HATCH

Newfoundland and Labrador Hydro

Annex No. 2 - Re-Assessment of Power and Energy

For

Feasibility Study of Hydraulic Potential of Coastal Labrador

H340870-0000-00-124-0009
Rev. 1
April 30, 2018

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REGISTERED PROFESSIONAL ENGINEER
ANTHONY CHISLETT
SIGNATURE
07-MAY-2018
DATE
NEWFOUNDLAND & LABRADOR

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1. Background

In 2013, Annex No.1 – Potential Storage was completed. This study evaluated potential hydroelectric sites from those previously screened sites that potentially could satisfy the power and energy requirements of the southern block of communities of Charlottetown (CHT), Port Hope Simpson (PHS), Mary's Harbour (MHS), and St. Lewis (STL). The study focused primarily on the technical viability of the proposed developments and the potential for storage and establishes the firm energy yield for a specific level of hydrologic reliability. Design layouts were prepared from the recently completed topographic mapping and design variables and parameters verified. Detailed cost estimates based on take-off quantities, in consistent 2012 dollars, are included in Annex No. 1 for the hydro developments assessed.

Two base generation options for providing firm power to the communities were examined that assessed the ability of the sites to deliver firm power based on a projected load demand and considered the cost factor of producing this power. Reservoir yields were verified thereby providing an estimate of the reliability of firm power. Layouts of the proposed storage sites were completed, available reservoir capacities were estimated from the new mapping and cost estimates for construction of the schemes were prepared. Based on the work undertaken, Hatch concluded that the potential for hydro storage sites to displace diesel generation at the four communities was viable and provided two generation options.

Under Generation Option #2 the generation of firm power from Site 5B-2 is combined with the run-of-river hydro site 8C-2. In the 2013 analysis, it was concluded that the reservoir size at Site 5B-2 can produce 116 MCM of live storage and 2,300 kW of power to be delivered from this site to an inter-connected mini-transmission grid linking all four communities. Generation from Site 8C-2 is variable; when estimated for the critical dry period, the combined generation from Site 5B-2 and Site 8C-2 would satisfy the forecasted energy requirements from all four communities but would not supply the forecasted peak power demand during four months. The shortfall in demanded power would need to be supplied by additional generation (e.g., stand-by diesel); it should be noted that costs of such additional generation are not included in the Annex No. 1 cost estimates.

The results of Annex No.1 indicated that the most economical generation option is to have storage at Site 5B-2 to deliver 2,300 kW of firm power along with variable power from Site 8C-2. The total cost would be approximately $89 million and the levelized cost of demand energy is the second lowest of all scenarios analyzed at $0.408/kWh. The levelized cost on the supply energy side is $0.280/kWh. These costs are in 2012 dollars and do not include the environmental and mitigation costs as well as the cost of obtaining approvals. The environmental costs would be considerable and raise the total cost as well as the levelized cost of demanded energy.

1.1 Hydrological and Energy Uncertainty

The hydrological database used in this study comprised synthesized flow series and Hatch recommended that these need to be further evaluated and verified during the next study stage. Since Site 5B has reasonable attributes for a hydro storage site, a streamflow recording station was installed in 2013 on the Gilbert River, in the vicinity of the proposed powerhouse. A similar gauging station was also established on the St Lewis River for Site 8C in 2012. Streamflow measurements were concluded in October 2016 and development of discharge rating curves for both sites were subsequently prepared. The stage/discharge relationships for both sites were used to perform regression analyses of mean monthly flows (MMFs) of the computed flows at the Gilbert River site for 2013-2016 and the St. Lewis River site for 2012 -2016 to Alexis River recorded flows over the corresponding periods. Mean monthly flow series for both the Gilbert and St Lewis sites, covering the period 1978 to 2016, were developed from the correlations. Mean annual generation from the potential storage Site 5B and the proposed run-of-river Site 8C was then re-assessed using monthly time steps with the water balance model and the generation model.

1.2 Objective

The objective of this report is to present the re-assessed energy values from the two potential development hydro sites (Site 5B and Site 8C), and compare them to those estimated in the 2013 Annex No.1 Potential Storage report that formed part of the Phase 2 – Project Definition Phase.

1.3 Purpose of Annex No. 2

The purpose of the Annex No. 2 report is to describe and summarize the hydrological relationships that were derived, compare the re-assessed energy values from the 2013 synthesized hydrological series (obtained from generalized FDCs) to the recently computed amounts and to advise on any changes in the Power vs Demand graphs for the driest year (1986-1987) for the identified communities.

