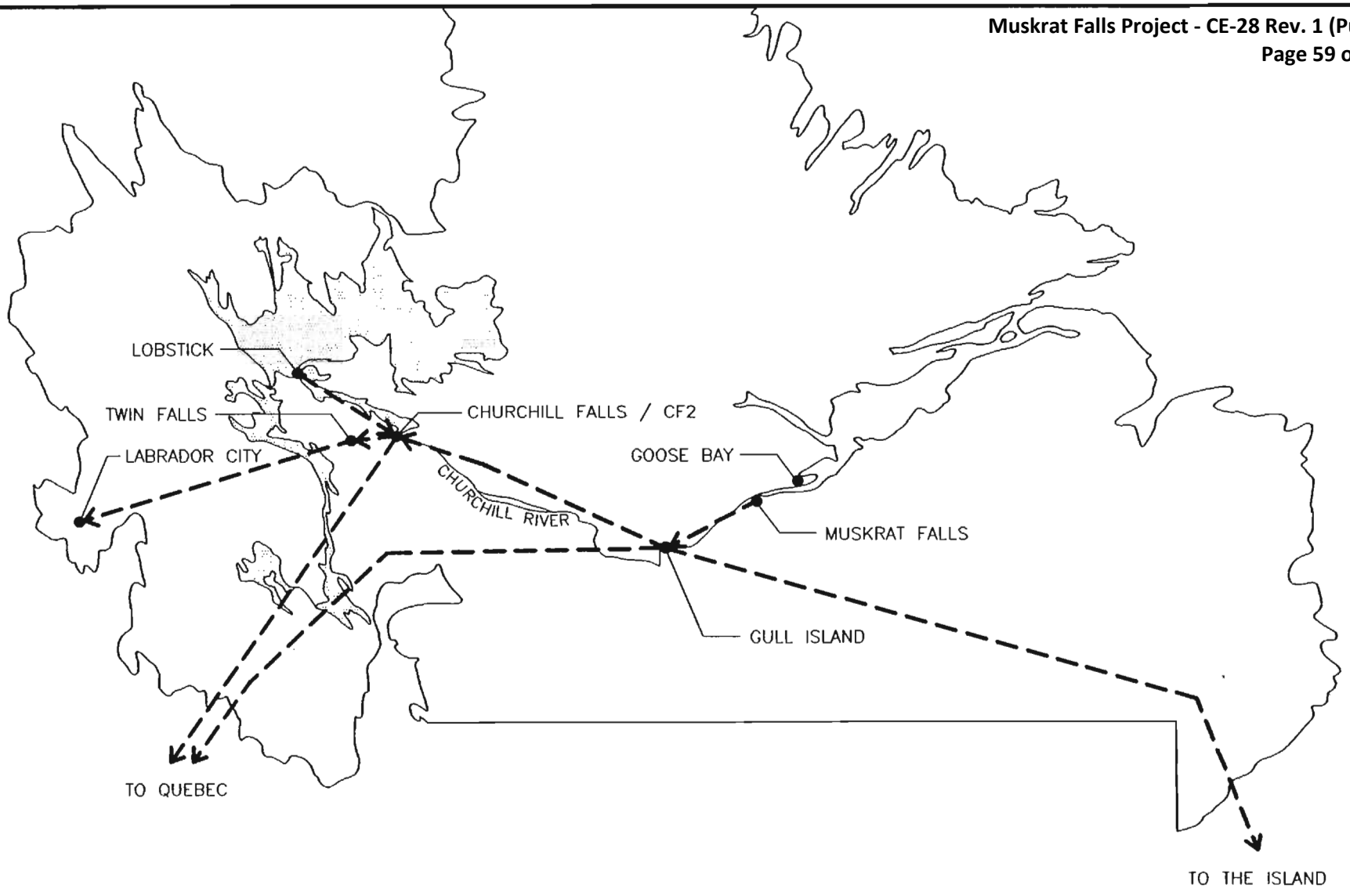


FIG. 6.1

NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
POWER AND ENERGY MODELING

TRANSMISSION LAYOUT

ACRES

Table 6.1

Summary of Transmission System Losses

Run No.	Max. Total Generation (1) (MW)	Max. Generator Transformer (2) Losses (MW)	Maximum 230kV Bus Load (3) (MW)	Max Load at 230kV Sending End (MW) (4)	Losses at Max. Load (MW) (5)
1	5600	15.6	377.1	5207.3	52.1
2	7864	22.8	1092.4	6748.8	71.7
3	8688	24.8	1092.4	7570.8	105.9
4	6600	18.4	377.1	6204.5	70.1
5	8864	25.4	1092.4	7746.2	90.5
6	9688	27.4	1092.4	8568.2	126.0
7	9024	26.0	1092.4	7905.6	98.5
8	9848	28.0	1092.4	8727.6	133.9

Notes:
1. Maximum Total Generation is the gross generation output less unit service, excitation system, and isophase bus losses. This yields the generation at the low voltage bushing of the generator step up transformer.
2. The 15/230 kV and 13.8/230 kV generator step up transformer losses.
3. 230 kV bus load includes Labrador Loads, Station Service/Twin Falls Loads and HVDC Loads at Gull Island where appropriate.
4. This is the available generation for the 735 kV network and is calculated as Total Generation less generator transformer losses and 230 kV bus loads. Churchill Falls 230 kV cable losses are ignored.
5. This is the 230/735 kV autotransformer and 735 kV transmission line losses to the border. 735 kV shunt reactor losses are ignored.

For total generator output levels other than those given in the table, losses are approximated as follows for each generation scenario:

Generator Transformer Losses (MW) = (0.15 * TLF + 0.85 * TLF^2) * (Max. Generator Trans. Losses)

$$TLF = \frac{\text{(Current Total Generation)}}{\text{(Maximum Total Generation)}}$$

Transmission System Losses (MW) = (0.15 * LF + 0.85 * LF^2) * (Losses at Maximum Load)

$$LF = \frac{\text{(Current Load at 230kV Bus)}}{\text{(Maximum Load at 230kV Bus)}}$$

Current Load at Sending End = Current Total Generation - Generation Transformer Losses - 230kV Bus Load

230kV Bus Load = HVDC Infeed Load + Station Service/Twin Falls (Twinco Block) Load + Labrador Load

Table 6.2

Average Annual and Monthly Energy Available for Sale at Quebec-Labrador Border (TWh)

Run No.	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
1	2.21	2.22	2.62	2.55	2.35	2.52	2.46	2.75	2.95	2.71	2.98	2.86	31.18
2	2.72	2.81	3.45	3.33	3.13	3.23	3.04	3.32	3.56	3.19	3.54	3.52	38.84
3	2.99	3.11	3.81	3.71	3.49	3.61	3.39	3.71	3.96	3.55	3.90	3.87	43.10
4	2.57	2.45	3.02	2.92	2.75	2.89	2.83	3.19	3.49	3.30	3.40	3.21	36.02
5	3.14	3.16	3.89	3.78	3.60	3.71	3.53	3.87	4.21	3.91	4.11	3.97	44.88
6	3.45	3.46	4.25	4.21	3.96	4.09	3.93	4.30	4.65	4.30	4.52	4.37	49.49
7	3.20	3.23	3.97	3.87	3.68	3.79	3.60	3.96	4.31	4.02	4.20	4.08	45.91
8	3.52	3.53	4.34	4.29	4.04	4.17	4.01	4.38	4.75	4.40	4.61	4.49	50.53

Table 6.3

Total and Incremental Average Annual Energy Available for Sale at Quebec-Labrador Border (TWh)

Run No.	Available Energy for Sale at Quebec- Labrador Border	
	Total (TWh)	Incremental (TWh)
1	31.18	-
2	38.84	7.66
3	43.10	11.92
4	36.02	4.84
5	44.88	13.70
6	49.49	18.31
7	45.91	14.73
8	50.53	19.35

Conclusions and Recommendations

7 Conclusions and Recommendations

7.1 Conclusions

The conclusions of the study are as follows.

1. The model of the existing Churchill River system, as set up in this study, gives similar results when compared with recorded data and previous studies.

2. The model was used to estimate firm and average annual energy for the existing and proposed developments in the Churchill River basin, and can be used to assess other arrangements.

3. The post-processor developed for this study is a useful tool in determining available energy for sale at the Québec-Labrador border from model results.

4. The Lower Churchill River hydrology may slightly underestimate flows. It could be reviewed using data from Environment Canada hydrometric stations in and around the basin.

7.2 Recommendations

The recommendations of the study are as follows.

1. As more information on diversions from Québec becomes available, the model setups which include the diversions should be updated.

2. The hydrology of the St. Jean River and Romaine River should be further investigated to develop more detailed inflow sequences for the rivers.

Appendix A
Available Information

Table A.1

Available Information

Number	Description
1	Newfoundland and Labrador Hydro (October 1997). *Gull Island Power Development: Review of Engineering and Capital Cost Estimate Final Report; Volume 1* . Prepared by SNC-Agra. Excerpts.
2	Newfoundland and Labrador Hydro (October 1997). *Gull Island Power Development: Review of Engineering and Capital Cost Estimate Final Report; Volume 2 - Detailed Calculation of Energy Simulation* . Prepared by SNC-Agra.
3	Hydro-Quebec (October 1997). *Churchill Falls Inflows Harmonization of Hydro-Quebec and CF(L)Co. Data Bases* . Preliminary*
4	Hydro-Quebec (February 1998). *Partial Diversions of Upper St. Jean and Romaine Rivers - Preliminary Studies.* Hydro-Quebec Presentation Notes. Prepared by Hydro-Quebec.
5	Hydro-Quebec (September 1997). *A Development Scenario for Upper Churchill Watershed.* Hydro-Quebec Presentation Notes.
6	Newfoundland and Labrador Hydro (January 1991). *Churchill River Complex Energy Studies Final Report; Volume 1.* Prepared by SNC.
7	Newfoundland and Labrador Hydro (January 1991). *Churchill River Complex Energy Studies Final Report; Volume 2 (Annex).* Prepared by SNC.
8	Hydro-Quebec and Churchill Falls (Labrador) Corporation Limited (May 1979) *Determination and Adjustments of Technical Operational Characteristics related to the application of the Power Contract of May 12, 1969 between Hydro-Quebec and Churchill Falls (Labrador) Corporation Limited.*

Table A.1 (cont.)

Available Information

Number	Description
9	Churchill Falls (Labrador) Corporation Limited (March 1989). *Flood Handling Study of the Churchill Falls System Main Report*. Prepared by Acres International Limited.
10	Churchill Falls (Labrador) Corporation Limited. *Churchill Falls Reservoir Storage Curves and Volume in International Units.*
11	Acres Canadian Bechtel of Churchill Falls (June 1973). *Rules of Operation for Churchill Falls Reservoir System.* Prepared by Acres Consulting Services Limited.
12	Churchill Falls (Labrador) Corporation Limited. *Storage Curves (November 1996), Structure Curves, and recorded site data (May 1995 to April 1997).* provided by CF(L)Co.

*Note: A comparison with the final report (April 1998) showed no difference in inflows.

Appendix B
Inflow Sequences

Diversions
Inflow Sequences

PERIOD AVERAGE CHANNEL FLOW (cms) : 1 St. Jean Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	40.613	129.750	84.066	85.223	55.015	27.485	21.813	10.779	7.920	6.546	16.524	8.749	41.354
2	1944	1944	38.674	96.430	52.485	29.989	24.918	32.456	22.077	14.175	6.646	5.517	7.311	16.132	28.972
3	1945	1945	61.188	70.866	36.471	17.917	15.413	25.682	21.039	12.136	10.442	4.525	9.514	9.231	24.649
4	1946	1946	33.239	80.698	40.813	14.785	10.825	23.142	14.739	10.096	8.203	8.439	12.199	6.400	22.008
5	1947	1947	21.913	78.012	39.639	26.474	20.457	33.603	31.828	18.536	8.357	6.018	9.122	6.983	25.134
6	1948	1948	36.753	80.315	26.720	21.121	16.879	18.399	18.882	12.582	8.467	4.406	7.693	11.025	21.973
7	1949	1949	31.627	106.590	36.853	17.325	29.606	33.885	25.282	18.763	7.092	8.175	7.939	9.131	27.685
8	1950	1950	105.961	99.516	39.439	25.928	11.999	19.892	19.674	18.417	10.843	19.564	13.064	10.761	33.003
9	1951	1951	38.692	65.676	35.196	30.617	20.575	20.821	15.714	12.054	12.035	8.339	5.408	9.368	22.940
10	1952	1952	28.113	85.022	44.855	26.939	23.871	32.092	21.631	17.188	8.558	21.504	6.118	11.152	27.211
11	1953	1953	40.649	68.781	47.905	25.928	33.485	25.045	12.764	8.603	6.136	7.920	10.260	8.922	24.769
12	1954	1954	82.291	94.654	58.703	37.809	33.139	26.374	28.760	13.246	10.606	11.325	7.292	12.318	34.820
13	1955	1955	60.278	79.951	48.106	21.285	15.695	16.096	14.621	15.122	13.128	5.772	6.782	9.004	25.601
14	1956	1956	17.671	95.319	60.096	33.102	30.817	31.627	20.702	12.582	9.832	8.403	7.656	7.993	28.027
15	1957	1957	17.507	111.169	56.946	36.252	37.563	34.941	21.103	18.481	16.524	14.421	13.874	15.896	32.893
16	1958	1958	59.012	98.715	45.292	37.964	42.607	29.907	20.757	14.921	10.806	8.804	8.057	7.893	32.138
17	1959	1959	52.949	98.405	41.341	30.316	18.763	25.382	17.389	12.928	10.115	8.685	7.493	6.864	27.622
18	1960	1960	37.864	75.263	36.716	36.088	45.056	37.281	21.668	14.703	11.089	9.614	8.986	11.043	28.834
19	1961	1961	40.950	51.756	41.523	21.331	16.697	30.535	23.106	15.732	9.368	7.147	6.000	5.654	22.589
20	1962	1962	14.175	87.890	34.149	25.965	28.131	17.735	13.110	10.460	8.403	7.028	6.300	6.400	21.632
21	1963	1963	25.218	83.138	38.209	28.195	22.696	18.235	14.521	11.954	10.060	9.332	8.057	8.403	23.183
22	1964	1964	44.428	82.419	30.025	28.596	31.746	28.659	17.161	12.582	10.579	9.550	9.368	9.368	26.245
23	1965	1965	26.820	101.273	67.998	43.462	51.419	34.595	19.510	14.921	12.236	10.115	9.031	8.749	33.405
24	1966	1966	32.028	115.011	64.620	42.607	32.428	36.835	35.688	14.803	12.864	12.300	8.804	10.297	34.894
25	1967	1967	31.345	63.063	34.595	30.371	16.178	24.016	26.939	14.075	13.774	11.325	10.806	13.146	24.179
26	1968	1968	62.162	79.141	34.495	30.999	49.699	41.396	30.371	19.847	13.046	10.115	9.086	7.374	32.391
27	1969	1969	34.431	107.336	73.242	36.771	36.025	44.428	25.846	20.129	17.443	13.674	11.553	11.389	36.106
28	1970	1970	26.875	112.953	52.667	25.628	22.760	17.889	13.610	10.178	8.640	6.810	5.553	7.711	25.951
29	1971	1971	71.148	79.269	57.128	32.656	24.253	37.463	9.495	6.864	5.717	5.207	7.429	6.983	28.812
30	1972	1972	11.389	107.901	44.145	19.164	21.449	32.938	18.927	10.706	4.525	9.495	12.463	7.993	25.066
31	1973	1973	72.905	56.163	32.255	13.146	13.265	32.820	22.196	22.196	11.954	11.271	7.839	9.714	25.595
32	1974	1974	20.757	98.023	44.145	20.539	16.824	24.135	19.446	15.449	3.942	11.043	4.925	5.435	23.703
33	1975	1975	26.875	116.886	57.820	32.192	31.509	19.564	18.235	12.846	10.861	10.524	9.350	15.368	30.163
34	1976	1976	79.988	93.098	35.269	36.216	51.228	44.236	22.878	18.599	15.322	5.817	9.058	7.265	35.058
35	1977	1977	48.852	113.081	46.694	37.809	39.256	46.203	32.601	23.070	16.141	9.268	6.564	8.631	35.759
36	1978	1978	53.349	122.749	77.948	36.980	31.864	36.516	24.990	14.985	8.685	6.145	5.726	17.461	36.559
37	1979	1979	109.202	95.146	68.735	49.963	40.140	37.618	36.726	20.967	15.104	6.000	7.292	13.702	41.958
38	1980	1980	65.075	108.511	51.984	31.536	27.904	31.036	24.981	19.473	14.311	5.745	9.049	13.128	33.679
39	1981	1981	53.040	138.563	68.335	35.506	21.658	27.858	20.857	17.106	12.172	.956	2.959	14.530	34.579
40	1982	1982	26.292	109.995	63.801	34.422	36.188	23.625	19.000	15.777	10.916	4.142	5.918	17.161	30.656
41	1983	1983	107.318	93.808	54.260	32.538	34.450	46.521	31.564	21.658	14.148	5.526	6.418	13.847	38.722
42	1984	1984	62.554	96.694	64.183	33.102	29.597	22.496	21.130	17.143	13.046	4.306	4.161	14.830	32.069
43	1985	1985	15.431	84.749	49.535	37.636	22.778	27.904	25.783	15.513	13.101	3.696	2.586	11.280	25.902
44	1986	1986	62.608	63.646	45.192	29.169	29.679	30.061	20.074	14.466	10.260	3.614	4.024	20.866	27.941
45	1987	1987	54.824	50.800	33.639	45.347	31.564	33.339	29.779	24.208	12.609	5.007	7.547	10.588	28.436
46	1988	1988	55.653	75.044	45.902	21.986	25.437	29.779	27.831	17.953	10.315	.464	2.968	14.011	27.408
47	1989	1989	46.958	65.203	24.872	22.086	26.429	40.586	35.560	21.813	13.501	5.708	1.912	11.061	26.386
48	1990	1990	34.887	77.794	39.429	25.327	27.603	37.736	31.746	19.337	11.216	4.261	4.361	9.787	27.036
49	1991	1991	26.065	61.470	55.671	24.462	19.710	31.190	33.621	17.780	13.638	4.716	5.499	6.573	25.142
50	1992	1992	41.669	83.520	52.202	41.177	39.939	31.737	22.487	13.219	8.813	7.529	.228	6.728	29.182
51	1993	1993	37.818	62.335	34.113	23.652	22.268	35.333	24.563	16.897	12.782	2.394	4.679	12.281	24.203
52	1994	1994	30.508	80.243	56.509	48.870	42.343	35.005	25.892	17.534	12.236	10.879	1.821	7.474	30.850
53	1995	1995	57.337	64.019	31.727	26.784	12.928	22.569	27.175	18.800	11.617	5.644	5.827	12.190	24.827
54	1996	1996	60.096	75.454	37.791	25.673	12.108	19.901	27.567	18.718	4.871	.574	17.407	10.925	26.071
AVERAGE			45.852	88.394	47.712	31.239	28.275	30.122	23.063	15.798	10.834	7.691	7.553	10.503	28.999
MAXIMUM			109.202	138.563	84.066	85.223	55.015	46.521	36.726	24.208	17.443	21.504	17.407	20.866	41.958
MINIMUM			11.389	50.800	24.872	13.146	10.825	16.096	9.495	6.864	3.942	.464	.228	5.435	21.632