1.4 Revised Discharge Rating

In 2012, Hatch was engaged by Newfoundland and Labrador Hydro (NLH) to undertake a streamflow gauging program at Site 5B on the Gilbert River and Site 8C on the St Lewis River as a component of the Feasibility Study of the Hydraulic Potential of Coastal Labrador. In October 2012, the first hydrometric gauge (03QC003) was installed on the St. Lewis River (Site 8C). After completion of the Annex No.1 Potential Storage study, the proposed Gilbert River development was revived as a candidate for small hydro development (i.e., Site 5B). Subsequently, a hydrometric gauging station on the Gilbert River was recommended and installed near the proposed dam site in July 2013 (03QC004). Both streamflow gauging stations were decommissioned in October 2016.

Rating curves were developed based on the flow and stage data gathered during site visits on the Gilbert River (2013 – 2016) and the St. Lewis River (2012 – 2016). Daily average flow for the durations for which the gauges were active were generated by WSC. A report of the final streamflow monitoring results was prepared by Hatch and submitted to NLH in February 2017. It was concluded that the discharge rating curves for both sites were of sufficient confidence, and that these can be extended or extrapolated beyond the range of observed discharge measurements without leading to significant uncertainty in the prediction of discharges.

The daily flow series extend from July 2013 to October 2016 for the Gilbert River gauging site, and from October 2012 to October 2016 for the St Lewis River gauging site.

1.5 Flow Regression Analysis

Water Survey of Canada (WSC) operates an active gauge (03QC002) on the Alexis River near St. Lewis River and Gilbert River. WSC has been collecting data at the Alexis River gauge since 1978. These historical data were used to create a correlation between the Alexis River monthly average flow and the monthly average flows for both the Gilbert River and the St. Lewis River. A linear regression was performed comparing the mean monthly flow of the Alexis River against the mean monthly flow for the Gilbert River and the St. Lewis River.

Gilbert River

The linear regression between the Alexis River and the Gilbert River directly compares the measurements from both sites from 2013 - 2016 (Figure 1-1). There is a high degree of positive correlation between the mean monthly flows of the two rivers. The coefficient of determination (R^2) value of the correlation is 0.958. This means that approximately 95.8% of the runoff relationship for the site can be assessed or determined from this relationship. The adjusted R^2 has a value of 0.957.

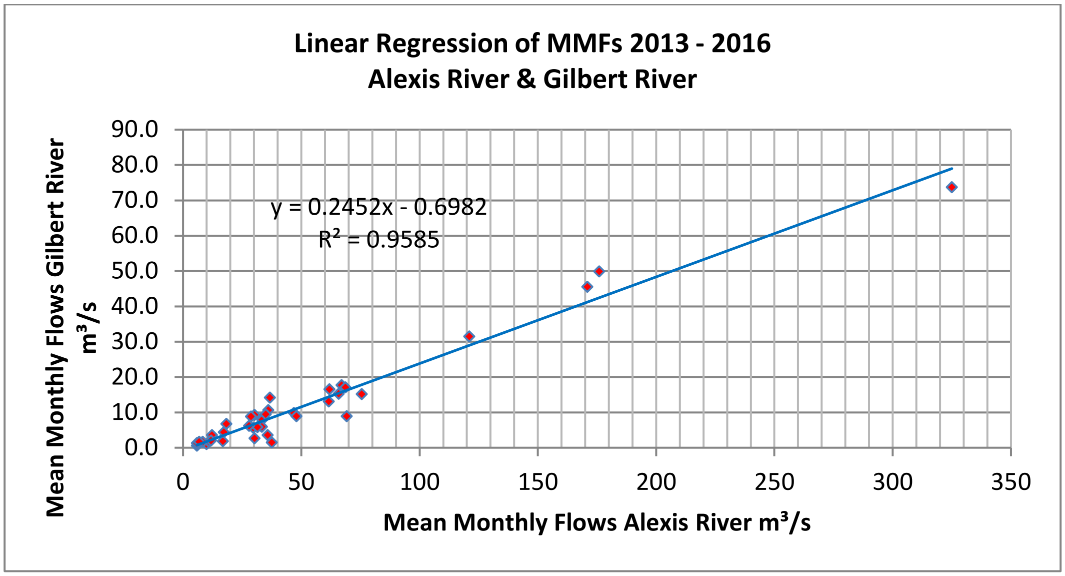

Figure 1-1: Mean Monthly Linear Regression of Gilbert River with Alexis River

Both the Alexis River and the Gilbert River have strong seasonal trends which can be seen in the single mass plot of the two rivers over the same time frame in Figure 1-2.