PERIOD AVERAGE CHANNEL FLOW (cms) : 3 Romaine Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	260.482	832.189	539.182	546.598	352.857	176.282	139.905	69.135	50.800	41.983	105.980	56.114	265.232
2	1944	1944	248.045	618.477	336.624	192.340	159.816	208.164	141.598	90.915	42.625	35.385	46.888	103.469	185.823
3	1945	1945	392.446	454.516	233.914	114.913	98.856	164.721	134.942	77.835	66.974	29.020	61.019	59.208	158.095
4	1946	1946	213.186	517.578	261.767	94.827	69.427	148.430	94.535	64.756	52.610	54.128	78.244	41.049	141.155
5	1947	1947	140.547	500.352	254.234	169.801	131.205	215.521	204.135	118.884	53.603	38.596	58.508	44.786	161.203
6	1948	1948	235.724	515.125	171.378	135.467	108.257	118.008	121.103	80.696	54.304	28.261	49.340	70.712	140.931
7	1949	1949	202.850	683.642	236.367	111.118	189.888	217.331	162.152	120.344	45.487	52.435	50.917	58.566	177.568
8	1950	1950	679.613	638.272	252.950	166.298	76.959	127.584	126.183	118.125	69.544	125.482	83.791	69.018	211.675
9	1951	1951	248.162	421.233	225.740	196.369	131.964	133.540	100.783	77.310	77.193	53.486	34.684	60.084	147.130
10	1952	1952	180.311	545.314	287.692	172.779	153.101	205.828	138.737	110.242	54.888	137.920	39.239	71.529	174.527
11	1953	1953	260.716	441.144	307.253	166.298	214.762	160.634	81.864	55.179	39.356	50.800	65.807	57.223	158.862
12	1954	1954	527.796	607.091	376.505	242.498	212.543	169.159	184.457	84.959	68.026	72.638	46.771	79.003	223.326
13	1955	1955	386.607	512.790	308.538	136.518	100.666	103.235	93.776	96.987	84.200	37.020	43.501	57.749	164.200
14	1956	1956	113.337	611.354	385.439	212.310	197.654	202.850	132.781	80.696	63.062	53.895	49.107	51.267	179.758
15	1957	1957	112.286	713.013	365.236	232.513	240.921	224.105	135.350	118.534	105.980	92.491	88.988	101.951	210.969
16	1958	1958	378.490	633.134	290.495	243.490	273.270	191.814	133.131	95.703	69.310	56.464	51.676	50.625	206.126
17	1959	1959	339.602	631.148	265.154	194.442	120.344	162.794	111.527	82.915	64.872	55.705	48.056	44.027	177.162
18	1960	1960	242.848	482.718	235.491	231.462	288.977	239.111	138.971	94.301	71.120	61.661	57.632	70.828	184.938
19	1961	1961	262.643	331.953	266.321	136.810	107.089	195.843	148.196	100.900	60.084	45.837	38.480	36.261	144.882
20	1962	1962	90.915	563.707	219.025	166.531	180.428	113.746	84.083	67.091	53.895	45.078	40.407	41.049	138.740
21	1963	1963	161.743	533.227	245.067	180.837	145.569	116.957	93.134	76.667	64.522	59.851	51.676	53.895	148.691
22	1964	1964	284.948	528.614	192.574	183.406	203.609	183.815	110.067	80.696	67.850	61.252	60.084	60.084	168.331
23	1965	1965	172.020	649.541	436.122	278.759	329.792	221.886	125.132	95.703	78.478	64.872	57.924	56.114	214.250
24	1966	1966	205.420	737.654	414.459	273.270	207.989	236.250	228.893	94.944	82.506	78.886	56.464	66.040	223.805
25	1967	1967	201.040	404.474	221.886	194.792	103.761	154.035	172.779	90.272	88.346	72.638	69.310	84.317	155.079
26	1968	1968	398.694	507.593	221.243	198.821	318.756	265.504	194.792	127.292	83.674	64.872	58.274	47.297	207.748
27	1969	1969	220.835	688.430	469.756	235.841	231.053	284.948	165.772	129.103	111.877	87.703	74.098	73.047	231.575
28	1970	1970	172.370	724.457	337.792	164.371	145.978	114.738	87.295	65.281	55.413	43.676	35.619	49.457	166.443
29	1971	1971	456.326	508.410	366.404	209.449	155.554	240.279	60.902	44.027	36.670	33.400	47.647	44.786	184.793
30	1972	1972	73.047	692.050	283.138	122.913	137.569	211.259	121.395	68.668	29.020	60.902	79.937	51.267	160.770
31	1973	1973	467.595	360.214	206.879	84.317	85.076	210.500	142.357	142.357	76.667	72.288	50.275	62.303	164.161
32	1974	1974	133.131	628.696	283.138	131.730	107.907	154.795	124.723	99.090	25.283	70.828	31.590	34.859	152.028
33	1975	1975	172.370	749.682	370.841	206.471	202.091	125.482	116.957	82.390	69.660	67.500	59.968	98.564	193.456
34	1976	1976	513.023	597.106	226.207	232.279	328.566	283.722	146.737	119.293	98.272	37.312	58.099	46.596	224.857
35	1977	1977	313.326	725.275	299.487	242.498	251.782	296.334	209.098	147.963	103.527	59.442	42.100	55.355	229.348
36	1978	1978	342.171	787.286	499.944	237.184	204.369	234.206	160.283	96.112	55.705	39.414	36.728	111.994	234.480
37	1979	1979	700.400	610.244	440.852	320.450	257.446	241.272	235.549	134.474	96.871	38.480	46.771	87.878	269.109
38	1980	1980	417.379	695.962	333.413	202.266	178.968	199.055	160.225	124.898	91.791	36.845	58.041	84.200	216.012
39	1981	1981	340.186	888.711	438.283	227.725	138.912	178.676	133.774	109.717	78.069	6.131	18.977	93.192	221.781
40	1982	1982	168.633	705.480	409.204	220.776	232.104	151.525	121.862	101.192	70.011	26.568	37.954	110.067	196.623
41	1983	1983	688.313	601.661	348.010	208.689	220.952	298.378	202.442	138.912	90.740	35.443	41.166	88.813	248.353
42	1984	1984	401.205	620.171	411.657	212.310	189.829	144.284	135.526	109.950	83.674	27.619	26.685	95.119	205.686
43	1985	1985	98.973	543.562	317.705	241.388	146.094	178.968	165.363	99.498	84.025	23.707	16.583	72.346	166.126
44	1986	1986	401.555	408.211	289.853	187.085	190.355	192.807	128.752	92.783	65.807	23.181	25.809	133.832	179.206
45	1987	1987	351.631	325.822	215.755	290.846	202.442	213.828	190.997	155.262	80.872	32.115	48.406	67.909	182.380
46	1988	1988	356.944	481.317	294.407	141.014	163.144	190.997	178.501	115.147	66.157	2.978	19.035	89.864	175.789
47	1989	1989	301.181	418.196	159.524	141.657	169.509	260.307	228.075	139.905	86.594	36.611	12.262	70.945	169.236
48	1990	1990	223.754	498.951	252.891	162.444	177.042	242.031	203.609	124.022	71.938	27.327	27.969	62.770	173.405
49	1991	1991	167.173	394.256	357.061	156.897	126.417	200.048	215.638	114.038	87.470	30.247	35.268	42.158	161.254
50	1992	1992	267.256	535.679	334.814	264.102	256.161	203.551	144.226	84.784	56.522	48.289	1.460	43.151	187.167
51	1993	1993	242.556	399.803	218.791	151.700	142.824	226.615	157.539	108.374	81.981	15.357	30.013	78.769	155.230
52	1994	1994	195.668	514.658	362.433	313.443	271.577	224.513	166.064	112.461	78.478	69.777	11.678	47.939	197.862
53	1995	1995	367.747	410.606	203.493	171.786	82.915	144.751	174.297	120.577	74.507	36.202	37.370	78.186	159.235
54	1996	1996	385.439	483.945	242.381	164.663	77.660	127.643	176.808	120.052	31.239	3.679	111.644	70.069	167.212
AVERAGE			294.086	566.939	306.014	200.362	181.347	193.197	147.922	101.322	69.484	49.327	48.443	67.365	185.996
MAXIMUM			700.400	888.711	539.182	546.598	352.857	298.378	235.549	155.262	111.877	137.920	111.644	133.832	269.109
MINIMUM			73.047	325.822	159.524	84.317	69.427	103.235	60.902	44.027	25.283	2.978	1.460	34.859	138.740

Upper Churchill River
Inflow Sequences

PERIOD AVERAGE CHANNEL FLOW (cms) : 7 Lac Joseph Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	205.300	655.900	425.000	430.800	278.100	138.900	110.300	54.500	40.000	33.100	83.500	44.200	209.041
2	1944	1944	195.500	487.500	265.300	151.600	126.000	164.100	111.600	71.700	33.600	27.900	37.000	81.600	146.479
3	1945	1945	309.300	358.200	184.400	90.500	77.900	129.900	106.400	61.400	52.800	22.900	48.100	46.700	124.618
4	1946	1946	168.000	407.900	206.300	74.700	54.700	117.000	74.500	51.000	41.400	42.700	61.700	32.400	111.243
5	1947	1947	110.800	394.400	200.400	133.800	103.400	169.900	160.900	93.700	42.300	30.400	46.100	35.300	127.064
6	1948	1948	185.800	406.000	135.100	106.800	85.300	93.000	95.500	63.600	42.800	22.300	38.900	55.700	111.083
7	1949	1949	159.900	538.800	186.300	87.600	149.700	171.300	127.800	94.800	35.800	41.300	40.100	46.100	139.940
8	1950	1950	535.700	503.100	199.400	131.100	60.600	100.600	99.400	93.100	54.800	98.900	66.000	54.400	166.838
9	1951	1951	195.600	332.000	177.900	154.800	104.000	105.300	79.400	61.000	60.800	42.200	27.400	47.400	115.979
10	1952	1952	142.100	429.800	226.700	136.200	120.700	162.200	109.300	86.900	43.300	108.700	30.900	56.400	137.553
11	1953	1953	205.500	347.700	242.200	131.100	169.300	126.600	64.500	43.500	31.000	40.000	51.900	45.100	125.216
12	1954	1954	416.000	478.500	296.800	191.100	167.500	133.300	145.400	67.000	53.600	57.300	36.900	62.300	176.030
13	1955	1955	304.700	404.200	243.200	107.600	79.300	81.400	73.900	76.500	66.400	29.200	34.300	45.500	129.429
14	1956	1956	89.300	481.900	303.800	167.300	155.800	159.900	104.600	63.600	49.700	42.500	38.700	40.400	141.678
15	1957	1957	88.500	562.000	287.900	183.200	189.900	176.600	106.700	93.400	83.500	72.900	70.100	80.300	166.267
16	1958	1958	298.300	499.000	229.000	191.900	215.400	151.200	104.900	75.400	54.600	44.500	40.700	39.900	162.455
17	1959	1959	267.700	497.500	209.000	153.200	94.800	128.300	87.900	65.300	51.200	43.900	37.900	34.700	139.635
18	1960	1960	191.400	380.500	185.600	182.400	227.800	188.500	109.500	74.300	56.000	48.600	45.400	55.800	145.755
19	1961	1961	207.000	261.600	209.900	107.800	84.400	154.400	116.800	79.500	47.400	36.100	30.300	28.600	114.187
20	1962	1962	71.700	444.300	172.600	131.300	142.200	89.600	66.300	52.900	42.500	35.500	31.900	32.400	109.363
21	1963	1963	127.500	420.300	193.200	142.500	114.700	92.200	73.400	60.400	50.800	47.200	40.700	42.500	117.192
22	1964	1964	224.600	416.600	151.800	144.600	160.500	144.900	86.800	63.600	53.500	48.300	47.400	47.400	132.695
23	1965	1965	135.600	512.000	343.700	219.700	259.900	174.900	98.600	75.400	61.900	51.200	45.600	44.200	168.864
24	1966	1966	161.900	581.400	326.700	215.400	163.900	186.200	180.400	74.800	65.000	62.200	44.500	52.100	176.398
25	1967	1967	158.400	318.800	174.900	153.500	81.800	121.400	136.200	71.200	69.600	57.300	54.600	66.500	122.233
26	1968	1968	314.200	400.100	174.400	156.700	251.200	209.300	153.500	100.300	66.000	51.200	45.900	37.300	163.746
27	1969	1969	174.100	542.600	370.300	185.900	182.100	224.600	130.700	101.800	88.200	69.100	58.400	57.600	182.540
28	1970	1970	135.900	571.000	266.200	129.600	115.100	90.500	68.800	51.500	43.700	34.400	28.100	39.000	131.207
29	1971	1971	359.700	400.700	288.800	165.100	122.600	189.400	48.000	34.700	28.900	26.300	37.600	35.300	145.656
30	1972	1972	57.600	545.500	223.200	96.900	108.400	166.500	95.700	54.100	22.900	48.000	63.000	40.400	126.724
31	1973	1973	368.500	283.900	163.000	66.500	67.100	165.900	112.200	112.200	60.400	57.000	39.600	49.100	129.381
32	1974	1974	104.900	495.500	223.200	103.800	85.000	122.000	98.300	78.100	19.900	55.800	24.900	27.500	119.814
33	1975	1975	135.900	590.900	292.300	162.700	159.300	98.900	92.200	64.900	54.900	53.200	47.300	77.700	152.484
34	1976	1976	404.300	470.600	178.300	183.100	259.000	223.600	115.700	94.000	77.500	29.400	45.800	36.700	177.227
35	1977	1977	247.000	571.700	236.100	191.200	198.500	233.600	164.800	116.600	81.600	46.800	33.200	43.700	180.794
36	1978	1978	269.700	620.500	394.000	186.900	161.100	184.600	126.300	75.700	43.900	31.100	29.000	88.300	184.807
37	1979	1979	552.000	481.000	347.500	252.600	202.900	190.100	185.600	106.000	76.300	30.400	36.900	69.300	212.106
38	1980	1980	328.900	548.500	262.800	159.400	141.000	156.900	126.300	98.400	72.400	29.100	45.800	66.400	170.256
39	1981	1981	268.100	700.500	345.400	179.500	109.500	140.800	105.400	86.500	61.500	4.800	15.000	73.400	174.792
40	1982	1982	132.900	556.000	322.500	174.000	183.000	119.400	96.000	79.800	55.200	20.900	29.900	86.700	154.961
41	1983	1983	542.500	474.200	274.300	164.500	174.100	235.200	159.600	109.500	71.500	27.900	32.400	70.000	195.740
42	1984	1984	316.200	488.800	324.400	167.400	149.600	113.700	106.800	86.700	66.000	21.800	21.000	75.000	162.120
43	1985	1985	78.000	428.400	250.400	190.200	115.200	141.000	130.300	78.400	66.200	18.700	13.000	57.000	130.915
44	1986	1986	316.500	321.700	228.400	147.500	150.100	151.900	101.500	73.100	51.900	18.200	20.300	105.500	141.236
45	1987	1987	277.200	256.800	170.000	229.200	159.500	168.600	150.600	122.400	63.800	25.300	38.200	53.500	143.758
46	1988	1988	281.400	379.300	232.000	111.100	128.600	150.500	140.700	90.800	52.100	2.400	15.000	70.900	138.554
47	1989	1989	237.400	329.600	125.700	111.600	133.600	205.200	179.700	110.300	68.200	28.900	9.700	55.900	133.382
48	1990	1990	176.400	393.200	199.300	128.100	139.500	190.800	160.500	97.800	56.700	21.600	22.100	49.500	136.693
49	1991	1991	131.700	310.700	281.500	123.700	99.700	157.700	170.000	89.900	68.900	23.800	27.800	33.200	127.100
50	1992	1992	210.700	422.200	263.900	208.100	201.900	160.500	113.700	66.800	44.500	38.000	1.100	34.000	147.511
51	1993	1993	191.200	315.100	172.400	119.500	112.600	178.600	124.100	85.400	64.600	12.100	23.700	62.100	122.338
52	1994	1994	154.200	405.600	285.700	247.000	214.000	176.900	130.900	88.700	61.900	55.000	9.200	37.800	155.947
53	1995	1995	289.900	323.600	160.400	135.400	65.300	114.100	137.400	95.000	58.700	28.600	29.400	61.600	125.501
54	1996	1996	303.800	381.400	191.000	129.800	61.200	100.600	139.300	94.600	24.600	2.900	88.000	55.200	131.777
AVERAGE			231.794	446.843	241.194	157.917	142.931	152.278	116.585	79.861	54.763	38.885	38.183	53.102	146.598
MAXIMUM			552.000	700.500	425.000	430.800	278.100	235.200	185.600	122.400	88.200	108.700	88.000	105.500	212.106
MINIMUM			57.600	256.800	125.700	66.500	54.700	81.400	48.000	34.700	19.900	2.400	1.100	27.500	109.363

PERIOD AVERAGE CHANNEL FLOW (cms) : 9 Ossokmanuan Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	446.10	1425.20	923.40	936.10	604.30	301.90	239.60	118.40	87.00	71.90	181.50	96.10	454.23
2	1944	1944	424.80	1059.20	576.50	329.40	273.70	356.50	242.50	155.70	73.00	60.60	80.30	177.20	318.24
3	1945	1945	672.10	778.40	400.60	196.80	169.30	282.10	231.10	133.30	114.70	49.70	104.50	101.40	270.75
4	1946	1946	365.10	886.40	448.30	162.40	118.90	254.20	161.90	110.90	90.10	92.70	134.00	70.30	241.74
5	1947	1947	240.70	856.90	435.40	290.80	224.70	369.10	349.60	203.60	91.80	66.10	100.20	76.70	276.08
6	1948	1948	403.70	882.20	293.50	232.00	185.40	202.10	207.40	138.20	93.00	48.40	84.50	121.10	241.36
7	1949	1949	347.40	1170.80	404.80	190.30	325.20	372.20	277.70	206.10	77.90	89.80	87.20	100.30	304.10
8	1950	1950	1163.90	1093.10	433.20	284.80	131.80	218.50	216.10	202.30	119.10	214.90	143.50	118.20	362.51
9	1951	1951	425.00	721.40	386.60	336.30	226.00	228.70	172.60	132.40	132.20	91.60	59.40	102.90	251.97
10	1952	1952	308.80	933.90	492.70	295.90	262.20	352.50	237.60	188.80	94.00	236.20	67.20	122.50	298.89
11	1953	1953	446.50	755.50	526.20	284.80	367.80	275.10	140.20	94.50	67.40	87.00	112.70	98.00	272.07
12	1954	1954	903.90	1039.70	644.80	415.30	364.00	289.70	315.90	145.50	116.50	124.40	80.10	135.30	382.47
13	1955	1955	662.10	878.20	528.40	233.80	172.40	176.80	160.60	166.10	144.20	63.40	74.50	98.90	281.21
14	1956	1956	194.10	1047.00	660.10	363.60	338.50	347.40	227.40	138.20	108.00	92.30	84.10	87.80	307.85
15	1957	1957	192.30	1221.10	625.50	398.20	412.60	383.80	231.80	203.00	181.50	158.40	152.40	174.60	361.30
16	1958	1958	648.20	1084.30	497.50	417.00	468.00	328.50	228.00	163.90	118.70	96.70	88.50	86.70	353.01
17	1959	1959	581.60	1080.90	454.10	333.00	206.10	278.80	191.00	142.00	111.10	95.40	82.30	75.40	303.41
18	1960	1960	415.90	826.70	403.30	396.40	494.90	409.50	238.00	161.50	121.80	105.60	98.70	121.30	316.72
19	1961	1961	449.80	568.50	456.10	234.30	183.40	335.40	253.80	172.80	102.90	78.50	65.90	62.10	248.12
20	1962	1962	155.70	965.40	375.10	285.20	309.00	194.80	144.00	114.90	92.30	77.20	69.20	70.30	237.60
21	1963	1963	277.00	913.20	419.70	309.70	249.30	200.30	159.50	131.30	110.50	102.50	88.50	92.30	254.65
22	1964	1964	488.00	905.30	329.80	314.10	348.70	314.80	188.50	138.20	116.20	104.90	102.90	102.90	288.28
23	1965	1965	294.60	1112.40	746.90	477.40	564.80	380.00	214.30	163.90	134.40	111.10	99.20	96.10	366.92
24	1966	1966	351.80	1263.30	709.80	468.00	356.20	404.60	392.00	162.60	141.30	135.10	96.70	113.10	383.29
25	1967	1967	344.30	692.70	380.00	333.60	177.70	263.80	295.90	154.60	151.30	124.40	118.70	144.40	265.59
26	1968	1968	682.80	869.30	378.90	340.50	545.90	454.70	333.60	218.00	143.30	111.10	99.80	81.00	355.79
27	1969	1969	378.20	1179.00	804.50	403.90	395.70	488.00	283.90	221.10	191.60	150.20	126.90	125.10	396.59
28	1970	1970	295.20	1240.70	578.50	281.50	250.00	196.50	149.50	111.80	94.90	74.80	61.00	84.70	285.05
29	1971	1971	781.50	870.70	627.50	358.70	266.40	411.50	104.30	75.40	62.80	57.20	81.60	76.70	316.48
30	1972	1972	125.10	1185.20	484.90	210.50	235.60	361.80	207.90	117.60	49.70	104.30	136.90	87.80	275.33
31	1973	1973	800.80	616.90	354.30	144.40	145.70	360.50	243.80	243.80	131.30	123.80	86.10	106.70	281.14
32	1974	1974	228.00	1076.70	484.90	225.60	184.80	265.10	213.60	169.70	43.30	121.30	54.10	59.70	260.36
33	1975	1975	295.20	1283.90	635.10	353.60	346.10	214.90	200.30	141.10	119.30	115.60	102.70	168.80	331.31
34	1976	1976	878.60	1022.60	387.40	397.80	562.70	485.90	251.30	204.30	168.30	63.90	99.50	79.80	385.09
35	1977	1977	536.60	1242.10	512.90	415.30	431.20	507.50	358.10	253.40	177.30	101.80	72.10	94.80	392.78
36	1978	1978	586.00	1348.30	856.20	406.20	350.00	401.10	274.50	164.60	95.40	67.50	62.90	191.80	401.57
37	1979	1979	1199.50	1045.10	755.00	548.80	440.90	413.20	403.40	230.30	165.90	65.90	80.10	150.50	460.87
38	1980	1980	714.80	1191.90	571.00	346.40	306.50	340.90	274.40	213.90	157.20	63.10	99.40	144.20	369.94
39	1981	1981	582.60	1522.00	750.60	390.00	237.90	306.00	229.10	187.90	133.70	10.50	32.50	159.60	379.82
40	1982	1982	288.80	1208.20	700.80	378.10	397.50	259.50	208.70	173.30	119.90	45.50	65.00	188.50	336.74
41	1983	1983	1178.80	1030.40	596.00	357.40	378.40	511.00	346.70	237.90	155.40	60.70	70.50	152.10	425.33
42	1984	1984	687.10	1062.10	705.00	363.60	325.10	247.10	232.10	188.30	143.30	47.30	45.70	162.90	352.26
43	1985	1985	169.50	930.90	544.10	413.40	250.20	306.50	283.20	170.40	143.90	40.60	28.40	123.90	284.51
44	1986	1986	687.70	699.10	496.40	320.40	326.00	330.20	220.50	158.90	112.70	39.70	44.20	229.20	306.91
45	1987	1987	602.20	558.00	369.50	498.10	346.70	366.20	327.10	265.90	138.50	55.00	82.90	116.30	312.34
46	1988	1988	611.30	824.30	504.20	241.50	279.40	327.10	305.70	197.20	113.30	5.10	32.60	153.90	301.05
47	1989	1989	515.80	716.20	273.20	242.60	290.30	445.80	390.60	239.60	148.30	62.70	21.00	121.50	289.83
48	1990	1990	383.20	854.50	433.10	278.20	303.20	414.50	348.70	212.40	123.20	46.80	47.90	107.50	296.97
49	1991	1991	286.30	675.20	611.50	268.70	216.50	342.60	369.30	195.30	149.80	51.80	60.40	72.20	276.16
50	1992	1992	457.70	917.40	573.40	452.30	438.70	348.60	247.00	145.20	96.80	82.70	2.50	73.90	320.54
51	1993	1993	415.40	684.70	374.70	259.80	244.60	388.10	269.80	185.60	140.40	26.30	51.40	134.90	265.85
52	1994	1994	335.10	881.40	620.70	536.80	465.10	384.50	284.40	192.60	134.40	119.50	20.00	82.10	338.86
53	1995	1995	629.80	703.20	348.50	294.20	142.00	247.90	298.50	206.50	127.60	62.00	64.00	133.90	272.71
54	1996	1996	660.10	828.80	415.10	282.00	133.00	218.60	302.80	205.60	53.50	6.30	191.20	120.00	286.37
AVERAGE			503.65	970.94	524.08	343.14	310.57	330.87	253.33	173.52	119.00	84.48	82.96	115.37	318.54
MAXIMUM			1199.50	1522.00	923.40	936.10	604.30	511.00	403.40	265.90	191.60	236.20	191.20	229.20	460.87
MINIMUM			125.10	558.00	273.20	144.40	118.90	176.80	104.30	75.40	43.30	5.10	2.50	59.70	237.60

PERIOD AVERAGE CHANNEL FLOW (cms) : 13 Smallwood Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	1309.60	4184.00	2710.90	2748.10	1773.90	886.30	703.30	347.70	255.30	211.00	532.70	282.00	1333.46
2	1944	1944	1247.10	3109.50	1692.50	967.00	803.60	1046.50	711.80	457.10	214.20	177.80	235.70	520.30	934.24
3	1945	1945	1973.10	2285.10	1176.10	577.60	496.90	828.30	678.50	391.40	336.70	145.90	306.70	297.60	794.84
4	1946	1946	1071.90	2602.20	1316.10	476.70	349.00	746.30	475.40	325.60	264.40	272.20	393.30	206.40	709.68
5	1947	1947	706.60	2515.60	1278.33	853.70	659.70	1083.60	1026.30	597.80	269.60	194.10	294.30	225.30	810.53
6	1948	1948	1185.20	2589.80	861.50	681.20	544.40	593.20	608.90	405.70	272.90	142.00	248.10	355.60	708.54
7	1949	1949	1019.80	3437.00	1188.40	558.70	954.70	1092.70	815.30	605.00	228.60	263.70	255.90	294.36	892.73
8	1950	1950	3416.90	3209.10	1271.80	836.10	386.80	641.40	634.30	593.90	349.70	631.00	421.30	347.10	1064.25
9	1951	1951	1247.70	2117.70	1135.00	987.20	663.60	671.40	506.60	388.80	388.10	268.90	174.50	302.20	739.74
10	1952	1952	906.50	2741.60	1446.30	868.70	769.70	1034.80	697.40	554.20	276.10	693.50	197.30	359.50	877.44
11	1953	1953	1310.90	2218.00	1544.70	836.10	1079.70	807.50	411.60	277.40	198.00	255.30	330.80	287.80	798.71
12	1954	1954	2653.60	3052.20	1893.00	1219.10	1068.60	850.50	927.30	427.20	341.90	365.30	235.10	397.20	1122.79
13	1955	1955	1943.80	2578.10	1551.20	686.40	506.00	519.00	471.50	487.70	423.30	186.20	218.80	290.40	825.56
14	1956	1956	569.80	3073.70	1938.00	1067.30	993.70	1019.80	667.50	405.70	317.10	270.90	246.80	257.90	903.75
15	1957	1957	564.60	3584.90	1836.40	1168.90	1211.20	1126.60	680.50	595.80	532.70	465.00	447.40	512.50	1060.65
16	1958	1958	1902.80	3183.10	1460.60	1224.30	1374.00	964.40	669.40	481.20	348.40	283.90	259.80	254.60	1036.35
17	1959	1959	1707.40	3173.30	1333.00	977.50	605.00	818.60	560.70	416.80	326.30	280.00	241.60	221.40	890.71
18	1960	1960	1221.00	2427.00	1183.90	1163.70	1452.80	1202.10	698.70	474.10	357.50	310.00	289.80	356.20	929.80
19	1961	1961	1320.60	1669.00	1338.90	687.70	538.50	984.60	745.00	507.30	302.20	230.50	193.40	182.30	728.42
20	1962	1962	457.10	2834.00	1101.20	837.40	907.10	571.80	422.60	337.30	270.90	226.60	203.20	206.40	697.52
21	1963	1963	813.30	2681.00	1232.10	909.10	731.90	588.00	468.20	385.50	324.30	300.90	259.80	270.90	747.56
22	1964	1964	1432.60	2657.60	968.30	922.10	1023.70	924.10	553.50	405.70	341.20	308.00	302.20	302.20	846.35
23	1965	1965	864.80	3265.80	2192.60	1401.40	1658.00	1115.50	629.10	481.20	394.60	326.30	291.10	282.00	1077.15
24	1966	1966	1032.80	3708.60	2083.80	1374.00	1045.80	1187.80	1150.70	477.30	414.80	396.60	283.90	332.10	1125.23
25	1967	1967	1010.70	2033.70	1115.50	979.40	521.60	774.30	868.70	453.90	444.10	365.30	348.40	423.90	779.67
26	1968	1968	2004.40	2552.10	1112.20	999.60	1602.60	1335.00	979.40	640.10	420.70	326.30	293.00	237.70	1044.51
27	1969	1969	1110.30	3461.10	2361.90	1185.80	1161.70	1432.60	833.50	649.20	562.60	440.90	372.50	367.30	1164.32
28	1970	1970	866.70	3642.20	1698.30	826.40	733.90	577.00	438.90	328.20	278.70	219.50	179.10	248.80	836.84
29	1971	1971	2294.20	2556.00	1842.20	1053.00	782.10	1208.00	306.10	221.40	184.30	168.00	239.60	225.30	929.08
30	1972	1972	367.30	3479.40	1423.50	618.00	691.60	1062.10	610.20	345.10	145.90	306.10	401.80	257.90	808.27
31	1973	1973	2350.80	1811.00	1040.00	423.90	427.80	1058.20	715.70	715.70	385.50	363.40	252.70	313.20	825.31
32	1974	1974	669.40	3160.90	1423.50	662.30	542.50	778.20	627.10	498.20	127.00	356.20	158.90	175.20	764.35
33	1975	1975	866.70	3769.10	1864.40	1038.00	1015.90	631.00	588.00	414.20	350.30	339.30	301.50	495.60	972.62
34	1976	1976	2415.00	2781.50	973.10	968.30	1167.90	764.30	651.10	528.30	583.80	452.90	180.00	445.70	994.15
35	1977	1977	1400.70	3401.10	1248.60	1077.60	1442.90	873.90	1081.60	669.90	600.90	480.60	178.40	350.10	1066.51
36	1978	1978	1516.10	3111.30	1435.30	1334.70	881.40	789.60	632.60	415.90	455.60	136.70	215.90	545.40	958.92
37	1979	1979	3973.40	2385.00	1818.10	894.10	1088.60	901.90	980.70	554.00	554.10	364.70	410.10	414.60	1201.52
38	1980	1980	2244.50	2944.60	1404.90	832.50	463.80	1125.90	711.90	564.80	473.80	496.50	258.80	460.00	1001.02
39	1981	1981	1819.80	3736.40	1493.60	824.20	818.60	450.40	519.40	464.60	340.80	274.20	172.90	10.50	911.73
40	1982	1982	1836.70	3266.90	1293.30	830.40	1045.00	527.70	504.60	489.50	230.80	389.90	487.80	705.10	967.53
41	1983	1983	3390.30	1747.00	1141.70	794.70	914.60	1111.30	891.70	906.60	247.10	348.80	313.70	375.00	1021.05
42	1984	1984	1925.20	2288.40	1383.50	929.00	685.60	667.10	884.10	428.60	414.50	328.00	280.80	324.20	880.94
43	1985	1985	786.40	2410.20	954.80	657.80	632.60	635.50	551.40	533.70	70.10	184.20	150.00	576.80	678.70
44	1986	1986	3006.50	1534.70	1343.80	598.40	827.30	729.80	474.90	248.30	516.00	298.10	393.90	1232.90	938.02
45	1987	1987	1887.70	817.10	1137.70	982.40	982.30	824.50	852.60	337.30	644.40	188.30	421.30	331.30	789.22
46	1988	1988	1859.50	2033.70	594.20	554.70	873.70	838.00	665.00	182.70	51.50	661.00	574.50	526.80	782.99
47	1989	1989	1646.90	1758.40	391.10	448.60	551.10	1162.20	967.60	638.90	201.40	274.90	420.90	286.90	731.03
48	1990	1990	1042.80	2508.30	1023.90	632.70	792.80	1323.90	684.50	600.30	330.10	219.90	220.10	160.00	797.02
49	1991	1991	715.50	2066.00	930.30	548.10	675.50	745.50	875.60	396.00	380.00	212.10	392.50	328.10	689.42
50	1992	1992	730.90	3521.10	1633.10	1058.50	1161.30	902.70	346.20	332.90	242.50	215.90	141.90	277.00	880.91
51	1993	1993	1409.30	1436.70	721.40	500.10	787.90	867.30	466.40	354.50	238.50	341.90	459.90	273.20	656.38
52	1994	1994	1034.40	2366.00	1300.90	726.50	655.30	985.90	708.20	472.30	273.70	323.20	283.30	370.10	792.94
53	1995	1995	1785.50	1315.30	759.00	167.00	587.80	738.60	797.00	501.40	303.00	516.50	307.50	377.10	680.00
54	1996	1996	1937.80	2433.10	1218.50	828.00	390.50	641.60	888.80	603.50	157.20	18.50	561.20	352.40	840.67
AVERAGE			1514.54	2689.37	1366.98	888.98	861.19	884.61	685.51	468.84	332.55	311.43	300.67	348.38	889.66
MAXIMUM			3973.40	4184.00	2710.90	2748.10	1773.90	1432.60	1150.70	906.60	644.40	693.50	574.50	1232.90	1333.46
MINIMUM			367.30	817.10	391.10	167.00	349.00	450.40	306.10	182.70	51.50	18.50	141.90	10.50	656.38

PERIOD AVERAGE CHANNEL FLOW (cms) : 16 West Forebay Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	32.200	102.800	66.600	67.500	43.600	21.800	17.300	8.500	6.300	5.200	13.100	6.900	32.766
2	1944	1944	30.600	76.400	41.600	23.800	19.700	25.700	17.500	11.200	5.300	4.400	5.800	12.800	22.957
3	1945	1945	48.500	56.200	28.900	14.200	12.200	20.400	16.700	9.600	8.300	3.600	7.500	7.300	19.540
4	1946	1946	26.300	63.900	32.300	11.700	8.600	18.300	11.700	8.000	6.500	6.700	9.700	5.100	17.434
5	1947	1947	17.400	61.800	31.400	21.000	16.200	26.600	25.200	14.700	6.600	4.800	7.200	5.500	19.910
6	1948	1948	29.100	63.600	21.200	16.700	13.400	14.600	15.000	10.000	6.700	3.500	6.100	8.700	17.412
7	1949	1949	25.100	84.500	29.200	13.700	23.500	26.900	20.000	14.900	5.600	6.500	6.300	7.200	21.947
8	1950	1950	84.000	78.900	31.300	20.500	9.500	15.800	15.600	14.600	8.600	15.500	10.400	8.500	26.165
9	1951	1951	30.700	52.000	27.900	24.300	16.300	16.500	12.400	9.600	9.500	6.600	4.300	7.400	18.177
10	1952	1952	22.300	67.400	35.500	21.300	18.900	25.400	17.100	13.600	6.800	17.000	4.800	8.800	21.542
11	1953	1953	32.200	54.500	38.000	20.500	26.500	19.800	10.100	6.800	4.900	6.300	8.100	7.100	19.621
12	1954	1954	65.200	75.000	46.500	30.000	26.300	20.900	22.800	10.500	8.400	9.000	5.800	9.800	27.604
13	1955	1955	47.800	63.400	38.100	16.900	12.400	12.800	11.600	12.000	10.400	4.600	5.400	7.100	20.299
14	1956	1956	14.000	75.500	47.600	26.200	24.400	25.100	16.400	10.000	7.800	6.700	6.100	6.300	22.209
15	1957	1957	13.900	88.100	45.100	28.700	29.800	27.700	16.700	14.600	13.100	11.400	11.000	12.600	26.061
16	1958	1958	46.800	78.200	35.900	30.100	33.800	23.700	16.400	11.800	8.600	7.000	6.400	6.300	25.478
17	1959	1959	42.000	78.000	32.800	24.000	14.900	20.100	13.800	10.200	8.000	6.900	5.900	5.400	21.888
18	1960	1960	30.000	59.600	29.100	28.600	35.700	29.500	17.200	11.600	8.800	7.600	7.100	8.800	22.842
19	1961	1961	32.500	41.000	32.900	16.900	13.200	24.200	18.300	12.500	7.400	5.700	4.800	4.500	17.909
20	1962	1962	11.200	69.600	27.100	20.600	22.300	14.100	10.400	8.300	6.700	5.600	5.000	5.100	17.156
21	1963	1963	20.000	65.900	30.300	22.300	18.000	14.400	11.500	9.500	8.000	7.400	6.400	6.700	18.378
22	1964	1964	35.200	65.300	23.800	22.700	25.200	22.700	13.600	10.000	8.400	7.600	7.400	7.400	20.805
23	1965	1965	21.300	80.200	53.900	34.400	40.700	27.400	15.500	11.800	9.700	8.000	7.200	6.900	26.465
24	1966	1966	25.400	91.100	51.200	33.800	25.700	29.200	28.300	11.700	10.200	9.700	7.000	8.200	27.655
25	1967	1967	24.800	50.000	27.400	24.100	12.800	19.000	21.300	11.200	10.900	9.000	8.600	10.400	19.159
26	1968	1968	49.300	62.700	27.300	24.600	39.400	32.800	24.100	15.700	10.300	8.000	7.200	5.800	25.664
27	1969	1969	27.300	85.000	58.000	29.100	28.500	35.200	20.500	16.000	13.800	10.800	9.200	9.000	28.600
28	1970	1970	21.300	89.500	41.700	20.300	18.000	14.200	10.800	8.100	6.800	5.400	4.400	6.100	20.559
29	1971	1971	56.400	62.800	45.300	25.900	19.200	29.700	7.500	5.400	4.500	4.100	5.900	5.500	22.824
30	1972	1972	9.000	85.500	35.000	15.200	17.000	26.100	15.000	8.500	3.600	7.500	9.900	6.300	19.864
31	1973	1973	57.800	44.500	25.600	10.400	10.500	26.000	17.600	17.600	9.500	8.900	6.200	7.700	20.286
32	1974	1974	16.400	77.700	35.000	16.300	13.300	19.100	15.400	12.200	3.100	8.800	3.900	4.300	18.776
33	1975	1975	21.300	92.600	45.800	25.500	25.000	15.500	14.400	10.200	8.600	8.300	7.400	12.200	23.895
34	1976	1976	127.800	45.900	38.200	24.500	131.000	37.800	-.400	-25.800	-1.700	-1.400	13.000	75.000	38.722
35	1977	1977	72.800	135.100	20.000	39.400	68.400	46.600	5.100	-18.100	-33.500	4.800	-6.400	29.800	30.222
36	1978	1978	104.500	80.500	65.300	130.300	41.800	19.000	-3.300	16.500	8.400	-33.400	18.000	44.800	41.646
37	1979	1979	122.000	33.700	143.000	73.900	3.200	36.200	46.100	-10.900	-1.600	6.000	11.000	29.900	41.470
38	1980	1980	120.900	86.100	32.800	27.700	23.400	33.900	11.200	2.800	7.500	-6.200	27.000	-18.000	29.419
39	1981	1981	79.800	150.300	111.600	19.300	17.500	37.100	21.300	8.700	-24.900	-24.000	-24.300	-8.300	30.625
40	1982	1982	83.300	98.000	61.100	33.100	49.400	19.700	-1.500	-2.200	7.400	3.100	-1.400	55.700	33.879
41	1983	1983	128.400	49.700	32.800	42.100	29.800	48.400	13.800	-23.100	-10.100	15.600	22.300	13.700	30.443
42	1984	1984	105.100	53.800	17.400	-6.200	22.200	28.100	-7.500	-30.400	-39.100	-34.700	-47.100	-7.600	4.705
43	1985	1985	40.800	101.500	14.600	-5.200	17.300	39.800	-21.100	-7.800	-25.900	-25.600	-48.600	-24.600	4.698
44	1986	1986	88.400	34.300	20.900	-13.200	14.100	18.900	-16.100	-11.100	-48.300	-67.100	-112.800	-19.700	-8.970
45	1987	1987	29.500	31.900	42.600	38.800	33.000	40.300	-2.500	-31.900	-52.400	-83.600	-75.900	-44.100	-5.673
46	1988	1988	101.600	47.700	48.400	5.200	10.100	24.900	-24.700	-35.300	-88.100	-105.000	-102.000	-54.300	-13.645
47	1989	1989	96.400	30.100	10.200	8.400	39.400	46.200	-12.100	-10.900	-53.400	-104.400	-107.500	-75.300	-10.380
48	1990	1990	62.800	72.600	33.800	17.300	53.600	60.700	28.500	-14.000	-2.400	-63.400	-32.200	-29.000	16.169
49	1991	1991	20.200	68.300	28.800	14.900	20.800	43.000	11.900	-32.500	-14.500	-48.600	-43.000	-38.900	2.811
50	1992	1992	50.200	146.600	43.200	71.300	46.200	37.100	11.400	9.000	-14.100	-11.700	-11.800	29.700	34.031
51	1993	1993	77.200	51.300	40.600	33.900	17.000	43.800	-11.000	5.000	-25.900	-102.800	-97.500	-61.900	-1.716
52	1994	1994	39.300	75.400	32.700	40.100	30.100	53.100	5.700	-12.300	-15.600	-63.500	-66.400	-39.900	7.011
53	1995	1995	85.300	25.400	41.700	16.300	38.500	48.800	21.600	-5.500	-50.600	-83.100	-30.800	-2.800	9.357
54	1996	1996	47.600	59.800	29.900	20.300	9.600	15.800	21.800	14.800	3.900	.500	13.800	8.700	20.658
AVERAGE			50.948	70.763	39.424	26.185	26.498	28.156	11.776	2.887	-3.948	-10.748	-8.724	2.048	19.765
MAXIMUM			128.400	150.300	143.000	130.300	131.000	60.700	46.100	17.600	13.800	17.000	27.000	75.000	41.646
MINIMUM			9.000	25.400	10.200	-13.200	3.200	12.800	-24.700	-35.300	-88.100	-105.000	-112.800	-75.300	-13.645

PERIOD AVERAGE CHANNEL FLOW (cms) : 19 East Forebay Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	17.900	57.300	37.100	37.600	24.300	12.100	9.600	4.800	3.500	2.900	7.300	3.900	18.256
2	1944	1944	17.100	42.500	23.200	13.200	11.000	14.300	9.700	6.300	2.900	2.400	3.200	7.100	12.774
3	1945	1945	27.000	31.300	16.100	7.900	6.800	11.300	9.300	5.400	4.600	2.000	4.200	4.100	10.884
4	1946	1946	14.700	35.600	18.000	6.500	4.800	10.200	6.500	4.500	3.600	3.700	5.400	2.800	9.711
5	1947	1947	9.700	34.400	17.500	11.700	9.000	14.800	14.000	8.200	3.700	2.700	4.000	3.100	11.091
6	1948	1948	16.200	35.400	11.800	9.300	7.400	8.100	8.300	5.600	3.700	1.900	3.400	4.900	9.683
7	1949	1949	14.000	47.000	16.300	7.600	13.100	15.000	11.200	8.300	3.100	3.600	3.500	4.000	12.224
8	1950	1950	46.800	43.900	17.400	11.400	5.300	8.800	8.700	8.100	4.800	8.600	5.800	4.700	14.561
9	1951	1951	17.100	29.000	15.500	13.500	9.100	9.200	6.900	5.300	5.300	3.700	2.400	4.100	10.120
10	1952	1952	12.400	37.500	19.800	11.900	10.500	14.200	9.500	7.600	3.800	9.500	2.700	4.900	12.007
11	1953	1953	17.900	30.300	21.100	11.400	14.800	11.000	5.600	3.800	2.700	3.500	4.500	3.900	10.905
12	1954	1954	36.300	41.800	25.900	16.700	14.600	11.600	12.700	5.800	4.700	5.000	3.200	5.400	15.357
13	1955	1955	26.600	35.300	21.200	9.400	6.900	7.100	6.500	6.700	5.800	2.500	3.000	4.000	11.301
14	1956	1956	7.800	42.100	26.500	14.600	13.600	14.000	9.100	5.600	4.300	3.700	3.400	3.500	12.369
15	1957	1957	7.700	49.100	25.100	16.000	16.600	15.400	9.300	8.200	7.300	6.400	6.100	7.000	14.518
16	1958	1958	26.000	43.600	20.000	16.800	18.800	13.200	9.200	6.600	4.800	3.900	3.600	3.500	14.201
17	1959	1959	23.400	43.400	18.200	13.400	8.300	11.200	7.700	5.700	4.500	3.800	3.300	3.000	12.189
18	1960	1960	16.700	33.200	16.200	15.900	19.900	16.400	9.600	6.500	4.900	4.200	4.000	4.900	12.724
19	1961	1961	18.100	22.800	18.300	9.400	7.400	13.500	10.200	6.900	4.100	3.200	2.600	2.500	9.963
20	1962	1962	6.300	38.800	15.100	11.500	12.400	7.800	5.800	4.600	3.700	3.100	2.800	2.800	9.552
21	1963	1963	11.100	36.700	16.900	12.400	10.000	8.000	6.400	5.300	4.400	4.100	3.600	3.700	10.223
22	1964	1964	19.600	36.400	13.200	12.600	14.000	12.600	7.600	5.600	4.700	4.200	4.100	4.100	11.575
23	1965	1965	11.800	44.700	30.000	19.200	22.700	15.300	8.600	6.600	5.400	4.500	4.000	3.900	14.752
24	1966	1966	14.100	50.700	28.500	18.800	14.300	16.300	15.700	6.500	5.700	5.400	3.900	4.500	15.384
25	1967	1967	13.800	27.800	15.300	13.400	7.100	10.600	11.900	6.200	6.100	5.000	4.800	5.800	10.669
26	1968	1968	27.400	34.900	15.200	13.700	21.900	18.300	13.400	8.800	5.800	4.500	4.000	3.300	14.302
27	1969	1969	15.200	47.400	32.300	16.200	15.900	19.600	11.400	8.900	7.700	6.000	5.100	5.000	15.929
28	1970	1970	11.900	49.800	23.200	11.300	10.000	7.900	6.000	4.500	3.800	3.000	2.500	3.400	11.447
29	1971	1971	31.400	35.000	25.200	14.400	10.700	16.500	4.200	3.000	2.500	2.300	3.300	3.100	12.712
30	1972	1972	5.000	47.600	19.500	8.500	9.500	14.500	8.300	4.700	2.000	4.200	5.500	3.500	11.056
31	1973	1973	32.200	24.800	14.200	5.800	5.900	14.500	9.800	9.800	5.300	5.000	3.500	4.300	11.310
32	1974	1974	9.200	43.300	19.500	9.100	7.400	10.600	8.600	6.800	1.700	4.900	2.200	2.400	10.467
33	1975	1975	11.900	51.600	25.500	14.200	13.900	8.600	8.000	5.700	4.800	4.600	4.100	6.800	13.306
34	1976	1976	71.200	25.600	21.300	13.600	72.900	21.100	-.200	-14.400	-.900	-.800	7.200	41.700	21.561
35	1977	1977	40.500	75.300	11.200	21.900	38.100	26.000	2.800	-10.100	-18.700	2.700	-3.500	16.600	16.838
36	1978	1978	58.200	44.800	36.400	72.500	23.200	10.600	-1.800	9.200	4.700	-18.600	10.000	25.000	23.191
37	1979	1979	68.000	18.800	79.600	41.200	1.800	20.100	25.600	-6.000	-.900	3.400	6.200	16.700	23.113
38	1980	1980	67.300	48.000	18.200	15.500	13.100	18.900	6.300	1.600	4.100	-3.400	15.000	-10.000	16.398
39	1981	1981	44.500	83.700	62.200	10.700	9.700	20.600	11.900	4.800	-13.900	-13.400	-13.600	-4.600	17.041
40	1982	1982	46.400	54.600	34.100	18.400	27.500	10.900	-.800	-1.300	4.100	1.700	-.800	31.000	18.856
41	1983	1983	71.500	27.600	18.200	23.400	16.600	26.900	7.700	-12.800	-5.700	8.700	12.400	7.700	16.938
42	1984	1984	58.500	30.000	9.700	-3.400	12.300	15.700	-4.200	-16.900	-21.700	-19.400	-26.200	-4.200	2.632
43	1985	1985	22.700	56.500	8.100	-2.900	9.700	22.100	-11.700	-4.400	-14.400	-14.200	-27.100	-13.700	2.612
44	1986	1986	49.200	19.100	11.600	-7.300	7.900	10.600	-9.000	-6.200	-26.900	-37.300	-62.800	-10.900	-4.979
45	1987	1987	16.500	17.700	23.800	21.600	18.300	22.400	-1.400	-17.700	-29.200	-46.600	-42.300	-24.500	-3.161
46	1988	1988	56.500	26.600	26.900	2.900	5.600	13.900	-13.700	-19.600	-49.100	-58.400	-56.800	-30.200	-7.590
47	1989	1989	53.700	16.800	5.700	4.700	21.900	25.800	-6.700	-6.000	-29.700	-58.200	-59.800	-42.000	-5.762
48	1990	1990	34.900	40.400	18.800	9.600	29.900	33.800	15.900	-7.800	-1.300	-35.300	-18.000	-16.100	8.999
49	1991	1991	11.300	38.100	16.000	8.300	11.600	24.000	6.700	-18.100	-8.000	-27.100	-23.900	-21.600	1.597
50	1992	1992	27.900	81.600	24.100	39.700	25.800	20.600	6.300	5.000	-7.800	-6.500	-6.600	16.500	18.942
51	1993	1993	43.000	28.500	22.600	18.900	9.500	24.400	-6.200	2.800	-14.400	-57.300	-54.300	-34.500	-.965
52	1994	1994	21.900	42.000	18.200	22.300	16.700	29.500	3.200	-6.800	-8.700	-35.400	-36.900	-22.200	3.902
53	1995	1995	47.500	14.100	23.200	9.100	21.500	27.200	12.100	-3.000	-28.100	-46.300	-17.100	-1.500	5.239
54	1996	1996	26.500	33.300	16.700	11.300	5.300	8.800	12.200	8.300	2.200	.300	7.700	4.800	11.515
AVERAGE			28.370	39.409	21.952	14.580	14.756	15.674	6.561	1.620	-2.196	-5.989	-4.856	1.146	11.008
MAXIMUM			71.500	83.700	79.600	72.500	72.900	33.800	25.600	9.800	7.700	9.500	15.000	41.700	23.191
MINIMUM			5.000	14.100	5.700	-7.300	1.800	7.100	-13.700	-19.600	-49.100	-58.400	-62.800	-42.000	-7.590