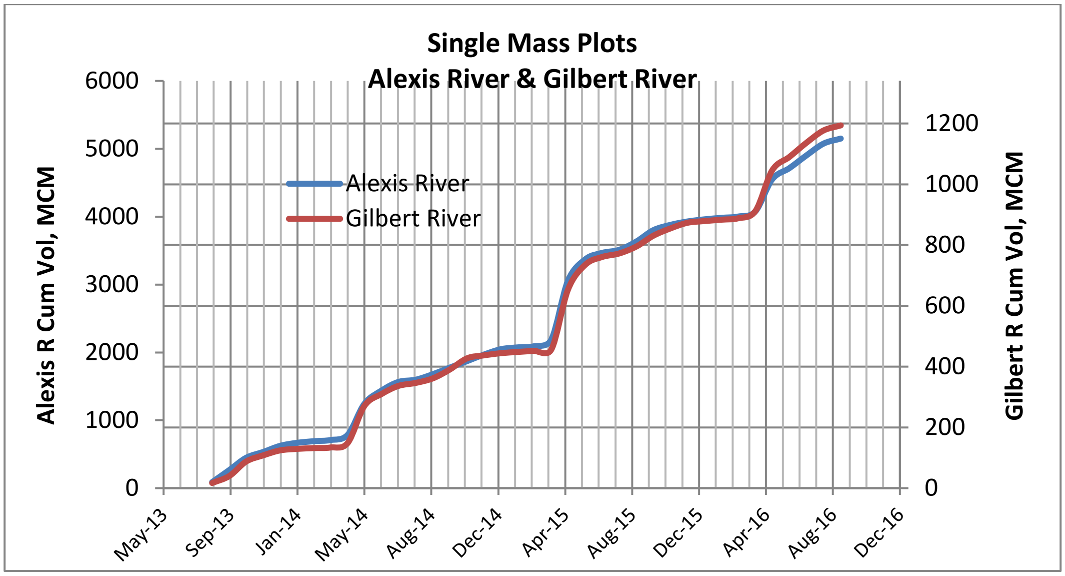

Figure 1-2: Single Mass Plot showing the relationship between Gilbert River and Alexis River

The time series plots of mean monthly recorded flows at Alexis River and Gilbert River gauges (2013-2016) are shown in Figure 1-3. This figure depicts the seasonal variation of flow at both sites and the close coincidences of peak annual flows.

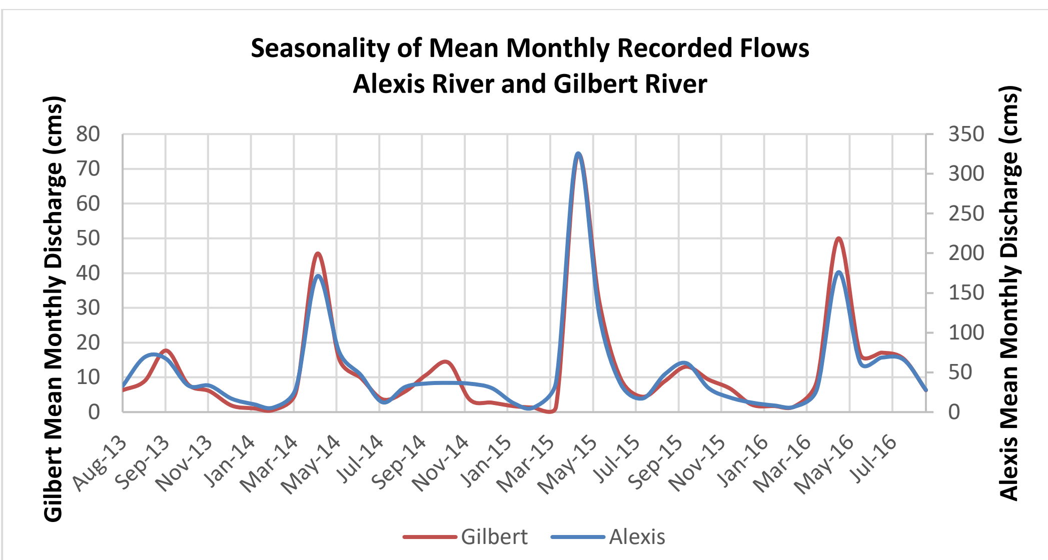

Figure 1-3: Time Series Plots showing seasonality of Gilbert River and Alexis River recorded mean monthly flows