Lower Churchill River
Inflow Sequences

PERIOD AVERAGE CHANNEL FLOW (cms) : 25 Gull Island Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	584.30	548.60	241.10	168.30	162.30	137.70	366.20	178.30	103.50	84.00	82.30	155.10	234.74
2	1944	1944	1120.80	747.50	445.20	439.10	423.20	400.80	105.20	51.20	29.70	24.10	26.40	54.00	324.61
3	1945	1945	1507.60	737.70	656.10	57.30	55.20	141.70	407.40	198.40	115.20	93.50	126.80	203.80	360.65
4	1946	1946	1333.00	519.70	465.20	176.40	170.00	176.10	546.90	266.30	154.70	125.50	169.80	234.60	363.39
5	1947	1947	853.30	264.60	462.60	142.00	136.80	256.40	313.30	152.50	88.60	71.90	85.10	114.50	246.97
6	1948	1948	977.60	696.30	368.10	155.10	149.50	163.60	150.80	73.50	42.70	34.60	43.90	108.60	248.45
7	1949	1949	1695.70	932.30	919.10	359.30	346.30	210.30	165.30	80.40	46.20	37.90	45.50	79.30	413.17
8	1950	1950	1223.20	1185.90	668.60	88.50	85.30	131.30	744.00	362.20	210.40	170.70	211.80	293.00	448.77
9	1951	1951	1229.40	387.00	283.60	226.30	218.20	197.00	627.20	305.40	177.40	143.90	170.80	236.30	351.72
10	1952	1952	1136.70	782.60	426.70	500.30	482.20	278.60	364.60	177.60	103.20	83.70	126.70	214.50	391.52
11	1953	1953	1220.60	1212.20	510.30	643.20	620.00	178.60	461.80	224.90	130.70	106.00	155.70	262.30	478.47
12	1954	1954	1386.10	1208.00	416.80	391.30	377.10	351.20	366.80	178.60	103.70	84.20	99.80	194.40	431.50
13	1955	1955	1898.50	938.90	347.60	206.80	199.40	214.40	686.90	334.50	194.30	157.60	167.00	281.70	470.89
14	1956	1956	452.50	1362.60	616.20	275.10	265.20	559.00	469.40	243.20	126.70	70.70	52.70	74.90	381.45
15	1957	1957	199.30	2180.70	935.50	356.90	371.90	386.50	62.60	38.90	106.00	77.80	112.20	171.40	416.36
16	1958	1958	1319.20	1240.20	516.10	619.30	730.20	356.10	180.70	101.70	72.00	50.70	44.50	61.10	442.96
17	1959	1959	1446.90	1018.20	123.40	100.30	62.90	332.40	633.10	357.60	187.30	189.80	150.80	143.60	396.46
18	1960	1960	1375.50	684.10	362.80	268.40	432.90	362.10	218.50	86.20	77.70	51.50	39.10	117.30	341.79
19	1961	1961	623.50	726.00	341.90	253.20	147.00	559.60	202.80	114.30	159.10	111.40	67.40	35.20	279.83
20	1962	1962	1012.40	1469.80	294.00	242.80	106.60	62.20	108.40	57.00	33.20	50.30	63.50	102.70	300.69
21	1963	1963	1392.60	1188.20	539.80	373.10	294.00	352.50	362.00	95.10	92.10	87.10	109.00	192.80	425.01
22	1964	1964	1358.70	1469.70	354.30	428.10	287.20	231.30	175.20	97.70	41.50	17.70	86.50	106.60	389.58
23	1965	1965	1057.30	1613.10	603.70	330.20	615.60	397.40	153.70	16.70	9.20	58.10	77.80	64.10	417.21
24	1966	1966	88.50	794.70	1318.40	401.40	274.10	585.40	636.50	175.00	107.50	52.10	45.00	71.00	381.11
25	1967	1967	839.20	1220.90	344.30	395.50	187.80	336.50	375.30	242.60	72.00	103.50	111.70	199.00	369.82
26	1968	1968	1500.50	966.90	465.80	413.50	512.90	535.60	283.50	155.70	116.70	86.80	124.90	97.60	440.96
27	1969	1969	1081.40	2125.90	510.20	593.00	521.20	510.60	667.10	431.70	204.80	121.30	129.50	102.40	584.09
28	1970	1970	433.50	1105.40	361.40	409.50	279.30	290.10	235.00	37.30	54.50	73.10	78.10	227.20	298.77
29	1971	1971	1542.90	1016.70	357.30	324.60	281.10	490.20	367.30	234.40	116.00	144.00	165.30	186.70	437.64
30	1972	1972	372.30	2626.60	438.20	408.00	295.60	591.20	175.90	204.30	252.40	263.50	94.50	119.70	485.21
31	1973	1973	1731.30	926.20	579.70	283.60	185.40	293.30	279.20	164.60	167.80	352.10	115.20	72.20	430.55
32	1974	1974	736.50	1678.80	411.60	278.50	163.60	363.50	152.60	100.10	104.90	64.60	24.10	59.50	345.31
33	1975	1975	768.50	1725.50	392.30	256.00	348.20	256.90	213.10	102.30	75.10	173.40	87.70	241.10	385.74
34	1976	1976	1579.10	1069.50	255.10	485.30	492.20	302.20	168.20	74.00	50.20	41.00	47.30	48.20	386.52
35	1977	1977	1113.20	1584.40	241.20	546.20	545.30	482.80	277.90	138.40	142.90	132.20	68.60	.90	440.24
36	1978	1978	1176.80	1992.90	481.00	128.90	326.40	566.90	137.40	120.30	60.10	103.10	103.10	257.70	454.98
37	1979	1979	1520.40	882.20	343.60	566.90	420.90	326.40	335.00	137.40	77.30	68.70	68.70	77.30	404.51
38	1980	1980	1603.80	1297.10	635.70	300.60	240.50	335.00	214.80	128.90	103.10	94.50	85.90	189.00	438.00
39	1981	1981	1212.90	1606.30	420.90	446.70	322.10	429.50	120.30	85.90	60.10	41.20	57.60	74.70	408.16
40	1982	1982	850.40	1564.20	524.00	274.90	420.90	212.20	154.60	69.60	60.10	41.20	57.60	226.80	371.68
41	1983	1983	1657.00	755.90	481.00	180.40	257.70	463.90	163.20	69.60	51.50	77.30	43.00	77.30	359.25
42	1984	1984	1626.90	1297.10	506.80	189.00	438.10	249.10	103.10	68.70	60.10	43.00	43.00	43.00	390.94
43	1985	1985	661.40	1550.50	524.00	438.10	266.30	369.40	180.40	85.90	51.50	43.00	60.10	240.50	373.25
44	1986	1986	1271.30	699.20	519.70	343.60	326.40	317.80	171.80	103.10	85.90	103.10	146.00	257.70	364.24
45	1987	1987	884.80	576.40	384.80	326.40	309.20	524.00	429.50	266.30	197.60	214.80	180.40	137.40	370.64
46	1988	1988	1385.60	1683.60	403.70	121.10	137.40	317.80	317.80	68.70	60.10	41.20	57.60	74.70	390.17
47	1989	1989	772.20	924.30	352.20	255.10	234.50	258.60	258.60	130.60	51.00	109.40	222.00	96.50	306.23
48	1990	1990	103.70	126.00	196.70	308.50	443.00	396.40	134.90	52.70	-14.10	115.50	59.40	41.60	163.84
49	1991	1991	684.40	1050.50	568.70	303.40	237.60	309.40	205.70	43.30	-.20	54.20	59.50	8.30	294.81
50	1992	1992	828.90	1178.60	351.90	527.30	447.20	384.20	191.00	3.40	53.30	36.20	82.90	82.70	348.46
51	1993	1993	1185.20	630.40	453.40	550.70	320.20	622.90	194.00	173.80	1.20	75.20	100.40	164.70	375.62
52	1994	1994	1160.80	1040.70	495.60	439.30	493.80	331.20	271.10	58.90	80.10	103.80	205.60	257.70	412.94
53	1995	1995	1260.00	527.10	452.60	127.80	140.20	367.90	319.90	85.50	128.90	227.30	159.90	162.20	331.25
54	1996	1996	852.00	1069.80	535.80	364.00	171.70	280.40	390.80	263.60	69.10	8.20	246.80	155.00	369.35
AVERAGE			1090.56	1118.67	466.78	329.43	310.74	343.30	296.26	145.72	94.57	96.13	100.86	139.85	379.08
MAXIMUM			1898.50	2626.60	1318.40	643.20	730.20	622.90	744.00	431.70	252.40	352.10	246.80	293.00	584.09
MINIMUM			88.50	126.00	123.40	57.30	55.20	62.20	62.60	3.40	-14.10	8.20	24.10	.90	163.84

PERIOD AVERAGE CHANNEL FLOW (cms) : 28 Muskrat Falls Local Inflow

SIM	YEAR OF HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	95.900	90.000	39.600	27.600	26.600	22.600	60.100	29.300	17.000	13.800	13.500	25.500	38.528
2	1944	1944	183.900	122.700	73.100	72.100	69.400	65.800	17.300	8.400	4.900	4.000	4.300	8.900	53.284
3	1945	1945	247.400	121.100	107.700	9.400	9.100	23.300	66.900	32.600	18.900	15.300	20.800	33.400	59.196
4	1946	1946	218.700	85.300	76.300	28.900	27.900	28.900	89.700	43.700	25.400	20.600	27.900	38.500	59.624
5	1947	1947	140.000	43.400	75.900	23.300	22.400	42.100	51.400	25.000	14.500	11.800	14.000	18.800	40.518
6	1948	1948	160.400	114.300	60.400	25.500	24.500	26.800	24.700	12.100	7.000	5.700	7.200	17.800	40.767
7	1949	1949	278.300	153.000	150.800	59.000	56.800	34.500	27.100	13.200	7.600	6.200	7.500	13.000	67.804
8	1950	1950	200.700	194.600	109.700	14.500	14.000	21.500	122.100	59.400	34.500	28.000	34.800	48.100	73.633
9	1951	1951	201.700	63.500	46.500	37.100	35.800	32.300	102.900	50.100	29.100	23.600	28.000	38.800	57.698
10	1952	1952	186.500	128.400	70.000	82.100	79.100	45.700	59.800	29.100	16.900	13.700	20.800	35.200	64.227
11	1953	1953	200.300	198.900	83.700	105.500	101.700	29.300	75.800	36.900	21.400	17.400	25.600	43.000	78.501
12	1954	1954	227.500	198.200	68.400	64.200	61.900	57.600	60.200	29.300	17.000	13.800	16.400	31.900	70.808
13	1955	1955	311.500	154.100	57.000	33.900	32.700	35.200	112.700	54.900	31.900	25.900	27.400	46.200	77.266
14	1956	1956	74.300	223.600	101.100	45.100	43.500	91.700	77.000	39.900	20.800	11.600	8.600	12.300	62.584
15	1957	1957	32.700	357.900	153.500	58.600	61.000	63.400	10.300	6.400	17.400	12.800	18.400	28.100	68.328
16	1958	1958	216.500	203.500	84.700	101.600	119.800	58.400	29.700	16.700	11.800	8.300	7.300	10.000	72.683
17	1959	1959	237.400	167.100	20.200	16.500	10.300	54.500	103.900	58.700	30.700	31.100	24.700	23.600	65.045
18	1960	1960	225.700	112.300	59.500	44.000	71.000	59.400	35.900	14.100	12.800	8.500	6.400	19.200	56.079
19	1961	1961	102.300	119.100	56.100	41.600	24.100	91.800	33.300	18.800	26.100	18.300	11.100	5.800	45.927
20	1962	1962	166.100	241.200	48.200	39.800	17.500	10.200	17.800	9.400	5.400	8.300	10.400	16.900	49.339
21	1963	1963	228.500	195.000	88.600	61.200	48.200	57.800	59.400	15.600	15.100	14.300	17.900	31.600	69.732
22	1964	1964	223.000	241.200	58.100	70.300	47.100	38.000	28.800	16.000	6.800	2.900	14.200	17.500	63.939
23	1965	1965	173.500	264.700	99.100	54.200	101.000	65.200	25.200	2.700	1.500	9.500	12.800	10.500	68.458
24	1966	1966	14.500	130.400	216.300	65.900	45.000	96.100	104.400	28.700	17.600	8.500	7.400	11.700	62.533
25	1967	1967	137.700	200.300	56.500	64.900	30.800	55.200	61.600	39.800	11.800	17.000	18.300	32.700	60.680
26	1968	1968	246.200	158.700	76.400	67.900	84.200	87.900	46.500	25.600	19.200	14.200	20.500	16.000	72.368
27	1969	1969	177.500	348.900	83.700	97.300	85.500	83.800	109.500	70.800	33.600	19.900	21.300	16.800	95.853
28	1970	1970	71.100	181.400	59.300	67.200	45.800	47.600	38.600	6.100	8.900	12.000	12.800	37.300	49.019
29	1971	1971	253.200	166.800	58.600	53.300	46.100	80.400	60.300	38.500	19.000	23.600	27.100	30.600	71.802
30	1972	1972	61.100	431.000	71.900	67.000	48.500	97.000	28.900	33.500	41.400	43.200	15.500	19.600	79.614
31	1973	1973	284.100	152.000	95.100	46.500	30.400	48.100	45.800	27.000	27.500	57.800	18.900	11.800	70.635
32	1974	1974	120.900	275.500	67.500	45.700	26.800	59.700	25.000	16.400	17.200	10.600	4.000	9.800	56.666
33	1975	1975	126.100	283.200	64.400	42.000	57.100	42.200	35.000	16.800	12.300	28.500	14.400	39.600	63.313
34	1976	1976	259.100	175.500	41.900	79.600	80.800	49.600	27.600	12.100	8.200	6.700	7.800	7.900	63.422
35	1977	1977	182.700	260.000	39.600	89.600	89.500	79.200	45.600	22.700	23.400	21.700	11.300	.100	72.239
36	1978	1978	193.100	327.000	78.900	21.200	53.600	93.000	22.500	19.700	9.900	16.900	16.900	42.300	74.655
37	1979	1979	249.500	144.800	56.400	93.000	69.100	53.600	55.000	22.500	12.700	11.300	11.300	12.700	66.393
38	1980	1980	263.200	212.900	104.300	49.300	39.500	55.000	35.200	21.200	16.900	15.500	14.100	31.000	71.879
39	1981	1981	199.000	263.600	69.100	73.300	52.900	70.500	19.700	14.100	9.900	6.800	9.500	12.300	66.994
40	1982	1982	139.600	256.700	86.000	45.100	69.100	34.800	25.400	11.400	9.900	6.800	9.500	37.200	61.007
41	1983	1983	271.900	124.000	78.900	29.600	42.300	76.100	26.800	11.400	8.500	12.700	7.100	12.700	58.954
42	1984	1984	267.000	212.900	83.200	31.000	71.900	40.900	16.900	11.300	9.900	7.100	7.100	7.100	64.179
43	1985	1985	108.500	254.400	86.000	71.900	43.700	60.600	29.600	14.100	8.500	7.100	9.900	39.500	61.258
44	1986	1986	208.600	114.700	85.300	56.400	53.600	52.200	28.200	16.900	14.100	16.900	24.000	42.300	59.780
45	1987	1987	145.200	94.600	63.100	53.600	50.700	86.000	70.500	43.700	32.400	35.200	29.600	22.500	60.812
46	1988	1988	227.400	276.300	66.200	19.900	22.500	52.200	52.200	11.300	9.900	6.800	9.500	12.300	64.049
47	1989	1989	126.700	151.700	57.800	41.900	38.500	42.400	42.400	21.400	8.400	18.000	36.400	15.800	50.249
48	1990	1990	17.000	20.700	32.300	50.600	72.700	65.000	22.100	8.600	-2.300	19.000	9.700	6.800	26.874
49	1991	1991	112.300	172.400	93.300	49.800	39.000	50.800	33.800	7.100	.000	8.900	9.800	1.400	48.393
50	1992	1992	136.000	193.400	57.700	86.500	73.400	63.000	31.300	.600	8.700	5.900	13.600	13.600	57.165
51	1993	1993	194.500	103.400	74.400	90.400	52.500	102.200	31.800	28.500	.200	12.300	16.500	27.000	61.625
52	1994	1994	190.500	170.800	81.300	72.100	81.000	54.300	44.500	9.700	13.100	17.000	33.700	42.300	67.753
53	1995	1995	206.800	86.500	74.300	21.000	23.000	60.400	52.500	14.000	21.200	37.300	26.200	26.600	54.365
54	1996	1996	139.800	175.600	87.900	59.700	28.200	46.000	64.100	43.300	11.300	1.300	40.500	25.400	60.600
AVERAGE			178.956	183.578	76.589	54.059	50.983	56.330	48.617	23.909	15.515	15.776	16.559	22.950	62.205
MAXIMUM			311.500	431.000	216.300	105.500	119.800	102.200	122.100	70.800	41.400	57.800	40.500	48.100	95.853
MINIMUM			14.500	20.700	20.200	9.400	9.100	10.200	10.300	.600	-2.300	1.300	4.000	.100	26.874

Appendix C
Description of ARSP Model

ACRES RESERVOIR SIMULATION PROGRAM (ARSP) COMPUTER MODELING PROGRAM

ARSP is a general reservoir simulation program that is capable of simulating a wide range of operating policies in multipurpose, multi reservoir systems. Water resource allocation problems involving energy production, flood control, water supply, irrigation, low-flow augmentation, diversion, navigation, environmental, and many other requirements can be modeled. The model takes natural inflows, precipitation, evaporation and evapotranspiration data as input.

A major advantage of ARSP is its flexibility in allowing the user to make structural or operating policy changes by modifying the input data rather than by changing the computer program itself. Furthermore, the operating policies are modeled separately from the physical system. In this way, a unique and powerful division in representation of a water resource network is realized and is responsible, in large part, for the flexibility and general applicability of the model. This approach allows alternative water resource policies to be investigated by superimposing new penalty structures on the existing network. The penalty structure defines the relative priorities of conflicting water uses under various hydrologic conditions, and at various times of the year. The priorities are specified by the user, and are not dependent on the system configuration.

Operational features that can be represented include storage and release of water by reservoirs, physical discharge controls at reservoir outlets, water flow in channels (e.g., streams, power channels, diversion or irrigation canals), consumptive demands (e.g., agricultural, industrial or municipal), hydropower releases, head losses in channels, water losses in channels, hydraulic routing through channels and reservoirs, and inflow forecasts. Flow and water level constraints may be absolute, or they may be relative to the flow or level in a previous time step.

ARSP is based on the premise that a water resource system can be represented by a flow network and that an optimal operating decision for the upcoming time period can be made given the initial state of the system and estimates of net inflows during the period. It is a steady-state model since the system configuration and the penalty structure do not change with time. It is not an "optimization model", but it does use a solution algorithm that is based on optimization principles. It is known as the "out of kilter" algorithm.

In the model, a physical water resource system is described as a network consisting of discrete components, each of which is defined separately. Junctions and control points, such as reservoirs, are represented as nodes, while natural or man-made flow paths that connect junctions are referred to as channels. The network solution technique allocates water in such a way that the total penalties for demand and reservoir storage are minimized for a given time step, e.g., the model might determine if it is preferable to draw a reservoir down to maintain a minimum flow in a channel or to keep the water in storage and allow the channel flow to fall below the desired value.

Appendix D
Storage Curves

E M M A G A S I N E M E N T A O s s o k m a n u a n

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
471.8				0.00	0.00	0.00	0.00	0.00	0.00	0.00
471.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
475.0	0.00	0.00	0.00	0.00	2.34	7.89	13.45	19.02	24.61	30.22
475.1	35.84	41.48	47.13	52.80	58.48	64.18	69.89	75.61	81.35	87.10
475.2	92.87	98.65	104.44	110.24	116.06	121.89	127.60	133.45	139.32	145.20
475.3	151.10	157.00	162.92	168.85	174.79	180.74	186.70	192.68	198.66	204.66
475.4	210.67	216.68	222.71	228.75	234.80	240.86	246.93	253.00	259.09	265.19
475.5	271.30	277.26	283.39	289.52	295.67	301.82	307.98	314.15	320.32	326.51
475.6	332.70	338.91	345.12	351.34	357.56	363.80	370.04	376.28	382.54	388.80
475.7	395.07	401.35	407.63	413.93	420.22	426.53	432.68	439.00	445.32	451.65
475.8	457.99	464.33	470.68	477.03	483.39	489.75	496.12	502.50	508.88	515.26
475.9	521.66	528.05	534.45	540.86	547.27	553.69	560.11	566.53	572.96	579.39

E M M A G A S I N E M E N T A O s s o k m a n u a n

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
476.0	585.83	592.12	598.56	605.02	611.47	617.93	624.39	630.86	637.33	643.80
476.1	650.28	656.76	663.25	669.73	676.23	682.72	689.22	695.72	702.23	708.73
476.2	715.24	721.76	728.27	734.79	741.32	747.84	754.21	760.74	767.27	773.81
476.3	780.35	786.89	793.43	799.97	806.52	813.07	819.62	826.18	832.73	839.29
476.4	845.85	852.41	858.98	865.55	872.11	878.68	885.26	891.83	898.41	904.98
476.5	911.56	917.98	924.57	931.15	937.74	944.33	950.92	957.51	964.10	970.69
476.6	977.29	983.89	990.49	997.09	1003.69	1010.29	1016.90	1023.50	1030.11	1036.72
476.7	1043.33	1049.94	1056.55	1063.17	1069.78	1076.40	1082.86	1089.48	1096.10	1102.72
476.8	1109.35	1115.97	1122.60	1129.23	1135.86	1142.49	1149.12	1155.76	1162.39	1169.03
476.9	1175.67	1182.31	1188.95	1195.59	1202.23	1208.88	1215.53	1222.18	1228.83	1235.48
477.0	1242.13	1248.63	1255.29	1261.94	1268.60	1275.27	1281.93	1288.60	1295.27	1301.93
477.1	1308.61	1315.28	1321.95	1328.63	1335.31	1341.99	1348.68	1355.36	1362.05	1368.74
477.2	1375.43	1382.13	1388.82	1395.52	1402.23	1408.93	1415.47	1422.18	1428.89	1435.61
477.3	1442.33	1449.05	1455.77	1462.50	1469.23	1475.96	1482.69	1489.43	1496.17	1502.92
477.4	1509.67	1516.42	1523.17	1529.93	1536.69	1543.46	1550.22	1557.00	1563.78	1570.56
477.5	1577.34	1583.96	1590.76	1597.55	1604.35	1611.16	1617.97	1624.78	1631.60	1638.42
477.6	1645.25	1652.09	1658.92	1665.76	1672.61	1679.47	1686.32	1693.19	1700.06	1706.93
477.7	1713.81	1720.70	1727.59	1734.49	1741.39	1748.30	1755.05	1761.97	1768.89	1775.83
477.8	1782.77	1789.72	1796.67	1803.63	1810.60	1817.58	1824.56	1831.55	1838.55	1845.55
477.9	1852.56	1859.58	1866.61	1873.65	1880.69	1887.74	1894.80	1901.87	1908.95	1916.03
478.0	1923.13	1930.06	1937.17	1944.29	1951.42	1958.56	1965.71	1972.87	1980.04	1987.22
478.1	1994.40	2001.60	2008.81	2016.03	2023.26	2030.50	2037.75	2045.02	2052.29	2059.57
478.2	2066.87	2074.18	2081.50	2088.83	2096.17	2103.53	2110.71	2118.09	2125.49	2132.89
478.3	2140.31	2147.74	2155.18	2162.64	2170.11	2177.59	2185.09	2192.60	2200.13	2207.67
478.4	2215.22	2222.79	2230.37	2237.97	2245.59	2253.21	2260.86	2268.52	2276.19	2283.88
478.5	2291.59	2299.13	2306.86	2314.62	2322.39	2330.18	2337.99	2345.81	2353.65	2361.51
478.6	2369.39	2377.28	2385.19	2393.12	2401.07	2409.04	2417.03	2425.03	2433.06	2441.10
478.7	2449.17	2457.25	2465.35	2473.48	2481.62	2489.79	2497.77	2505.98	2514.21	2522.46
478.8	2530.73	2539.02	2547.33	2555.67	2564.03	2572.41	2580.81	2589.24	2597.69	2606.16
478.9	2614.66	2623.18	2631.73	2640.30	2648.89	2657.51	2666.15	2674.82	2683.51	2692.23
479.0	2700.98	2709.54	2718.33	2727.15	2736.00	2744.88	2753.78	2762.72	2771.67	2780.66
479.1	2789.67	2798.72	2807.79	2816.89	2826.01	2835.17	2844.36	2853.57	2862.82	2872.10
479.2	2881.41	2890.74	2900.11	2909.51	2918.94	2928.40	2937.66	2947.19	2956.75	2966.34
479.3	2975.96	2985.62	2995.30	3005.03	3014.78	3024.58	3034.40	3044.26	3054.15	3064.08
479.4	3074.05	3084.05	3094.08	3104.16	3114.26	3124.41	3134.59	3144.81	3155.06	3165.36
479.5	3175.69	3185.81	3196.21	3206.66	3217.15	3227.67	3238.24	3248.84	3259.48	3270.17
479.6	3280.89	3291.66	3302.47	3313.32	3324.21	3335.14	3346.12	3357.13	3368.19	3379.30
479.7	3390.45	3401.64	3412.87	3424.15	3435.48	3446.85	3457.98	3469.44	3480.95	3492.50
479.8	3504.10	3515.74	3527.44	3539.17	3550.96	3562.79	3574.68	3586.61	3598.59	3610.62
479.9	3622.70	3634.83	3647.01	3659.23	3671.52	3683.85	3696.23	3708.66	3721.15	3733.69

E M M A G A S I N E M E N T A S m a l l w o o d

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
463.9	-98.51	-92.38	-86.24	-80.08	-73.91	-67.72	-61.52	-55.30	-49.07	-42.82
464.0	-36.56	-30.44	-24.15	-17.84	-11.52	-5.19	1.15	7.52	13.90	20.29
464.1	26.70	33.12	39.56	46.02	52.48	58.97	65.46	71.98	78.50	85.05
464.2	91.60	98.17	104.76	111.36	117.98	124.61	131.09	137.75	144.43	151.12
464.3	157.82	164.54	171.27	178.02	184.79	191.56	198.36	205.16	211.99	218.82
464.4	225.68	232.54	239.43	246.32	253.23	260.16	267.10	274.06	281.03	288.01
464.5	295.01	301.85	308.88	315.93	322.99	330.06	337.15	344.25	351.37	358.50
464.6	365.65	372.81	379.99	387.18	394.39	401.61	408.84	416.10	423.36	430.64
464.7	437.94	445.25	452.57	459.91	467.27	474.63	481.84	489.24	496.65	504.08
464.8	511.52	518.98	526.45	533.94	541.44	548.95	556.48	564.03	571.59	579.17
464.9	586.76	594.36	601.98	609.62	617.27	624.93	632.61	640.30	648.01	655.73
465.0	663.47	671.03	678.80	686.58	694.38	702.19	710.02	717.86	725.71	733.58
465.1	741.47	749.37	757.28	765.21	773.16	781.12	789.09	797.08	805.08	813.10
465.2	821.13	829.18	837.24	845.32	853.41	861.52	869.44	877.58	885.73	893.89
465.3	902.07	910.27	918.48	926.70	934.94	943.19	951.46	959.75	968.04	976.36
465.4	984.68	993.03	1001.38	1009.75	1018.14	1026.54	1034.96	1043.39	1051.83	1060.29
465.5	1068.77	1077.05	1085.55	1094.08	1102.61	1111.16	1119.72	1128.30	1136.89	1145.50
465.6	1154.12	1162.76	1171.41	1180.07	1188.76	1197.45	1206.16	1214.89	1223.63	1232.38
465.7	1241.15	1249.93	1258.73	1267.55	1276.38	1285.22	1293.86	1302.73	1311.62	1320.52
465.8	1329.44	1338.37	1347.32	1356.28	1365.25	1374.24	1383.25	1392.27	1401.30	1410.35
465.9	1419.42	1428.49	1437.59	1446.70	1455.82	1464.96	1474.11	1483.28	1492.46	1501.65
466.0	1510.87	1519.87	1529.11	1538.36	1547.63	1556.92	1566.22	1575.53	1584.86	1594.20
466.1	1603.56	1612.93	1622.32	1631.72	1641.14	1650.57	1660.02	1669.48	1678.96	1688.45
466.2	1697.95	1707.47	1717.01	1726.56	1736.12	1745.70	1755.06	1764.67	1774.29	1783.93
466.3	1793.58	1803.25	1812.93	1822.63	1832.34	1842.07	1851.81	1861.56	1871.33	1881.12
466.4	1890.92	1900.73	1910.56	1920.40	1930.26	1940.13	1950.02	1959.93	1969.84	1979.77
466.5	1989.72	1999.44	2009.42	2019.41	2029.41	2039.43	2049.47	2059.52	2069.58	2079.66
466.6	2089.75	2099.86	2109.98	2120.12	2130.27	2140.44	2150.62	2160.82	2171.03	2181.26
466.7	2191.50	2201.75	2212.02	2222.31	2232.61	2242.92	2253.00	2263.34	2273.70	2284.07
466.8	2294.46	2304.86	2315.28	2325.71	2336.15	2346.62	2357.09	2367.58	2378.09	2388.61
466.9	2399.14	2409.69	2420.25	2430.83	2441.43	2452.03	2462.66	2473.29	2483.95	2494.61
467.0	2505.29	2515.73	2526.44	2537.17	2547.91	2558.66	2569.43	2580.21	2591.01	2601.83
467.1	2612.65	2633.78	2670.59	2707.46	2744.37	2781.35	2818.38	2855.47	2892.61	2929.80
467.2	2967.05	3004.35	3041.71	3079.12	3116.58	3154.10	3190.75	3228.38	3266.05	3303.78
467.3	3341.56	3379.39	3417.28	3455.22	3493.21	3531.25	3569.34	3607.48	3645.68	3683.92
467.4	3722.22	3760.56	3798.96	3837.41	3875.90	3914.45	3953.05	3991.69	4030.39	4069.13
467.5	4107.92	4145.82	4184.71	4223.64	4262.63	4301.66	4340.74	4379.87	4419.05	4458.27
467.6	4497.54	4536.86	4576.22	4615.64	4655.09	4694.59	4734.14	4773.74	4813.38	4853.06
467.7	4892.80	4932.57	4972.39	5012.26	5052.17	5092.12	5131.14	5171.19	5211.27	5251.40
467.8	5291.57	5331.79	5372.05	5412.35	5452.69	5493.08	5533.51	5573.98	5614.50	5655.05
467.9	5695.64	5736.28	5776.96	5817.68	5858.44	5899.25	5940.09	5980.97	6021.89	6062.86

E M M A G A S I N E M E N T A S m a l l w o o d

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
468.0	6103.86	6143.90	6184.98	6226.10	6267.26	6308.46	6349.69	6390.97	6432.29	6473.64
468.1	6515.03	6556.46	6597.92	6639.42	6680.96	6722.54	6764.15	6805.80	6847.49	6889.21
468.2	6930.97	6972.77	7014.60	7056.46	7098.37	7140.30	7181.25	7223.26	7265.30	7307.37
468.3	7349.49	7391.63	7433.81	7476.02	7518.27	7560.55	7602.86	7645.20	7687.58	7729.99
468.4	7772.44	7814.91	7857.42	7899.96	7942.53	7985.13	8027.77	8070.43	8113.13	8155.86
468.5	8198.62	8240.36	8283.18	8326.03	8368.91	8411.82	8454.75	8497.72	8540.72	8583.75
468.6	8626.80	8669.88	8712.99	8756.14	8799.30	8842.50	8885.72	8928.98	8972.25	9015.56
468.7	9058.89	9102.25	9145.64	9189.05	9232.50	9275.96	9319.39	9361.91	9405.45	9449.02
468.8	9492.61	9536.23	9579.87	9623.54	9667.23	9710.95	9754.69	9798.46	9842.25	9886.06
468.9	9929.89	9973.75	10017.64	10061.54	10105.47	10149.42	10193.39	10237.39	10281.40	10325.44
469.0	10369.50	10412.51	10456.61	10500.73	10544.88	10589.04	10633.23	10677.43	10721.66	10765.91
469.1	10810.17	10854.46	10898.76	10943.08	10987.42	11031.79	11076.17	11120.57	11164.98	11209.42
469.2	11253.87	11298.34	11342.83	11387.34	11431.86	11476.41	11519.87	11564.45	11609.04	11653.64
469.3	11698.27	11742.91	11787.56	11832.23	11876.92	11921.62	11966.33	12011.07	12055.81	12100.57
469.4	12145.34	12190.13	12234.93	12279.75	12324.58	12369.42	12414.28	12459.15	12504.03	12548.92
469.5	12593.83	12637.66	12682.59	12727.53	12772.49	12817.46	12862.43	12907.42	12952.42	12997.44
469.6	13042.46	13087.49	13132.53	13177.58	13222.65	13267.72	13312.80	13357.90	13403.00	13448.11
469.7	13493.23	13538.36	13583.50	13628.64	13673.79	13718.95	13763.02	13808.19	13853.38	13898.57
469.8	13943.76	13988.97	14034.18	14079.40	14124.62	14169.85	14215.09	14260.33	14305.58	14350.83
469.9	14396.09	14441.36	14486.62	14531.90	14577.17	14622.46	14667.75	14713.03	14758.33	14803.62
470.0	14848.92	14897.14	14942.77	14988.44	15034.14	15079.90	15125.69	15171.53	15217.41	15263.33
470.1	15309.30	15355.31	15401.35	15447.45	15493.58	15539.75	15585.97	15632.23	15678.53	15724.87
470.2	15771.25	15817.67	15864.13	15910.63	15957.18	16003.74	16049.22	16095.80	16142.59	16189.31
470.3	16236.11	16282.96	16329.80	16376.71	16423.66	16470.64	16517.65	16564.73	16611.83	16658.96
470.4	16706.14	16753.37	16800.64	16847.93	16895.28	16942.66	16990.07	17037.52	17084.99	17132.55
470.5	17180.13	17226.56	17274.23	17321.90	17369.63	17417.37	17465.21	17513.04	17560.91	17608.84
470.6	17656.70	17704.77	17752.82	17800.87	17849.00	17897.14	17945.32	17993.56	18041.82	18090.12
470.7	18138.46	18186.83	18235.26	18283.72	18332.19	18380.73	18429.13	18476.73	18525.37	18574.06
470.8	18622.78	18671.54	18720.33	18769.18	18818.07	18866.97	18915.94	18964.92	19013.94	19063.00
470.9	19112.10	19161.27	19210.48	19259.67	19308.94	19358.26	19407.59	19456.97	19506.39	19555.84
471.0	19605.34	19653.67	19703.26	19752.87	19802.52	19852.20	19901.96	19951.72	20001.52	20051.37
471.1	20101.28	20151.21	20201.18	20251.20	20301.25	20351.36	20401.47	20451.67	20501.87	20552.12
471.2	20602.41	20652.78	20703.14	20753.55	20804.01	20854.53	20903.83	20954.42	21005.05	21055.72
471.3	21106.43	21157.18	21207.98	21258.82	21309.69	21360.61	21411.57	21462.58	21513.62	21564.73
471.4	21615.87	21667.05	21710.27	21769.53	21820.86	21872.21	21923.60	21975.03	22026.53	22078.06
471.5	22129.65	22180.02	22231.69	22283.38	22335.16	22386.94	22438.81	22490.71	22542.64	22594.63
471.6	22646.68	22698.74	22750.87	22803.07	22855.27	22907.53	22959.85	23012.23	23064.65	23117.12
471.7	23169.63	23222.18	23274.81	23327.45	23380.16	23432.92	23484.43	23537.29	23590.21	23643.17
471.8	23696.16	23749.22	23802.35	23855.50	23908.70	23961.99	24015.29	24068.68	24122.08	24175.58
471.9	24229.09	24282.67	24336.30	24390.01	24443.75	24497.54	24551.39	24605.31	24659.27	24713.28
472.0	24767.33	24820.16	24874.34	24928.58	24982.91	25037.25	25091.66	25146.13	25200.65	25255.25
472.1	25309.89	25364.59	25419.37	25474.18	25529.05	25584.00	25639.00	25694.06	25749.17	25804.36
472.2	25859.63	25914.93	25970.30	26025.71	26081.22	26136.79	26191.04	26246.75	26302.49	26358.30
472.3	26414.17	26470.12	26526.12	26582.19	26638.32	26694.55	26750.82	26807.16	26863.55	26920.04
472.4	26976.59	27033.19	27089.89	27146.62	27203.44	27260.33	27317.29	27374.34	27431.42	27488.60
472.5	27545.87	27601.77	27659.16	27716.61	27774.15	27831.75	27889.43	27947.20	28005.05	28062.94
472.6	28120.91	28178.98	28237.12	28295.32	28353.62	28411.98	28470.44	28528.94	28587.54	28646.24
472.7	28705.00	28763.83	28822.75	28881.77	28940.84	29000.00	29057.83	29117.14	29176.56	29236.05
472.8	29295.62	29355.30	29415.04	29474.88	29534.79	29594.78	29654.89	29715.07	29775.34	29835.69
472.9	29896.13	29956.66	30017.30	30078.00	30138.81	30199.67	30260.68	30321.76	30382.92	30444.17

E M M A G A S I N E M E N T A S m a l l w o o d

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
473.0	30505.53	30565.47	30627.01	30688.64	30750.38					