St. Lewis River

The linear regression was also carried out for the Alexis River gauge MMF discharges, and those of the St. Lewis River site. Figure 1-4 directly compares the mean monthly flows for the two sites for the years 2012 – 2016. The relationship between the Alexis River and the St. Lewis River mean monthly flows has a R^2 value of 0.967, which is slightly better than the same relationship seen above for the Gilbert River. The adjusted R^2 value is 0.966.

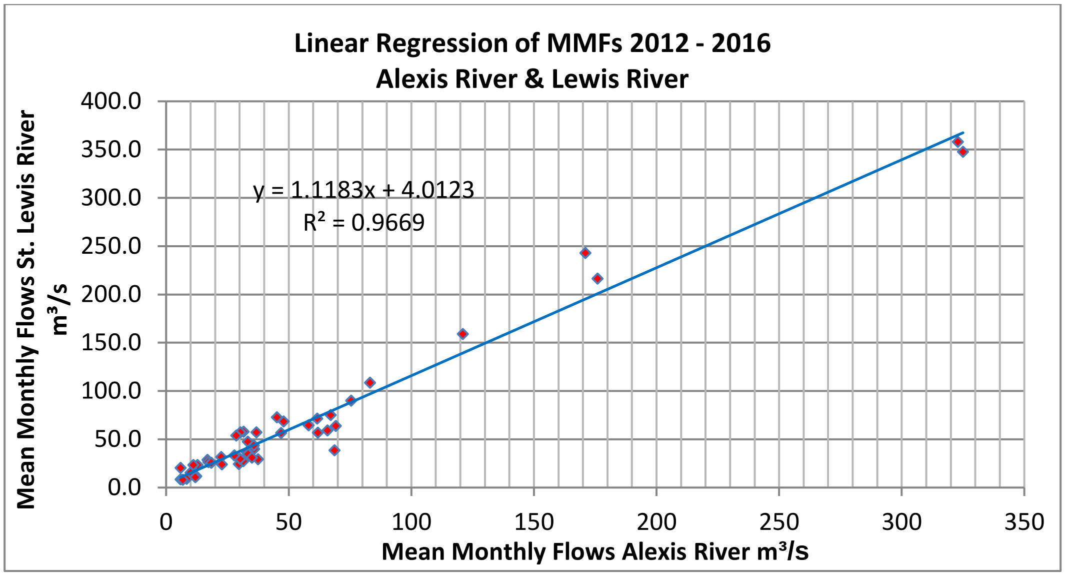

Figure 1-4: Mean Monthly Linear Regression of St. Lewis River with Alexis River

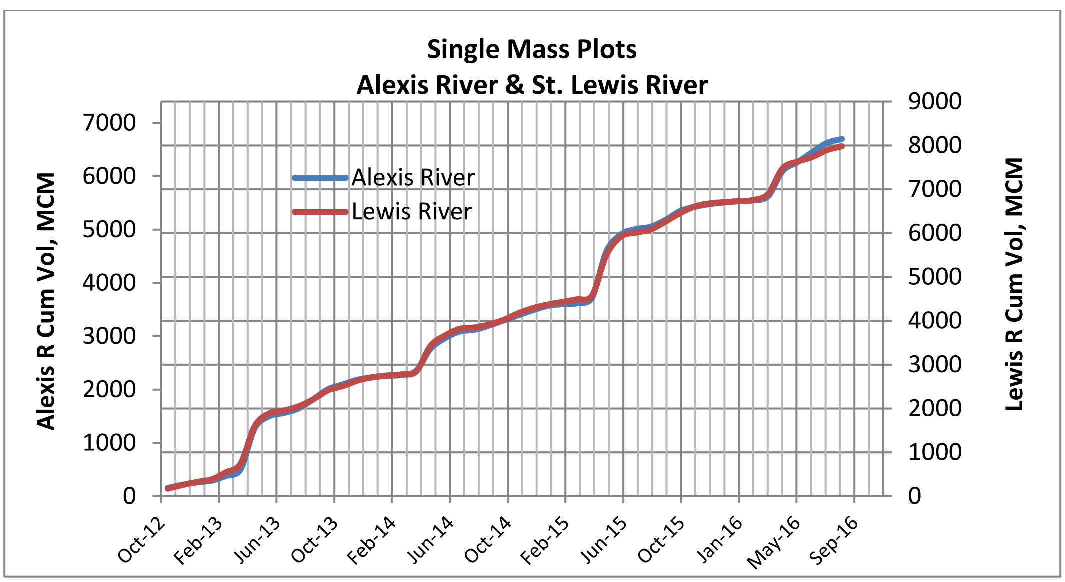

Figure 1-5: Single Mass Plot showing the relationship between St. Lewis River and Alexis River