EMMAGASINEMENT A Bief amont ouest

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
445.0		1.34	1.43	1.52	1.61	1.70	1.80	1.89	1.98	2.08
445.1	2.17	2.27	2.36	2.46	2.56	2.66	2.76	2.86	2.96	3.06
445.2	3.16	3.26	3.37	3.47	3.57	3.68	3.78	3.89	4.00	4.10
445.3	4.21	4.32	4.43	4.54	4.65	4.77	4.88	4.99	5.11	5.22
445.4	5.34	5.45	5.57	5.69	5.80	5.92	6.04	6.16	6.28	6.40
445.5	6.52	6.64	6.76	6.89	7.01	7.14	7.26	7.39	7.51	7.64
445.6	7.77	7.90	8.03	8.16	8.29	8.42	8.55	8.68	8.81	8.95
445.7	9.08	9.21	9.35	9.48	9.62	9.76	9.89	10.03	10.17	10.31
445.8	10.45	10.59	10.73	10.87	11.01	11.15	11.30	11.44	11.58	11.73
445.9	11.87	12.02	12.17	12.31	12.46	12.61	12.76	12.91	13.06	13.21
446.0	13.36	13.51	13.66	13.81	13.96	14.12	14.27	14.43	14.58	14.74
446.1	14.89	15.05	15.21	15.37	15.53	15.69	15.85	16.01	16.17	16.33
446.2	16.49	16.65	16.81	16.98	17.14	17.31	17.47	17.63	17.80	17.97
446.3	18.13	18.30	18.47	18.64	18.81	18.98	19.15	19.32	19.49	19.66
446.4	19.83	20.01	20.18	20.35	20.53	20.70	20.88	21.06	21.23	21.41
446.5	21.59	21.76	21.94	22.12	22.30	22.48	22.66	22.84	23.02	23.20
446.6	23.39	23.57	23.75	23.94	24.12	24.31	24.49	24.68	24.87	25.06
446.7	25.24	25.43	25.62	25.81	26.00	26.19	26.38	26.57	26.76	26.95
446.8	27.15	27.34	27.53	27.73	27.92	28.12	28.31	28.51	28.71	28.90
446.9	29.10	29.30	29.50	29.70	29.90	30.10	30.30	30.50	30.70	30.91
447.0	31.11	31.31	31.51	31.72	31.92	32.13	32.33	32.54	32.75	32.96
447.1	33.16	33.37	33.58	33.79	34.00	34.21	34.42	34.63	34.85	35.06
447.2	35.27	35.49	35.70	35.92	36.13	36.35	36.56	36.77	36.99	37.21
447.3	37.43	37.65	37.87	38.09	38.31	38.53	38.75	38.97	39.19	39.42
447.4	39.64	39.86	40.09	40.31	40.54	40.77	40.99	41.22	41.45	41.68
447.5	41.90	42.13	42.36	42.59	42.82	43.05	43.28	43.51	43.75	43.98
447.6	44.22	44.45	44.69	44.92	45.16	45.39	45.63	45.87	46.11	46.35
447.7	46.59	46.83	47.07	47.31	47.55	47.79	48.03	48.27	48.52	48.76
447.8	49.01	49.25	49.50	49.74	49.99	50.24	50.49	50.74	50.99	51.24
447.9	51.49	51.74	51.99	52.24	52.49	52.75	53.00	53.26	53.51	53.77
448.0	54.02	54.27	54.53	54.79	55.05	55.31	55.57	55.83	56.09	56.35
448.1	56.61	56.88	57.14	57.40	57.67	57.93	58.20	58.47	58.73	59.00
448.2	59.27	59.54	59.81	60.08	60.35	60.62	60.89	61.16	61.43	61.70
448.3	61.98	62.25	62.53	62.81	63.08	63.36	63.64	63.92	64.20	64.48
448.4	64.76	65.04	65.32	65.61	65.89	66.17	66.46	66.74	67.03	67.32
448.5	67.60	67.88	68.17	68.46	68.75	69.04	69.33	69.63	69.92	70.21
448.6	70.51	70.80	71.10	71.39	71.69	71.99	72.29	72.58	72.88	73.18
448.7	73.49	73.79	74.09	74.39	74.70	75.00	75.30	75.61	75.91	76.22
448.8	76.53	76.84	77.15	77.46	77.77	78.08	78.39	78.71	79.02	79.34
448.9	79.65	79.97	80.28	80.60	80.92	81.24	81.56	81.88	82.20	82.53
449.0	82.85	83.17	83.49	83.82	84.14	84.47	84.80	85.13	85.46	85.79
449.1	86.12	86.45	86.78	87.12	87.45	87.79	88.12	88.46	88.80	89.14
449.2	89.48	89.82	90.16	90.50	90.84	91.18	91.52	91.87	92.21	92.56
449.3	92.91	93.26	93.61	93.96	94.31	94.66	95.01	95.37	95.72	96.08
449.4	96.43	96.79	97.15	97.51	97.87	98.23	98.59	98.96	99.32	99.69
449.5	100.05	100.41	100.78	101.14	101.51	101.88	102.26	102.63	103.00	103.38
449.6	103.75	104.13	104.50	104.88	105.26	105.64	106.02	106.40	106.79	107.17
449.7	107.56	107.94	108.33	108.72	109.11	109.50	109.88	110.27	110.66	111.06
449.8	111.45	111.85	112.24	112.64	113.04	113.44	113.84	114.24	114.65	115.05
449.9	115.46	115.86	116.27	116.68	117.09	117.50	117.91	118.33	118.74	119.15

E M M A G A S I N E M E N T A B i e f a m o n t o u e s t

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
450.0	119.57	119.98	120.40	120.82	121.24	121.66	122.08	122.51	122.93	123.36
450.1	123.78	124.21	124.64	125.07	125.51	125.94	126.37	126.81	127.24	127.68
450.2	128.12	128.56	129.00	129.45	129.89	130.33	130.77	131.22	131.67	132.12
450.3	132.57	133.02	133.47	133.93	134.38	134.84	135.30	135.76	136.22	136.68
450.4	137.14	137.61	138.08	138.54	139.01	139.48	139.95	140.42	140.90	141.37
450.5	141.85	142.32	142.79	143.27	143.76	144.24	144.72	145.21	145.70	146.18
450.6	146.67	147.16	147.66	148.15	148.65	149.14	149.64	150.14	150.64	151.14
450.7	151.64	152.15	152.66	153.16	153.67	154.18	154.68	155.20	155.71	156.23
450.8	156.74	157.26	157.78	158.31	158.83	159.35	159.88	160.41	160.94	161.47
450.9	162.00	162.53	163.07	163.61	164.14	164.68	165.23	165.77	166.31	166.86
451.0	167.41	167.94	168.49	169.04	169.60	170.15	170.71	171.27	171.83	172.39
451.1	172.95	173.52	174.09	174.65	175.22	175.79	176.37	176.94	177.52	178.10
451.2	178.67	179.26	179.84	180.42	181.01	181.60	182.17	182.76	183.36	183.95
451.3	184.55	185.14	185.74	186.35	186.95	187.55	188.16	188.77	189.38	189.99
451.4	190.60	191.22	191.84	192.45	193.07	193.70	194.32	194.95	195.58	196.20
451.5	196.84	197.45	198.09	198.73	199.36	200.00	200.65	201.29	201.94	202.59
451.6	203.24	203.89	204.54	205.20	205.85	206.51	207.17	207.84	208.50	209.17
451.7	209.84	210.51	211.18	211.86	212.53	213.21	213.87	214.56	215.24	215.93
451.8	216.62	217.31	218.00	218.69	219.39	220.09	220.79	221.49	222.20	222.90
451.9	223.61	224.32	225.03	225.75	226.47	227.19	227.91	228.63	229.35	230.08
452.0	230.81	231.53	232.26	233.00	233.73	234.47	235.22	235.96	236.71	237.46
452.1	238.21	238.96	239.71	240.47	241.23	241.99	242.76	243.52	244.29	245.06
452.2	245.84	246.61	247.39	248.17	248.95	249.74	250.50	251.29	252.08	252.88
452.3	253.67	254.47	255.27	256.07	256.88	257.69	258.50	259.31	260.12	260.94
452.4	261.76	262.58	263.40	264.23	265.06	265.89	266.72	267.56	268.40	269.24
452.5	270.08	270.91	271.76	272.61	273.46	274.32	275.17	276.03	276.90	277.76
452.6	278.63	279.50	280.37	281.25	282.13	283.01	283.89	284.78	285.67	286.56
452.7	287.45	288.35	289.25	290.15	291.05	291.96	292.85	293.76	294.67	295.59
452.8	296.51	297.43	298.36	299.29	300.22	301.15	302.09	303.02	303.97	304.91
452.9	305.86	306.81	307.76	308.71	309.67	310.63	311.60	312.56	313.53	314.50

E M M A G A S I N E M E N T A B . - e s t , C h u r c h . F a l l s

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
443.7									-1.34	-0.35
443.8	0.63	1.62	2.61	3.60	4.60	5.59	6.59	7.58	8.58	9.57
443.9	10.57	11.57	12.57	13.57	14.57	15.57	16.58	17.58	18.59	19.59
444.0	20.60	21.58	22.59	23.60	24.60	25.61	26.63	27.64	28.65	29.66
444.1	30.68	31.69	32.71	33.72	34.74	35.76	36.78	37.80	38.82	39.84
444.2	40.86	41.88	42.91	43.93	44.96	45.98	46.98	48.01	49.04	50.07
444.3	51.10	52.13	53.16	54.19	55.23	56.26	57.29	58.33	59.37	60.40
444.4	61.44	62.48	63.52	64.56	65.60	66.64	67.68	68.73	69.77	70.82
444.5	71.86	72.88	73.93	74.98	76.01	77.08	78.13	79.19	80.23	81.28
444.6	82.34	83.39	84.45	85.50	86.56	87.62	88.68	89.74	90.80	91.86
444.7	92.92	93.98	95.04	96.11	97.17	98.24	99.28	100.35	101.41	102.48
444.8	103.55	104.62	105.69	106.77	107.84	108.91	109.99	111.06	112.14	113.22
444.9	114.29	115.37	116.45	117.53	118.61	119.69	120.77	121.86	122.94	124.03
445.0	125.11	126.17	127.26	128.35	129.44	130.53	131.62	132.71	133.80	134.89
445.1	135.98	137.08	138.17	139.27	140.37	141.46	142.56	143.66	144.76	145.86
445.2	146.96	148.06	149.17	150.27	151.38	152.48	153.56	154.67	155.78	156.88
445.3	157.99	159.10	160.21	161.33	162.44	163.55	164.67	165.78	166.90	168.01
445.4	169.13	170.25	171.37	172.49	173.61	174.73	175.85	176.97	178.10	179.22
445.5	180.35	181.45	182.57	183.70	184.83	185.96	187.09	188.22	189.35	190.48
445.6	191.62	192.75	193.89	195.02	196.16	197.29	198.43	199.57	200.71	201.85
445.7	202.99	204.13	205.28	206.42	207.56	208.71	209.83	210.97	212.12	213.27
445.8	214.42	215.57	216.72	217.87	219.02	220.18	221.33	222.49	223.64	224.80
445.9	225.95	227.11	228.27	229.43	230.59	231.75	232.91	234.08	235.24	236.40
446.0	237.57	238.71	239.87	241.04	242.21	243.38	244.55	245.72	246.89	248.06
446.1	249.23	250.41	251.58	252.76	253.93	255.11	256.29	257.47	258.65	259.83
446.2	261.01	262.19	263.37	264.55	265.74	266.92	268.08	269.27	270.45	271.64
446.3	272.83	274.02	275.21	276.40	277.59	278.79	279.98	281.17	282.37	283.57
446.4	284.76	285.96	287.16	288.36	289.56	290.76	291.96	293.16	294.37	295.57
446.5	296.77	297.95	299.16	300.36	301.57	302.78	303.99	305.20	306.41	307.62
446.6	308.84	310.05	311.26	312.48	313.69	314.91	316.13	317.35	318.57	319.79
446.7	321.01	322.23	323.45	324.67	325.90	327.12	328.32	329.54	330.77	332.00
446.8	333.23	334.46	335.69	336.92	338.15	339.38	340.62	341.85	343.08	344.32
446.9	345.56	346.79	348.03	349.27	350.51	351.75	352.99	354.23	355.48	356.72
447.0	357.97	359.18	360.43	361.67	362.92	364.17	365.42	366.67	367.92	369.17
447.1	370.42	371.68	372.93	374.19	375.44	376.70	377.96	379.21	380.47	381.73
447.2	382.99	384.25	385.52	386.78	388.04	389.31	390.54	391.81	393.07	394.34
447.3	395.61	396.88	398.15	399.42	400.69	401.96	403.24	404.51	405.78	407.06
447.4	408.34	409.61	410.89	412.17	413.45	414.73	416.01	417.29	418.57	419.86
447.5	421.14	422.40	423.68	424.97	426.26	427.54	428.83	430.12	431.41	432.70
447.6	434.00	435.29	436.58	437.88	439.17	440.47	441.77	443.06	444.36	445.66
447.7	446.96	448.26	449.57	450.87	452.17	453.48	454.75	456.05	457.36	458.67
447.8	459.98	461.28	462.59	463.90	465.22	466.53	467.84	469.15	470.47	471.78
447.9	473.10	474.42	475.73	477.05	478.37	479.69	481.01	482.33	483.66	484.98

EMMAGASINEMENT A B.-est, Church. Falls

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
448.0	486.30	487.60	488.92	490.25	491.58	492.90	494.23	495.56	496.89	498.22
448.1	499.56	500.89	502.22	503.56	504.89	506.23	507.56	508.90	510.24	511.58
448.2	512.92	514.26	515.60	516.94	518.29	519.63	520.94	522.29	523.63	524.98
448.3	526.33	527.68	529.03	530.38	531.73	533.08	534.43	535.79	537.14	538.49
448.4	539.85	541.21	542.56	543.92	545.28	546.64	548.00	549.36	550.72	552.09
448.5	553.45	554.78	556.15	557.51	558.88	560.25	561.62	562.99	564.36	565.73
448.6	567.10	568.47	569.84	571.22	572.59	573.97	575.35	576.72	578.10	579.48
448.7	580.86	582.24	583.62	585.00	586.39	587.77	589.12	590.51	591.89	593.28
448.8	594.67	596.05	597.44	598.83	600.22	601.62	603.01	604.40	605.79	607.19
448.9	608.59	609.98	611.38	612.78	614.18	615.57	616.97	618.38	619.78	621.18

Appendix E
Load Demands

Table E.1

Load Demands

Month	*Infeed to Newfoundland (GWh)	Labrador (GWh)	Site Services Twin Falls (GWh)
Jan	478.0	110.0	170.6
Feb	481.0	99.0	154.1
Mar	419.0	90.0	170.6
Apr	343.0	87.0	165.1
May	299.0	79.0	170.6
Jun	257.0	53.0	165.1
Jul	257.0	64.0	170.6
Aug	265.0	67.0	170.6
Sep	173.0	71.0	165.1
Oct	244.0	82.0	170.6
Nov	354.0	92.0	165.1
Dec	469.0	105.0	170.6
Total	4039	999	2008.7

*Sending End

Appendix F
Structure Curves and Tables

LOBSTICK CONTROL STRUCTURE Page

Rating table for one gate fully open ,

H: Main reservoir level upstream of the structure Q: discharge in cfs

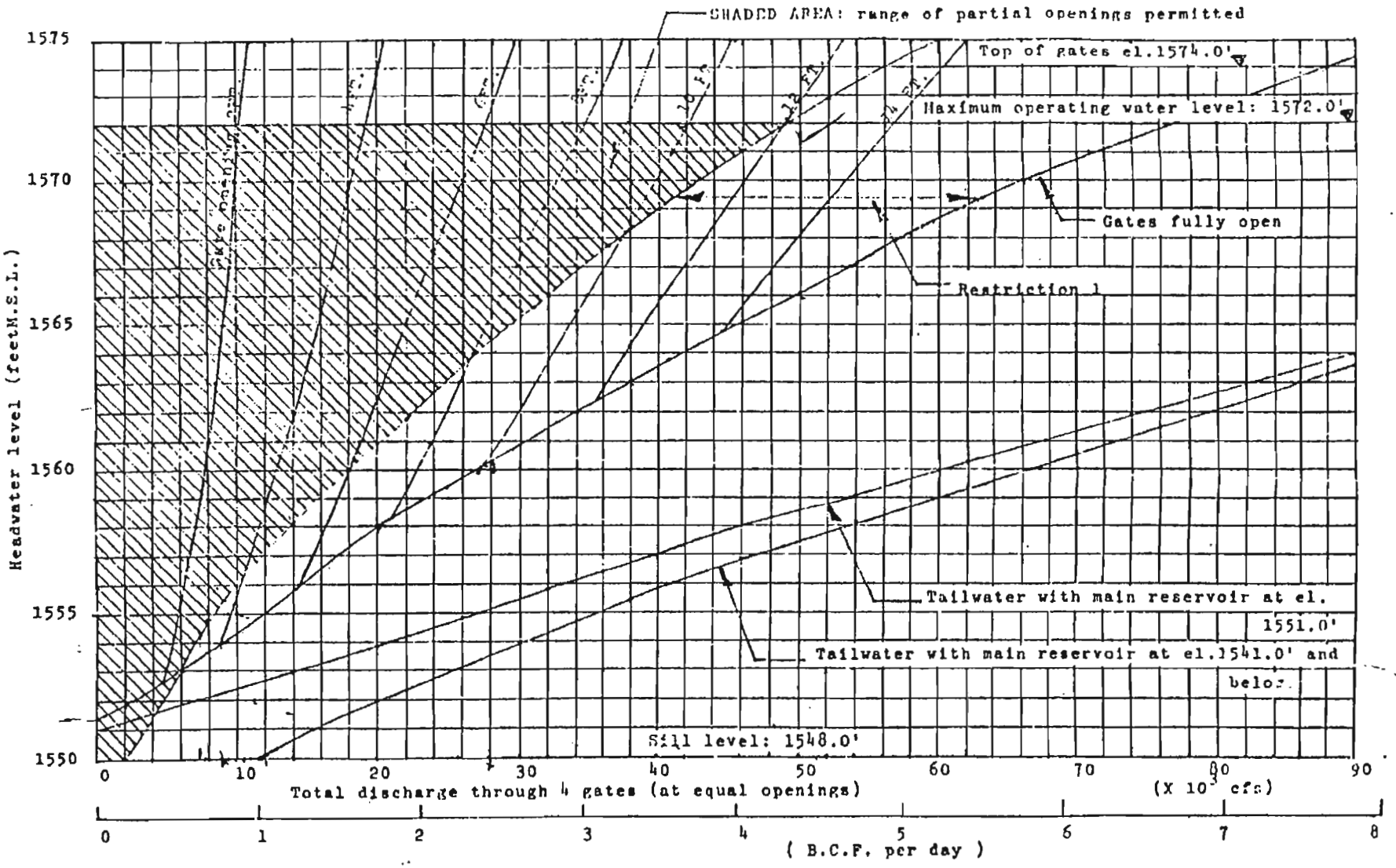
H	Q
1515.0	17,400
1515.5	18,300
1516.0	19,000
1516.5	19,800
1517.0	20,600
1517.5	21,300
1518.0	22,100
1518.5	22,800
1519.0	23,600
1519.5	24,300
1520.0	25,000
1520.5	25,800
1521.0	26,500
1521.5	27,200
1522.0	27,900
1522.5	28,700
1523.0	29,400
1523.5	30,100
1524.0	30,800
1524.5	31,500
1525.0	32,200

H	Q
1525.5	32,900
1526.0	33,600
1526.5	34,300
1527.0	35,000
1527.5	35,700
1528.0	36,400
1528.5	37,100
1529.0	37,800
1529.5	38,500
1530.0	39,200
1530.5	39,900
1531.0	40,600
1531.5	41,300
1532.0	42,000
1532.5	42,700
1533.0	43,400
1533.5	44,200
1534.0	44,900
1534.5	45,600
1535.0	46,400

H	Q
1535.5	47,200
1536.0	47,900
1536.5	48,700
1537.0	49,500
1537.5	50,200
1538.0	51,000
1538.5	51,800
1539.0	52,600
1539.5	53,400
1540.0	54,200
1540.5	55,000
1541.0	55,800
1541.5	56,700
1542.0	57,500
1542.5	58,400
1543.0	59,200
1543.5	60,100
1544.0	60,900
1544.5	61,800
1545.0	62,700

H	Q
1545.5	63,600
1546.0	64,500
1546.5	65,400
1547.0	66,400
1547.5	67,300
1548.0	68,200
1548.5	69,200
1549.0	70,100
1549.5	71,100
1550.0	72,200
1550.5	73,300
1551.0	74,500
1551.5	75,600
1552.0	76,700
1552.5	77,900
1553.0	79,100
1553.5	80,300
1554.0	81,500
1554.5	82,700
1555.0	83,900

Gabbro control structure rating curves



Gabbro Control Structure.....Rating table for one gate fully open.

H: Ossokmanuan reservoir level, upstream of the structure.

Q: Discharge in CFS.

H	Q
1555.0	2850
.1	2925
.2	3000
.3	3075
.4	3150
.5	3225
.6	3300
.7	3375
.8	3450
.9	3525
1556.0	3600
.1	3670
.2	3740
.3	3810
.4	3880
.5	3950
.6	4020
.7	4090
.8	4160
.9	4230
1557.0	4300
.1	4375
.2	4450
.3	4525
.4	4600
.5	4675
.6	4750
.7	4825
.8	4900
.9	4975
1558.0	5050
.1	5130
.2	5210
.3	5290

H	Q
1558.4	5370
.5	5450
.6	5530
.7	5610
.8	5690
.9	5770
1559.0	5850
.1	5930
.2	6010
.3	6090
.4	6170
.5	6250
.6	6330
.7	6410
.8	6490
.9	6570
1560.0	6650
.1	6740
.2	6830
.3	6920
.4	7010
.5	7100
.6	7190
.7	7280
.8	7370
.9	7460
1561.0	7550
.1	7640
.2	7730
.3	7820
.4	7910
.5	8000
.6	8090
.7	8180

H	Q
1561.8	8270
.9	8360
1562.0	8450
.1	8545
.2	8640
.3	8735
.4	8830
.5	8925
.6	9020
.7	9115
.8	9210
.9	9305
1563.0	9400
.1	9495
.2	9590
.3	9685
.4	9780
.5	9875
.6	9970
.7	10065
.8	10160
.9	10255
1564.0	10350
.1	10445
.2	10540
.3	10635
.4	10730
.5	10825
.6	10920
.7	11015
.8	11110
.9	11205
1565.0	11300
.1	11400

H	Q
1565.2	11500
.3	11600
.4	11700
.5	11800
.6	11900
.7	12000
.8	12100
.9	12200
1566.0	12300
.1	12400
.2	12500
.3	12600
.4	12700
.5	12800
.6	12900
.7	13000
.8	13100
.9	13200
1567.0	13300
.1	13400
.2	13500
.3	13600
.4	13700
.5	13800
.6	13900
.7	14000
.8	14100
.9	14200
1568.0	14300
.1	14400
.2	14500
.3	14600
.4	14700
.5	14800

H	Q
1568.6	14900
.7	15000
.8	15100
.9	15200
1569.0	15300
.1	15405
.2	15510
.3	15615
.4	15720
.5	15825
.6	15930
.7	16035
.8	16140
.9	16245
1570.0	16350
.1	16455
.2	16560
.3	16665
.4	16770
.5	16875
.6	16980
.7	17085
.8	17190
.9	17295
1571.0	17400
.1	17510
.2	17620
.3	17730
.4	17840
.5	17950
.6	18060
.7	18170
.8	18280
.9	18390

H	Q
1572.0	18500
.1	18610
.2	18720
.3	18830
.4	18940
.5	19050
.6	19160
.7	19270
.8	19380
.9	19490
1573.0	19600
.1	19715
.2	19830
.3	19945
.4	20060
.5	20175
.6	20290
.7	20405
.8	20520
.9	20635
1574.0	20750
.1	20860
.2	20970
.3	21080
.4	21190
.5	21300
.6	21410
.7	21520
.8	21630
.9	21740
1575.0	21850

WHEN USING THIS CHART ADD. (0.2) TO GET TRUE FLOW

Ossokmanuan Reservoir Storage

H: Upstream elevation at Gabbro structure

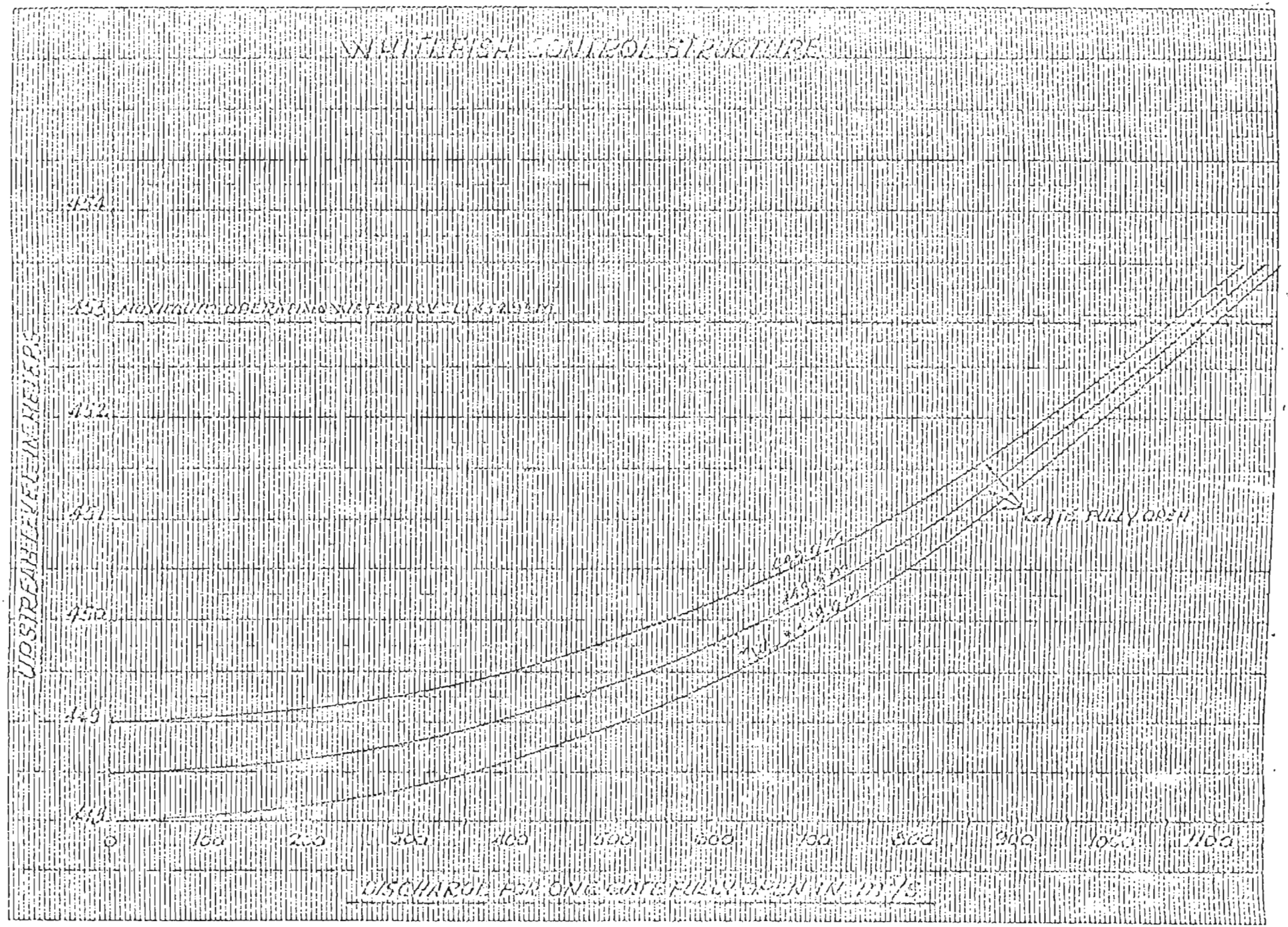
Q: CFS/days

S: Billion cubic feet (BCF)

H	Q	S
1565.0	510,000	44.064
.1	519,357	44.872
.2	528,714	45.681
.3	538,071	46.490
.4	547,428	47.298
.5	556,785	48.106
.6	566,142	48.915
.7	575,499	49.718
.8	584,856	50.526
.9	594,213	51.334
1566.0	603,570	52.142
.1	612,927	52.950
.2	622,284	53.758
.3	631,641	54.566
.4	640,998	55.374
.5	650,355	56.182
.6	659,712	56.990
.7	669,069	57.798
.8	678,426	58.606
.9	687,783	59.414
1567.0	697,140	60.222
.1	706,497	61.030
.2	715,854	61.838
.3	725,211	62.646
.4	734,568	63.454
.5	743,925	64.262
.6	753,282	65.070
.7	762,639	65.878
.8	771,996	66.686
.9	781,353	67.494

H	Q	S
1568.0	790,710	68.302
.1	800,067	69.110
.2	809,424	69.918
.3	818,781	70.726
.4	828,138	71.534
.5	837,495	72.342
.6	846,852	73.150
.7	856,209	73.958
.8	865,566	74.766
.9	874,923	75.574
1569.0	884,280	76.382
.1	893,637	77.190
.2	902,994	77.998
.3	912,351	78.806
.4	921,708	79.614
.5	931,065	80.422
.6	940,422	81.230
.7	949,779	82.038
.8	959,136	82.846
.9	968,493	83.654
1570.0	977,850	84.462
.1	987,207	85.270
.2	996,564	86.078
.3	1,005,921	86.886
.4	1,015,278	87.694
.5	1,024,635	88.502
.6	1,033,992	89.310
.7	1,043,349	90.118
.8	1,052,706	90.926
.9	1,062,063	91.734

H	Q	S
1571.0	1,071,420	92.542
.1	1,080,777	93.350
.2	1,090,134	94.158
.3	1,099,491	94.966
.4	1,108,848	95.774
.5	1,118,205	96.582
.6	1,127,562	97.390
.7	1,136,919	98.198
.8	1,146,276	99.006
.9	1,155,633	99.814
1572.0	1,164,990	100.622
.1	1,174,347	101.464
.2	1,183,704	102.272
.3	1,193,061	103.081


WATERSHED CONTROL STRUCTURE
UPSTREAM WATER LEVEL IN METRES
454
453 MAXIMUM OPERATING WATER LEVEL = 453.00 M
452
451
450
449
448
0
100
200
300
400
500
600
700
800
900
1000
1100
DISCHARGE IN CUBIC METRES PER SECOND IN 1975
GATE FULLY OPEN

WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTUR							
	447.8	447.9	448.0	448.1	448.2	448.3	448.4	448.5
448.0	224	160	0	0	0	0	0	0
448.1	274	226	161	0	0	0	0	0
448.2	316	276	228	163	0	0	0	0
448.3	353	319	279	230	164	0	0	0
448.4	386	356	322	281	232	166	0	0
448.5	417	390	359	325	284	234	167	0
448.6	445	421	393	363	328	286	236	169
448.7	472	449	424	397	366	330	289	238
448.8	497	476	453	428	400	369	333	292
448.9	520	501	480	457	432	404	372	336
449.0	543	525	506	485	461	436	407	376
449.1	565	548	530	510	489	465	440	411
449.2	585	570	553	534	515	493	469	443
449.3	605	590	575	558	539	519	497	474
449.4	624	610	596	580	562	544	524	502
449.5	643	630	616	601	585	567	548	528
449.6	661	648	635	621	606	590	572	553
449.7	678	666	654	641	626	611	595	577
449.8	695	684	672	659	646	632	616	600
449.9	711	701	689	678	665	651	637	621
450.0	727	717	706	695	683	671	657	642
450.1	742	733	723	712	701	689	676	662
450.2	757	748	739	729	718	707	695	682
450.3	772	764	755	745	735	724	713	700
450.4	786	778	770	761	751	741	730	718
450.5	800	793	785	776	767	757	747	736
450.6	814	807	799	791	782	773	763	753
450.7	828	821	813	806	797	789	779	770
450.8	841	834	827	820	812	804	795	786
450.9	854	848	841	834	827	819	810	801
451.0	867	861	854	848	841	833	825	817
451.1	879	874	867	861	854	847	840	832
451.2	892	886	880	874	868	861	854	846
451.3	904	899	893	887	881	875	868	860
451.4	916	911	906	900	894	888	881	874
451.5	928	923	918	913	907	901	895	888
451.6	940	935	930	925	920	914	908	902
451.7	952	947	942	937	932	927	921	915
451.8	964	959	954	950	945	939	934	928
451.9	976	971	966	962	957	952	946	941

WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTURE								
	447.8	447.9	448.0	448.1	448.2	448.3	448.4	448.5	448
452.0	988	984	979	974	969	964	959	954	9
452.1	1000	996	991	986	981	976	971	966	9
452.2	1012	1008	1003	998	993	988	983	978	9
452.3	1024	1020	1015	1011	1006	1001	996	991	9
452.4	1035	1031	1027	1023	1018	1013	1008	1003	9
452.5	1047	1043	1039	1035	1030	1026	1021	1016	10
452.6	1059	1055	1051	1047	1042	1038	1033	1028	10
452.7	1070	1066	1062	1059	1054	1050	1045	1041	10
452.8	1081	1078	1074	1070	1066	1062	1058	1053	10
452.9	1093	1089	1086	1082	1078	1074	1070	1065	10
453.0	1104	1100	1097	1093	1090	1086	1082	1077	10
453.1	1115	1112	1108	1105	1101	1097	1093	1089	10
453.2	1126	1123	1120	1116	1113	1109	1105	1101	10
453.3	1137	1134	1131	1128	1124	1121	1117	1113	11
453.4	1148	1145	1142	1139	1135	1132	1128	1125	11
453.5	1159	1156	1153	1150	1147	1143	1140	1136	11

WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTURE			
	448,7	448,8	448,9	449,0
448.0	0	0	0	0
448.1	0	0	0	0
448.2	0	0	0	0
448.3	0	0	0	0
448.4	0	0	0	0
448.5	0	0	0	0
448.6	0	0	0	0
448.7	0	0	0	0
448.8	171	0	0	0
448.9	242	172	0	0
449.0	296	244	174	0
449.1	342	299	246	175
449.2	382	345	301	248
449.3	418	385	348	304
449.4	451	421	388	351
449.5	481	455	425	392
449.6	510	485	458	428
449.7	537	514	489	462
449.8	562	541	518	493
449.9	586	567	546	523
450.0	609	591	571	550
450.1	631	614	596	576
450.2	653	637	619	601
450.3	673	658	642	624
450.4	693	678	663	647
450.5	712	698	684	668
450.6	730	717	704	689
450.7	748	736	723	709
450.8	765	754	741	729
450.9	782	771	759	747
451.0	798	788	777	765
451.1	814	804	794	783
451.2	829	820	810	800
451.3	844	836	826	817
451.4	859	851	842	833
451.5	874	866	857	848
451.6	888	880	872	864
451.7	902	894	887	879
451.8	915	908	901	893
451.9	929	922	915	908

WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTURE			
	448,7	448,8	448,9	449,0
452,0	942	936	929	922
452,1	955	949	942	936
452,2	968	962	956	949
452,3	980	975	969	963
452,4	993	987	982	976
452,5	1005	1000	995	989
452,6	1017	1012	1007	1002
452,7	1030	1025	1020	1014
452,8	1043	1038	1032	1027
452,9	1055	1050	1045	1039
453,0	1068	1063	1058	1052
453,1	1080	1075	1070	1065
453,2	1092	1088	1083	1078
453,3	1104	1100	1095	1090
453,4	1116	1112	1108	1103
453,5	1128	1124	1120	1115

Appendix G
Post-Processor Sample Output

TABLE OF RESULTS FOR RUN #1
Churchill Falls Existing (CF1)

System Production and Energy Distribution (MWc)													
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Average
Total Hydro Production	3329.0	3410.7	3876.0	3777.8	3625.5	3757.2	3800.6	4103.0	4388.7	4457.4	4392.6	4372.3	3938.2
Energy Sent to Island	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy Sent to Labrador	106.2	73.6	86.0	90.1	98.6	110.2	127.8	141.1	147.8	147.3	121.0	120.8	114.0
Energy Sent to Station Service/ Twin Falls (Twinco Block)	229.3	229.3	229.3	229.3	229.3	229.3	229.3	229.3	229.3	229.3	229.3	229.3	229.3
Energy Received at Quebec-Labrador Border	2968.0	3080.2	3525.1	3424.8	3266.7	3385.1	3411.3	3695.5	3969.3	4036.7	3998.7	3978.0	3559.1
Total Losses	25.5	27.6	35.6	33.6	30.9	32.5	32.2	37.1	42.3	44.0	43.7	44.2	35.7

System Production and Energy Distribution (GWh)													
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
Total Hydro Production	2476.7	2455.7	2883.8	2810.7	2610.4	2795.3	2736.4	3052.6	3265.2	2995.4	3268.1	3148.0	34498.4
Energy Sent to Island	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Energy Sent to Labrador	79.0	53.0	64.0	67.0	71.0	82.0	92.0	105.0	110.0	99.0	90.0	87.0	999.0
Energy Sent to Station Service/ Twin Falls (Twinco Block)	170.6	165.1	170.6	170.6	165.1	170.6	165.1	170.6	170.6	154.1	170.6	165.1	2008.7
Energy Received at Quebec-Labrador Border	2208.2	2217.8	2622.6	2548.1	2352.0	2518.5	2456.1	2749.4	2953.2	2712.7	2975.0	2864.2	31177.9
Total Losses	18.9	19.9	26.5	25.0	22.2	24.2	23.2	27.6	31.5	29.6	32.5	31.8	312.8

1. Enter the following parameters for the current run:

Maximum Total Generation (MW)	Maximum Generator Transformer Losses (MW)	Maximum Load at 230kV Sending End (MW)	Losses at Maximum Load (MW)
5600	15.6	5207.3	52.1

2. Enter the Following Parameters (GWh):

Month	Infeed Load (If Used)	Labrador Load	Station Service/ Twin Falls Load
May	0	79	170.6
Jun	0	53	165.1
Jul	0	64	170.6
Aug	0	67	170.6
Sep	0	71	165.1
Oct	0	82	170.6
Nov	0	92	165.1
Dec	0	105	170.6
Jan	0	110	170.6
Feb	0	99	154.1
Mar	0	90	170.6
Apr	0	87	165.1

3. Go to the sheet entitled Total Integrated Power, and paste the ARSP Total Integrated Power output for the current Run. This should be done such that the input for May 1943 is entered into cell D10.

4. To view results, go to the sheet entitled "RESULTS". Edit the title on the results sheet as appropriate.

GWh

Month	Infeed Load	Labrador Load	Station Service/Twin Falls Load
May	0.0	79.0	170.6
Jun	0.0	53.0	165.1
Jul	0.0	64.0	170.6
Aug	0.0	67.0	170.6
Sep	0.0	71.0	165.1
Oct	0.0	82.0	170.6
Nov	0.0	92.0	165.1
Dec	0.0	105.0	170.6
Jan	0.0	110.0	170.6
Feb	0.0	99.0	154.1
Mar	0.0	90.0	170.6
Apr	0.0	87.0	165.1

MWc

Month	Infeed Load	Labrador Load	Station Service/Twin Falls Load
May	0.0	106.2	229.3
Jun	0.0	73.6	229.3
Jul	0.0	86.0	229.3
Aug	0.0	90.1	229.3
Sep	0.0	98.6	229.3
Oct	0.0	110.2	229.3
Nov	0.0	127.8	229.3
Dec	0.0	141.1	229.3
Jan	0.0	147.8	229.3
Feb	0.0	147.3	229.3
Mar	0.0	121.0	229.3
Apr	0.0	120.8	229.3

PERIOD AVERAGE ENERGY (MW CONTINUOUS)

SIM	HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	3251.22	3159.13	5099.92	5099.91	5099.91	4722.83	3747.49	4102.99	4309.76	4187.89	5600.00	5545.24	4497.53
2	1944	1944	3251.22	3159.13	4412.07	3773.09	3163.43	4019.95	3747.49	4102.99	4309.76	4187.90	4628.70	5600.00	4029.57
3	1945	1945	3251.22	3159.13	3141.56	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
4	1946	1946	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
5	1947	1947	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
6	1948	1948	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
7	1949	1949	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
8	1950	1950	3251.22	3159.13	5099.92	3791.94	3163.43	3339.73	3747.52	4102.99	4309.76	4187.89	5219.48	5600.00	4082.00
9	1951	1951	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
10	1952	1952	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
11	1953	1953	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.13	3581.45
12	1954	1954	3251.22	5099.92	5099.92	5099.92	5099.92	4182.82	3747.52	4102.99	4309.74	5527.48	5402.31	5600.00	4701.66
13	1955	1955	3251.22	3159.10	4960.61	3175.24	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.14	3735.94
14	1956	1956	3251.22	3159.13	3141.57	3175.25	3312.48	4021.95	3747.52	4102.99	4309.76	4187.92	5079.16	5399.61	3905.10
15	1957	1957	3251.22	3159.13	4069.07	4654.50	4822.97	4487.54	3747.48	4102.99	4309.75	5600.00	5600.00	5600.00	4442.23
16	1958	1958	3251.20	5099.92	5099.92	5099.92	5099.92	5062.75	3747.52	4102.99	4309.76	4314.24	5497.77	5387.23	4673.95
17	1959	1959	3251.22	3159.10	5099.92	3839.87	3163.41	3339.71	3747.52	4102.99	4309.76	4187.92	3883.69	4962.51	3920.22
18	1960	1960	3251.22	3159.13	3141.57	3175.25	3297.73	4816.19	3747.49	4102.99	4309.76	4573.82	5600.00	5600.00	4061.65
19	1961	1961	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
20	1962	1962	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
21	1963	1963	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
22	1964	1964	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
23	1965	1965	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	5403.90	3733.73
24	1966	1966	3251.22	3159.13	5099.92	5099.92	5099.92	5099.92	4846.61	4102.99	4309.76	5600.00	5600.00	5600.00	4732.73
25	1967	1967	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.14	3581.45
26	1968	1968	3251.22	3159.13	3141.55	3175.25	5099.92	5099.92	4469.76	4102.96	4965.38	5600.00	5600.00	5600.00	4427.64
27	1969	1969	3251.22	3159.13	5099.92	5099.92	5099.92	5099.92	3833.61	4102.96	5565.98	5600.00	5600.00	5600.00	4756.16
28	1970	1970	3251.22	3159.11	5099.92	4883.39	3163.42	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.14	3892.85
29	1971	1971	3251.22	3159.11	5099.92	5099.92	3569.52	4841.98	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	4072.20
30	1972	1972	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.14	3581.45
31	1973	1973	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
32	1974	1974	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
33	1975	1975	3251.22	3159.13	3705.86	4083.40	3970.96	3339.71	3747.52	4102.99	4309.76	4187.92	4419.45	5600.00	3986.78
34	1976	1976	3251.22	5099.92	4928.02	4064.33	5099.92	4574.55	3747.52	4102.99	4309.74	5592.53	5362.89	5600.00	4634.02
35	1977	1977	3251.22	3159.13	5099.92	5099.92	5099.92	5099.92	4360.40	4102.96	5461.54	5600.00	5600.00	5600.00	4790.58
36	1978	1978	3251.22	3159.12	5099.92	5099.92	5099.92	3959.13	3747.52	4102.99	4309.76	4187.91	4880.04	5600.00	4376.03
37	1979	1979	5350.02	5099.92	5099.91	5099.92	5099.92	5099.92	4093.52	4102.99	5073.26	5600.00	5600.00	5600.00	5073.44
38	1980	1980	3251.22	5099.92	5099.92	5099.92	3163.42	4067.03	3747.49	4102.99	4309.75	5600.00	5600.00	5600.00	4555.02
39	1981	1981	3251.22	5099.92	5099.92	5099.92	3709.53	3339.71	3747.52	4102.99	4309.76	4187.92	3883.68	4124.04	4162.73
40	1982	1982	3251.22	3159.11	5099.92	4874.67	4375.35	3339.71	3747.52	4102.99	4309.76	4187.92	4196.69	5600.00	4186.70
41	1983	1983	5350.02	5099.92	5099.92	4564.59	3838.00	5062.02	3747.52	4102.97	4747.06	5600.00	5600.00	5600.00	4864.90
42	1984	1984	3251.22	3159.12	5099.92	4587.66	3163.42	3339.71	3747.52	4102.99	4309.76	4187.91	4468.85	5600.00	4085.83
43	1985	1985	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
44	1986	1986	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.14	3581.45
45	1987	1987	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.13	3581.45
46	1988	1988	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
47	1989	1989	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
48	1990	1990	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
49	1991	1991	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
50	1992	1992	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
51	1993	1993	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
52	1994	1994	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
53	1995	1995	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3546.69	3581.08
54	1996	1996	3251.22	3159.13	3141.57	3175.25	3163.43	3339.73	3747.52	4102.99	4309.76	4187.92	3883.69	3551.15	3581.45
AVERAGE			3328.95	3410.71	3876.01	3777.77	3625.54	3757.19	3800.60	4102.99	4388.73	4457.42	4392.61	4372.29	3938.17
MAXIMUM			5350.02	5099.92	5099.92	5099.92	5099.92	5099.92	4846.61	4102.99	5565.98	5600.00	5600.00	5600.00	5073.44
MINIMUM			3251.20	3159.10	3141.55	3175.24	3163.41	3339.71	3747.48	4102.96	4309.74	4187.89	3883.68	3546.69	3581.08