The time series plots of mean monthly recorded flow at St. Lewis River and Alexis River gauges are shown in Figure 1-6. This figure shows the seasonal variation of flows and close agreement of flow peaks at the two sites.

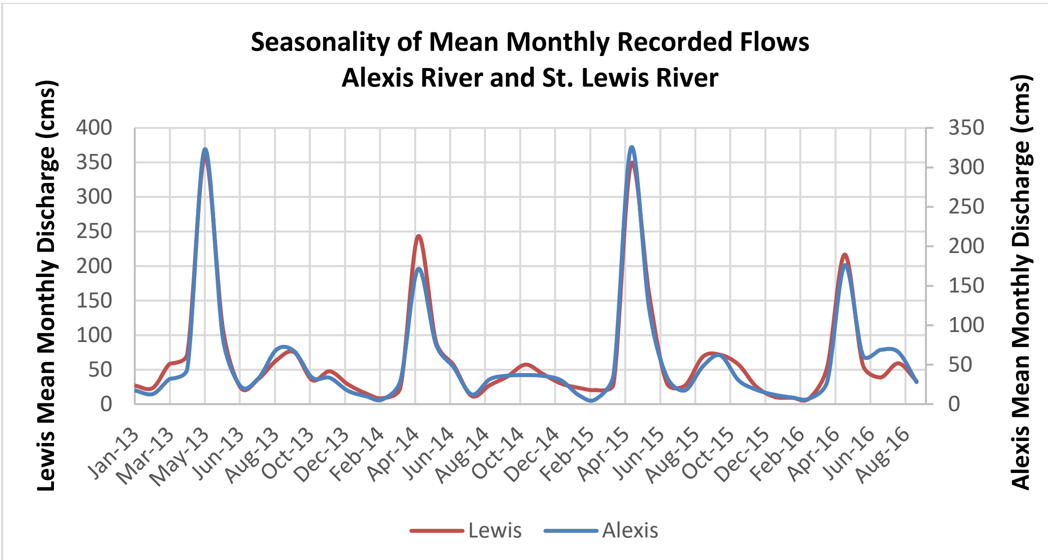

Figure 1-6: Time Series Plots showing seasonality of St. Lewis River and Alexis River recorded mean monthly flows

1.6 Monthly Flow Sequence 1978 – 2016

Using the regression equations for the mean monthly flows between the Alexis River with both the Gilbert River and the St. Lewis River, two long term hydrological flow series for the two sites were extrapolated covering the period 1978 to 2016. The flow series are presented in Table 1-1 and Table 1-2.

Table 1-1: Gilbert River Monthly Flow Sequence

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1978	1.7	1.1	0.8	1.9	45.4	38.5	9.4	7.5	11.3	17.7	4.2	2.4
1979	4.9	5.1	4.1	8.7	25.8	7.2	7.6	11.7	17.5	15.7	6.5	2.2
1980	1.2	0.7	0.6	5.8	59.6	50.3	15.1	8.7	8.6	17.0	24.6	6.8
1981	3.6	2.3	1.6	2.5	61.1	31.2	15.0	11.4	8.0	17.9	9.3	2.3
1982	1.2	0.9	0.7	0.9	41.5	39.5	21.1	9.1	7.2	5.3	10.3	4.1
1983	2.4	1.7	1.3	34.1	36.6	18.1	10.8	21.4	9.4	12.7	12.6	3.2
1984	1.6	1.0	1.0	0.9	79.5	24.1	11.0	3.9	3.4	2.8	2.5	1.3
1985	0.6	0.4	0.3	0.3	21.5	60.1	18.1	6.8	10.6	10.0	9.5	2.0
1986	1.0	1.2	0.6	31.7	33.9	10.3	8.0	3.5	4.5	5.4	1.8	1.0
1987	0.6	0.4	0.4	15.6	45.4	11.9	4.0	2.6	3.6	12.2	10.4	8.3
1988	3.2	1.6	1.4	2.0	68.4	27.0	12.3	4.9	10.4	13.9	7.3	2.9
1989	1.1	0.3	0.1	1.6	58.6	12.4	8.3	16.1	19.6	12.3	8.7	4.1
1990	1.9	0.9	0.5	1.3	42.2	53.2	14.0	7.1	6.7	4.1	9.0	8.1
1991	3.3	2.0	1.4	1.3	50.3	56.9	17.8	8.1	11.1	13.4	7.8	3.9
1992	2.0	1.2	0.8	1.6	48.3	32.4	8.7	10.3	9.2	10.6	5.2	1.9
1993	1.0	0.5	0.3	0.3	35.8	18.2	19.7	7.8	7.5	11.5	4.5	2.0
1994	1.1	0.6	0.3	0.2	38.3	22.6	10.3	8.8	8.8	10.5	20.0	3.7
1995	1.5	0.7	0.4	0.4	57.4	35.6	19.7	5.3	8.1	7.0	13.5	4.5
1996	3.5	2.0	2.6	10.9	56.2	19.1	20.0	5.8	3.0	8.7	12.7	2.1
1997	1.0	0.6	0.4	0.6	51.3	28.7	19.6	10.4	6.8	11.8	10.2	5.9
1998	2.3	1.4	4.3	7.4	44.4	23.3	7.5	7.1	27.0	19.0	14.5	3.4
1999	1.9	2.1	1.7	3.3	66.5	11.7	7.2	13.0	8.1	10.8	8.6	5.2
2000	1.8	1.1	2.0	2.8	54.2	44.2	17.8	2.7	2.0	5.2	11.6	3.4
2001	1.7	0.8	1.8	2.3	65.3	21.8	12.6	3.5	6.7	8.1	20.4	6.5
2002	4.5	1.1	1.1	1.9	33.4	26.3	9.9	9.7	12.2	7.7	6.3	2.7
2003	1.7	1.1	0.8	4.3	64.3	28.0	14.8	12.4	4.6	10.8	9.7	3.8
2004	2.0	1.3	1.0	3.2	67.0	33.9	4.1	4.6	2.0	6.4	2.1	1.6
2005	0.8	0.6	1.4	6.1	61.1	6.2	8.8	12.7	5.5	12.4	9.5	5.8
2006	1.0	0.5	1.1	13.5	60.8	8.6	2.7	1.9	2.1	7.6	13.0	4.3
2007	1.9	0.9	0.5	1.6	41.7	21.0	11.0	20.7	15.6	10.9	11.5	4.6
2008	2.7	1.8	1.3	7.2	54.7	15.7	5.1	4.5	13.7	15.8	6.8	4.0
2009	2.1	1.4	1.1	10.0	61.8	21.3	6.4	6.4	12.3	6.8	4.6	3.3
2010	3.1	5.5	2.8	23.4	66.2	27.0	13.4	7.2	2.9	24.8	22.0	19.7
2011	7.3	3.0	2.8	14.1	52.3	34.6	16.6	5.3	4.2	9.4	9.2	9.8
2012	3.9	1.1	0.5	16.3	53.7	3.9	11.0	2.5	4.7	18.6	13.5	4.8
2013	3.5	2.5	7.1	10.4	78.5	19.7	4.9	*6.3	*9.0	*17.7	*7.9	*6.0
2014	*1.9	*1.1	*0.7	*5.7	*45.6	*15.2	*9.9	*3.7	*5.9	*10.7	*14.3	*3.6
2015	*2.7	*1.7	*1.3	*1.5	*73.8	*31.5	*9.5	*4.4	*8.9	*13.1	*9.4	*6.8
2016	*2.1	*1.7	*1.7	*8.9	*50.0	*16.6	*17.1	*15.3	*6.3			