SIM	HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	5.83	5.54	13.13	13.13	13.13	11.40	7.50	8.83	9.65	9.17	15.60	15.32	10.70
2	1944	1944	5.83	5.54	10.07	7.60	5.55	8.51	7.50	8.83	9.65	9.17	10.99	15.60	8.74
3	1945	1945	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
4	1946	1946	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
5	1947	1947	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
6	1948	1948	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
7	1949	1949	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
8	1950	1950	5.83	5.54	13.13	7.66	5.55	6.11	7.50	8.83	9.65	9.17	13.70	15.60	9.03
9	1951	1951	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
10	1952	1952	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
11	1953	1953	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
12	1954	1954	5.83	13.13	13.13	13.13	13.13	9.15	7.50	8.83	9.65	15.23	14.60	15.60	11.54
13	1955	1955	5.83	5.54	12.48	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.59
14	1956	1956	5.83	5.54	5.49	5.59	6.02	8.52	7.50	8.83	9.65	9.17	13.03	14.58	8.31
15	1957	1957	5.83	5.54	8.70	11.11	11.85	10.39	7.50	8.83	9.65	15.60	15.60	15.60	10.48
16	1958	1958	5.83	13.13	13.13	13.13	13.13	12.95	7.50	8.83	9.65	9.67	15.08	14.52	11.39
17	1959	1959	5.83	5.54	13.13	7.84	5.55	6.11	7.50	8.83	9.65	9.17	8.00	12.49	8.30
18	1960	1960	5.83	5.54	5.49	5.59	5.98	11.82	7.50	8.83	9.65	10.76	15.60	15.60	9.01
19	1961	1961	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
20	1962	1962	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
21	1963	1963	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
22	1964	1964	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
23	1965	1965	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	14.61	7.64
24	1966	1966	5.83	5.54	13.13	13.13	13.13	13.13	11.96	8.83	9.65	15.60	15.60	15.60	11.73
25	1967	1967	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
26	1968	1968	5.83	5.54	5.49	5.59	13.13	13.13	10.32	8.83	12.50	15.60	15.60	15.60	10.55
27	1969	1969	5.83	5.54	13.13	13.13	13.13	13.13	7.82	8.83	15.43	15.60	15.60	15.60	11.88
28	1970	1970	5.83	5.54	13.13	12.12	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	8.20
29	1971	1971	5.83	5.54	13.13	13.13	6.88	11.94	7.50	8.83	9.65	9.17	8.00	6.82	8.89
30	1972	1972	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
31	1973	1973	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
32	1974	1974	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
33	1975	1975	5.83	5.54	7.36	8.76	8.33	6.11	7.50	8.83	9.65	9.17	10.11	15.60	8.55
34	1976	1976	5.83	13.13	12.33	8.68	13.13	10.76	7.50	8.83	9.65	15.56	14.40	15.60	11.24
35	1977	1977	5.83	5.54	13.13	13.13	13.13	13.13	9.86	8.83	14.89	15.60	15.60	15.60	12.00
36	1978	1978	5.83	5.54	13.13	13.13	13.13	8.28	7.50	8.83	9.65	9.17	12.11	15.60	10.16
37	1979	1979	14.34	13.13	13.13	13.13	13.13	13.13	8.80	8.83	13.00	15.60	15.60	15.60	13.10
38	1980	1980	5.83	13.13	13.13	13.13	5.55	8.69	7.50	8.83	9.65	15.60	15.60	15.60	10.99
39	1981	1981	5.83	13.13	13.13	13.13	7.37	6.11	7.50	8.83	9.65	9.17	8.00	8.91	9.23
40	1982	1982	5.83	5.54	13.13	12.08	9.92	6.11	7.50	8.83	9.65	9.17	9.20	15.60	9.38
41	1983	1983	14.34	13.13	13.13	10.72	7.83	12.95	7.50	8.83	11.51	15.60	15.60	15.60	12.21
42	1984	1984	5.83	5.54	13.13	10.82	5.55	6.11	7.50	8.83	9.65	9.17	10.31	15.60	9.01
43	1985	1985	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
44	1986	1986	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
45	1987	1987	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
46	1988	1988	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
47	1989	1989	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
48	1990	1990	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
49	1991	1991	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
50	1992	1992	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
51	1993	1993	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
52	1994	1994	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
53	1995	1995	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.80	7.00
54	1996	1996	5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.82	7.00
AVERAGE			6.14	6.52	8.33	7.89	7.32	7.72	7.71	8.83	10.01	10.39	10.21	10.31	8.44
MAXIMUM			14.34	13.13	13.13	13.13	13.13	13.13	11.96	8.83	15.43	15.60	15.60	15.60	13.10
MINIMUM			5.83	5.54	5.49	5.59	5.55	6.11	7.50	8.83	9.65	9.17	8.00	6.80	7.00

Net Total Energy at Sending End after generator transformer losses and losses due to Station Service/Twin Falls, Labrador, and Infeed Loads.

SIM	HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	2909.91	2850.67	4771.47	4767.43	4758.86	4371.91	3382.90	3723.73	3922.95	3802.09	5234.13	5179.78	4143.49
2	1944	1944	2909.91	2850.67	4086.67	3446.14	2829.96	3671.92	3382.90	3723.73	3922.95	3802.10	4267.44	5234.26	3677.49
3	1945	1945	2909.91	2850.67	2820.75	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
4	1946	1946	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
5	1947	1947	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
6	1948	1948	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
7	1949	1949	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
8	1950	1950	2909.91	2850.67	4771.47	3464.92	2829.96	2994.10	3382.93	3723.73	3922.95	3802.09	4855.51	5234.26	3729.63
9	1951	1951	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
10	1952	1952	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
11	1953	1953	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.18	3231.11
12	1954	1954	2909.91	4783.87	4771.47	4767.44	4758.87	3834.16	3382.93	3723.73	3922.93	5135.61	5037.44	5234.26	4346.78
13	1955	1955	2909.91	2850.64	4632.81	2850.30	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.19	3385.00
14	1956	1956	2909.91	2850.67	2820.76	2850.31	2978.54	3673.91	3382.93	3723.73	3922.95	3802.12	4715.86	5034.89	3553.45
15	1957	1957	2909.91	2850.67	3745.05	4324.04	4483.20	4137.63	3382.89	3723.73	3922.94	5207.76	5234.13	5234.26	4088.41
16	1958	1958	2909.89	4783.87	4771.47	4767.44	4758.87	4710.28	3382.93	3723.73	3922.95	3927.93	5132.42	5022.57	4319.21
17	1959	1959	2909.91	2850.64	4771.47	3512.68	2829.94	2994.08	3382.93	3723.73	3922.95	3802.12	3525.42	4599.88	3568.57
18	1960	1960	2909.91	2850.67	2820.76	2850.31	2963.84	4464.85	3382.90	3723.73	3922.95	4186.43	5234.13	5234.26	3709.30
19	1961	1961	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
20	1962	1962	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
21	1963	1963	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
22	1964	1964	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
23	1965	1965	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	5039.16	3382.75
24	1966	1966	2909.91	2850.67	4771.47	4767.44	4758.87	4747.28	4477.57	3723.73	3922.95	5207.76	5234.13	5234.26	4377.65
25	1967	1967	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.19	3231.11
26	1968	1968	2909.91	2850.67	2820.74	2850.31	4758.87	4747.28	4102.36	3723.70	4575.73	5207.76	5234.13	5234.26	4073.75
27	1969	1969	2909.91	2850.67	4771.47	4767.44	4758.87	4747.28	3468.71	3723.70	5173.40	5207.76	5234.13	5234.26	4400.93
28	1970	1970	2909.91	2850.65	4771.47	4551.91	2829.95	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.19	3541.30
29	1971	1971	2909.91	2850.65	4771.47	4767.44	3234.72	4490.53	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3719.97
30	1972	1972	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.19	3231.11
31	1973	1973	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
32	1974	1974	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
33	1975	1975	2909.91	2850.67	3383.18	3755.29	3634.72	2994.08	3382.93	3723.73	3922.95	3802.12	4059.08	5234.26	3634.88
34	1976	1976	2909.91	4783.87	4600.37	3736.29	4758.87	4224.27	3382.93	3723.73	3922.93	5200.33	4998.22	5234.26	4279.44
35	1977	1977	2909.91	2850.67	4771.47	4767.44	4758.87	4747.28	3993.46	3723.70	5069.49	5207.76	5234.13	5234.26	4435.24
36	1978	1978	2909.91	2850.66	4771.47	4767.44	4758.87	3611.33	3382.93	3723.73	3922.95	3802.11	4517.66	5234.26	4022.52
37	1979	1979	5000.20	4783.87	4771.46	4767.44	4758.87	4747.28	3727.64	3723.73	4683.11	5207.76	5234.13	5234.26	4717.00
38	1980	1980	2909.91	4783.87	4771.47	4767.44	2829.95	3718.82	3382.90	3723.73	3922.94	5207.76	5234.13	5234.26	4200.68
39	1981	1981	2909.91	4783.87	4771.47	4767.44	3374.24	2994.08	3382.93	3723.73	3922.95	3802.12	3525.41	3764.99	3810.15
40	1982	1982	2909.91	2850.65	4771.47	4543.23	4037.51	2994.08	3382.93	3723.73	3922.95	3802.12	3837.22	5234.26	3833.97
41	1983	1983	5000.20	4783.87	4771.47	4234.52	3502.25	4709.55	3382.93	3723.71	4358.40	5207.76	5234.13	5234.26	4509.34
42	1984	1984	2909.91	2850.66	4771.47	4257.49	2829.95	2994.08	3382.93	3723.73	3922.95	3802.11	4108.27	5234.26	3733.47
43	1985	1985	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
44	1986	1986	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.19	3231.11
45	1987	1987	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.18	3231.11
46	1988	1988	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
47	1989	1989	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
48	1990	1990	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
49	1991	1991	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
50	1992	1992	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
51	1993	1993	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
52	1994	1994	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
53	1995	1995	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3189.75	3230.74
54	1996	1996	2909.91	2850.67	2820.76	2850.31	2829.96	2994.10	3382.93	3723.73	3922.95	3802.12	3525.42	3194.20	3231.11
AVERAGE			2987.33	3101.27	3552.36	3450.53	3290.30	3409.95	3435.80	3723.73	4001.57	4070.39	4032.12	4011.84	3586.39
MAXIMUM			5000.20	4783.87	4771.47	4767.44	4758.87	4747.28	4477.57	3723.73	5173.40	5207.76	5234.13	5234.26	4717.00
MINIMUM			2909.89	2850.64	2820.74	2850.30	2829.94	2994.08	3382.89	3723.70	3922.93	3802.09	3525.41	3189.75	3230.74

SIM	HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	18.20	17.55	44.34	44.27	44.13	37.78	23.77	28.23	31.02	29.31	52.60	51.59	35 29
2	1944	1944	18.20	17.55	33.41	24.57	17.33	27.53	23.77	28.23	31.02	29.32	36.15	52.60	28 30
3	1945	1945	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22 16
4	1946	1946	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25 59	21.46	22 16
5	1947	1947	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25 59	21.46	22 16
6	1948	1948	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
7	1949	1949	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
8	1950	1950	18.20	17.55	44.34	24.81	17 33	19.13	23.77	28.23	31.02	29.31	45 79	52.60	29.36
9	1951	1951	18.20	17.55	17.23	17.55	17 33	19.13	23.77	28.23	31.02	29.32	25 59	21.46	22.16
10	1952	1952	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25 59	21.46	22.16
11	1953	1953	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25 59	21.46	22.16
12	1954	1954	18.20	44.56	44.34	44.27	44.13	29.76	23.77	28.23	31.02	50.78	49.00	52.60	38.26
13	1955	1955	18.20	17.55	42.01	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	24.27
14	1956	1956	18.20	17.55	17.23	17.55	18.96	27.56	23.77	28.23	31.02	29.32	43.40	48.96	26.78
15	1957	1957	18.20	17.55	28.53	37.03	39.55	34.17	23.77	28.23	31.02	52.11	52.60	52.60	34.48
16	1958	1958	18.20	44.56	44.34	44.27	44.13	43.30	23.77	28.23	31.02	31.09	50.72	48.74	37.72
17	1959	1959	18.20	17.55	44.34	25.42	17.33	19.13	23.77	28.23	31.02	29.32	25.59	41.46	26.78
18	1960	1960	18.20	17.55	17.23	17.55	18.79	39.26	23.77	28.23	31.02	34.91	52.60	52.60	29.27
19	1961	1961	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21 46	22.16
20	1962	1962	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
21	1963	1963	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
22	1964	1964	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
23	1965	1965	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	49.03	24.43
24	1966	1966	18.20	17.55	44.34	44.27	44.13	43.93	39.46	28.23	31.02	52.11	52.60	52.60	38.94
25	1967	1967	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
26	1968	1968	18.20	17.55	17.23	17.55	44.13	43.93	33.64	28.23	41.06	52.11	52.60	52.60	34.74
27	1969	1969	18.20	17.55	44.34	44.27	44.13	43.93	24.86	28.23	51.47	52.11	52.60	52.60	39.47
28	1970	1970	18.20	17.55	44.34	40.67	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	26.43
29	1971	1971	18.20	17.55	44.34	44.27	21.94	39.67	23.77	28.23	31.02	29.32	25.59	21.46	28.86
30	1972	1972	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21 46	22.16
31	1973	1973	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
32	1974	1974	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29 32	25.59	21.46	22.16
33	1975	1975	18.20	17.55	23.77	28.67	27.03	19.13	23.77	28.23	31.02	29 32	33.00	52.60	27.65
34	1976	1976	18.20	44.56	41.47	28.41	44.13	35.48	23.77	28.23	31.02	51.97	48.30	52.60	37.18
35	1977	1977	18.20	17.55	44.34	44.27	44.13	43.93	32.04	28.23	49.58	52.11	52.60	52.60	39 90
36	1978	1978	18.20	17.55	44.34	44.27	44.13	26.72	23.77	28.23	31.02	29.32	40.11	52.60	33.38
37	1979	1979	48.34	44.56	44.34	44.27	44.13	43.93	28.29	28.23	42.85	52.11	52.60	52.60	43.80
38	1980	1980	18.20	44.56	44.34	44.27	17.33	28.17	23.77	28.23	31.02	52.11	52.60	52.60	36.32
39	1981	1981	18.20	44.56	44.34	44.27	23.66	19.13	23.77	28.23	31.02	29.32	25.59	28.80	30.08
40	1982	1982	18.20	17.55	44.34	40.53	32.68	19.13	23.77	28.23	31.02	29.32	29.81	52.60	30.60
41	1983	1983	48.34	44.56	44.34	35.64	25.29	43.29	23.77	28.23	37.56	52.11	52.60	52.60	40.65
42	1984	1984	18.20	17.55	44.34	35.99	17.33	19.13	23.77	28.23	31.02	29.32	33.73	52.60	29.28
43	1985	1985	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22 16
44	1986	1986	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
45	1987	1987	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
46	1988	1988	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22 16
47	1989	1989	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
48	1990	1990	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
49	1991	1991	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
50	1992	1992	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
51	1993	1993	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
52	1994	1994	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
53	1995	1995	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.40	22.16
54	1996	1996	18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.32	25.59	21.46	22.16
AVERAGE			19.31	21.05	27.30	25.70	23.57	24.82	24.50	28.23	32.27	33.65	33.44	33.85	27.27
MAXIMUM			48.34	44.56	44.34	44.27	44.13	43.93	39.46	28.23	51.47	52.11	52.60	52.60	43.80
MINIMUM			18.20	17.55	17.23	17.55	17.33	19.13	23.77	28.23	31.02	29.31	25.59	21.40	22.16

SIM	HYD	OTH	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	AVE
1	1943	1943	2891.71	2833.12	4727.13	4723.15	4714.74	4334.13	3359.14	3695.49	3891.93	3772.77	5181.53	5128.19	4108.19
2	1944	1944	2891.71	2833.12	4053.26	3421.57	2812.63	3644.39	3359.14	3695.49	3891.93	3772.78	4231.29	5181.66	3649.19
3	1945	1945	2891.71	2833.12	2803.52	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
4	1946	1946	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
5	1947	1947	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
6	1948	1948	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
7	1949	1949	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
8	1950	1950	2891.71	2833.12	4727.13	3440.11	2812.63	2974.97	3359.17	3695.49	3891.93	3772.77	4809.72	5181.66	3700.27
9	1951	1951	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
10	1952	1952	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
11	1953	1953	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.72	3208.94
12	1954	1954	2891.71	4739.32	4727.13	4723.16	4714.75	3804.40	3359.17	3695.49	3891.91	5084.83	4988.44	5181.66	4308.52
13	1955	1955	2891.71	2833.09	4590.80	2832.75	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.73	3360.74
14	1956	1956	2891.71	2833.12	2803.53	2832.76	2959.58	3646.36	3359.17	3695.49	3891.93	3772.80	4672.46	4985.93	3526.67
15	1957	1957	2891.71	2833.12	3716.52	4287.01	4443.65	4103.46	3359.13	3695.49	3891.92	5155.65	5181.53	5181.66	4053.92
16	1958	1958	2891.69	4739.32	4727.13	4723.16	4714.75	4666.98	3359.17	3695.49	3891.93	3896.84	5081.70	4973.83	4281.49
17	1959	1959	2891.71	2833.09	4727.13	3487.25	2812.61	2974.95	3359.17	3695.49	3891.93	3772.80	3499.83	4558.43	3541.79
18	1960	1960	2891.71	2833.12	2803.53	2832.76	2945.04	4425.60	3359.14	3695.49	3891.93	4151.52	5181.53	5181.66	3680.03
19	1961	1961	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
20	1962	1962	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
21	1963	1963	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
22	1964	1964	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
23	1965	1965	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	4990.12	3358.32
24	1966	1966	2891.71	2833.12	4727.13	4723.16	4714.75	4703.34	4438.11	3695.49	3891.93	5155.65	5181.53	5181.66	4338.71
25	1967	1967	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.73	3208.95
26	1968	1968	2891.71	2833.12	2803.51	2832.76	4714.75	4703.34	4068.72	3695.46	4534.67	5155.65	5181.53	5181.66	4039.01
27	1969	1969	2891.71	2833.12	4727.13	4723.16	4714.75	4703.34	3443.85	3695.46	5121.93	5155.65	5181.53	5181.66	4361.46
28	1970	1970	2891.71	2833.10	4727.13	4511.24	2812.62	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.73	3514.87
29	1971	1971	2891.71	2833.10	4727.13	4723.16	3212.78	4450.86	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3691.11
30	1972	1972	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.73	3208.95
31	1973	1973	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
32	1974	1974	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
33	1975	1975	2891.71	2833.12	3359.41	3726.62	3607.69	2974.95	3359.17	3695.49	3891.93	3772.80	4026.08	5181.66	3607.23
34	1976	1976	2891.71	4739.32	4558.90	3707.89	4714.75	4188.79	3359.17	3695.49	3891.91	5148.36	4949.92	5181.66	4242.26
35	1977	1977	2891.71	2833.12	4727.13	4723.16	4714.75	4703.34	3961.42	3695.46	5019.91	5155.65	5181.53	5181.66	4395.33
36	1978	1978	2891.71	2833.11	4727.13	4723.16	4714.75	3584.61	3359.17	3695.49	3891.93	3772.79	4477.55	5181.66	3989.15
37	1979	1979	4951.86	4739.32	4727.12	4723.16	4714.75	4703.34	3699.35	3695.49	4640.26	5155.65	5181.53	5181.66	4673.20
38	1980	1980	2891.71	4739.32	4727.13	4723.16	2812.62	3690.65	3359.14	3695.49	3891.92	5155.65	5181.53	5181.66	4164.36
39	1981	1981	2891.71	4739.32	4727.13	4723.16	3350.59	2974.95	3359.17	3695.49	3891.93	3772.80	3499.82	3736.19	3780.07
40	1982	1982	2891.71	2833.10	4727.13	4502.70	4004.83	2974.95	3359.17	3695.49	3891.93	3772.80	3807.41	5181.66	3803.38
41	1983	1983	4951.86	4739.32	4727.13	4198.88	3476.96	4666.26	3359.17	3695.47	4320.83	5155.65	5181.53	5181.66	4468.69
42	1984	1984	2891.71	2833.11	4727.13	4221.50	2812.62	2974.95	3359.17	3695.49	3891.93	3772.79	4074.54	5181.66	3704.19
43	1985	1985	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
44	1986	1986	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.73	3208.95
45	1987	1987	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.72	3208.94
46	1988	1988	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
47	1989	1989	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
48	1990	1990	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
49	1991	1991	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
50	1992	1992	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
51	1993	1993	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
52	1994	1994	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
53	1995	1995	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3168.35	3208.59
54	1996	1996	2891.71	2833.12	2803.53	2832.76	2812.63	2974.97	3359.17	3695.49	3891.93	3772.80	3499.83	3172.74	3208.95
AVERAGE			2968.01	3080.22	3525.06	3424.83	3266.73	3385.13	3411.30	3695.49	3969.30	4036.75	3998.68	3977.99	3559.12
MAXIMUM			4951.86	4739.32	4727.13	4723.16	4714.75	4703.34	4438.11	3695.49	5121.93	5155.65	5181.53	5181.66	4673.20
MINIMUM			2891.69	2833.09	2803.51	2832.75	2812.61	2974.95	3359.13	3695.46	3891.91	3772.77	3499.82	3168.35	3208.59

Appendix H
Summary of Transmission Losses

Churchill River Project
Summary of Transmission Losses to Border

Scenaio	Maximum Total Generation (MW)	Maximum Generator Transformer Losses (MW)	Maximum 230 kV Bus Load (MW)	Maximum Load at 230 kV Sending End (MW)	Losses at Maximum Load (MW)
Existing	5560	15.4	460.8	5083.8	49.8
CF + GI	7824	22.6	1460.2	6341.0	63.9
CF + CF2	6560	18.2	460.8	6081.0	67.5
CF + GI + CF2	8824	25.2	1460.4	7338.4	81.9
CF + GI + MF	8648	24.6	1460.4	7163.0	95.6
CF + GI + CF2 + MF	9648	27.2	1460.4	8160.4	115.1
CF + GI + MF + LOB	8808	25.1	1460.4	7322.5	102.8
CF + GI + CF2 + LOB	8984	25.8	1460.4	7497.8	89.3
CF + GI + CF2 + MF + LOB	9808	27.8	1460.4	8319.8	122.5

For total generator output levels other than those given in the table losses are approximated as follows for each generation scenario:

Generator Transformer Losses (MW) = (0.15 * TLF + 0.85 * TLF^2) * (Max Generator Trans. Losses)

$$TLF = \frac{\text{(Current Total Generation)}}{\text{(Maximum Total Generation)}}$$

Transmission System Losses (MW) = (0.15 * LF + 0.85 * LF^2) * (Losses at Maximum Load)

$$LF = \frac{\text{(Current Load at 230 kV Sending End)}}{\text{(Maximum Load at 230 kV Sending End)}}$$

Current Load at 230 kV Sending End = Current Total Generation
- Generation Transformer Losses
- 230 kV Bus Load

230 kV Bus Load = Labrador West Load
+ Labrador East Load
+ Future Labrador Load
+ HVDC Infeed Load

Note: Transmission Losses as provided by Newfoundland and Labrador Hydro. Revised numbers are presented in Table 6.1.

PWT
May 7, 1998