Note: *RED values are measured values

Table 1-2: St. Lewis River Monthly Flow Sequence

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1978	14.9	12.1	10.9	15.9	214.3	182.9	50.1	41.6	58.9	88.0	26.2	18.3
1979	29.6	30.4	26.0	46.7	124.8	39.9	41.9	60.6	87.0	78.7	36.7	17.3
1980	12.7	10.5	9.8	33.6	279.1	236.6	76.3	47.0	46.6	84.5	119.2	38.3
1981	23.8	17.7	14.4	18.6	285.8	149.4	75.6	59.3	43.6	89.0	49.6	17.5
1982	12.7	11.2	10.4	11.2	196.4	187.4	103.4	48.6	40.0	31.5	54.1	26.0
1983	18.3	15.2	13.1	162.8	174.0	89.9	56.5	105.0	50.0	65.2	64.7	21.6
1984	14.6	11.7	11.7	11.4	369.7	117.0	57.6	24.8	22.9	19.8	18.6	13.3
1985	10.1	9.1	8.6	8.7	105.2	281.4	89.9	38.2	55.6	52.7	50.4	16.5
1986	11.8	12.8	10.0	151.6	161.7	54.1	43.8	23.4	27.7	31.7	15.3	11.6
1987	10.0	9.1	9.0	78.5	214.3	61.3	25.5	18.9	23.5	62.7	54.8	44.8
1988	21.9	14.4	13.7	16.4	319.4	130.4	63.5	29.4	54.8	70.7	40.6	20.3
1989	12.3	8.7	7.4	14.7	274.6	63.7	45.1	80.6	96.4	63.2	46.7	26.0
1990	16.0	11.5	9.3	13.0	199.7	250.0	71.1	39.5	37.7	25.7	48.1	44.0
1991	22.1	16.2	13.4	12.9	236.6	266.8	88.2	44.0	57.8	68.3	42.7	24.8
1992	16.3	12.8	11.0	14.5	227.7	155.0	47.1	54.2	49.3	55.5	30.9	16.0
1993	11.7	9.6	8.4	8.5	170.6	90.0	96.9	42.9	41.5	59.6	27.5	16.5
1994	12.2	10.1	8.8	8.1	181.8	110.5	54.1	47.3	47.5	55.0	98.6	24.1
1995	14.0	10.6	9.1	8.9	269.0	169.5	96.9	31.5	44.2	39.2	68.7	27.7
1996	23.4	16.5	19.0	56.7	263.5	94.5	98.4	33.6	20.7	47.1	65.1	17.0
1997	11.8	10.2	9.2	10.0	241.1	138.2	96.4	54.6	38.0	60.9	53.6	34.1
1998	17.7	13.8	26.7	41.0	209.8	113.5	41.6	39.7	130.4	93.7	73.5	22.8
1999	16.1	17.0	15.2	22.4	310.4	60.6	40.1	66.6	44.3	56.5	46.5	31.0
2000	15.3	12.3	16.5	19.8	254.5	208.7	88.6	19.4	16.3	30.9	60.2	22.9
2001	15.0	10.7	15.2	17.7	304.8	106.7	64.6	23.0	37.9	44.3	100.3	36.9
2002	27.6	12.3	12.2	15.8	159.5	127.0	52.4	51.7	62.7	42.1	35.8	19.6
2003	14.9	12.4	11.1	26.6	300.4	134.9	74.6	63.8	28.1	56.2	51.3	24.4
2004	16.2	13.2	11.8	21.7	312.7	161.7	25.8	28.4	16.4	36.4	16.8	14.4
2005	10.6	10.1	13.5	35.2	285.8	35.4	47.5	65.3	32.1	63.6	50.3	33.4
2006	11.9	9.7	12.3	68.8	284.7	46.5	19.4	15.9	16.9	41.8	66.5	26.9
2007	15.9	11.1	9.4	14.3	197.5	102.8	57.6	101.8	78.3	56.9	59.5	28.1
2008	19.3	15.3	13.1	39.9	256.7	78.8	30.6	27.9	69.8	79.4	38.3	25.4
2009	16.9	13.7	12.1	52.8	289.2	104.5	36.3	36.6	63.2	38.2	28.3	22.2
2010	21.5	32.3	20.0	113.7	309.3	130.4	68.1	40.2	20.5	120.3	107.5	97.2
2011	40.6	20.9	19.8	71.6	245.6	165.0	83.0	31.2	26.2	50.1	49.3	52.0
2012	25.1	12.3	9.3	81.7	252.3	25.0	57.5	18.6	28.7	91.8	*64.6	*31.6
2013	*26.7	*23.5	*57.9	*72.9	*358.2	*108.6	*24.0	*36.6	*63.8	*75.3	*34.7	*47.5
2014	*28.6	*15.5	*8.6	*24.3	*242.9	*90.2	*56.7	*11.8	*27.4	*39.9	*57.2	*43.7
2015	*29.7	*23.5	*20.4	*29.5	*347.8	*159.0	*30.9	*26.6	*68.6	*71.4	*57.3	*25.7
2016	*10.7	*9.2	*8.2	*53.9	*216.6	*56.9	*38.6	*59.1	*33.3			

Note: *RED values are measured values

2. Power and Energy Analysis

2.1 Methodology & Results

Site 5B – Gilbert River Storage

The extrapolated MMF series indicated that the driest "water year" in the 1978-2016 record remains the year 1986-1987. A draft rate for an installed capacity of 2300 kW was applied to the water balance model (a description of the model is provided in the Annex No.1 report on potential storage for reservoir sites). The firm monthly energy results for Site 5B calculated with the extrapolated flow series for the 1986-87 driest year are compared in Table 2-1 to the corresponding energy amounts calculated from the synthesized flow series (2013).

Table 2-1: Site 5B Monthly Firm Energy Comparison

Date	2013 Power (kW)	2017 Revised Power (kW)	Change in Power (kW)
86-M	2300	2300	
86-A	2300	2300	
86-M	2300	2300	
86-J	2300	2300	
86-J	2300	2300	
86-A	2300	2300	
86-S	2300	2300	
86-O	2300	2300	
86-N	2300	2300	
86-D	2300	2300	
87-J	2300	2300	
87-F	2300	2300	
87-M	2300	1016	-1284
87-A	2300	2300	
87-M	2300	2300	

For a live reservoir storage of 115.73 MCM, the water balance model yield falls to 1016 kW in March of 1987 (just before the spring freshet) and the Site 5B reservoir would be at its maximum draw-down level for part of the month. Alternatively, only a mean daily generation of 1016 kW would be possible. The daily shortfall in power generated will be 1284 kW hence the site would not be able to deliver a firm capacity of 2300 kW. The shortfall in demanded power would need to be supplied by additional generation (e.g., stand-by diesel).

Site 8C – St. Lewis Run-of River Operation

The power and energy model was applied to Site 8C with an installed capacity of 3000 kW and a rated flow of 19.6 m^3/s. The plant characteristics for Site 8C are the same as those given in Table 4-1 of the Annex No.1 report.

A comparison of the mean monthly generated power for Site 8C based on the 2013 energy assessment and the 2017 re-assessed monthly energy using the extrapolated MMF series for the driest year is provided in Table 2-2. The 2017 revised power exceeds the 2013 power estimates in all months of the driest year.

Table 2-2: Site 8C Monthly Firm Energy Comparison

Date	2013 Power (kW)	2017 Revised Power (kW)	Change in Power (kW)
86-M	982	1469	487
86-A	2690	3000	310
86-M	2881	3000	118
86-J	2881	3000	118
86-J	2854	3000	145
86-A	2566	3000	433
86-S	2827	3000	173
86-O	2863	3000	137
86-N	1864	2000	135
86-D	1211	1644	434
87-J	954	1441	487
87-F	795	1341	546
87-M	801	1332	531
87-A	2119	3000	881
87-M	2881	3000	118

2.2 Energy Re-Assessment Results Comparison

The combined generation of Site 5B (storage) and 8C (run-of–river) for the driest year 1986-87 is given in Table 2-3.

Table 2-3: Power for Sites 5B and 8C compared to demand from CHT/PHS/MHS/STL

Date	Site 5B - 2017 Revised Power (kW)	Site 8C - 2017 Revised Power (kW)	Demand (kW)	Deficit (kW)
86-M	2300	1469	3315	
86-A	2300	3000	3091	
86-M	2300	3000	3760	
86-J	2300	3000	4245	
86-J	2300	3000	4206	
86-A	2300	3000	3681	
86-S	2300	3000	3639	
86-O	2300	3000	3566	
86-N	2300	2000	3318	
86-D	2300	1644	3555	
87-J	2300	1441	3492	
87-F	2300	1341	3457	
87-M	1016	1332	3315	-967
87-A	2300	3000	3091	
87-M	2300	3000	3760	

The corresponding figures of Power vs Demand are shown in Figure 2-1 (replicated from the 2013 report) and Figure 2-2 (re-assessed power with extrapolated MMF series). The same relationships calculated in 2013 using the FDC synthesized flow series is given in Figure 2-2.

Comparing Figures 2-1 and 2-2 for the 1986-87 driest year, Site 8C produced an increase in power generation using the 2017 flows when compared to the 2013 assessment. Site 5B produced less power in just one month (March 1987), resulting in the only month of combined power shortfall in the driest year.

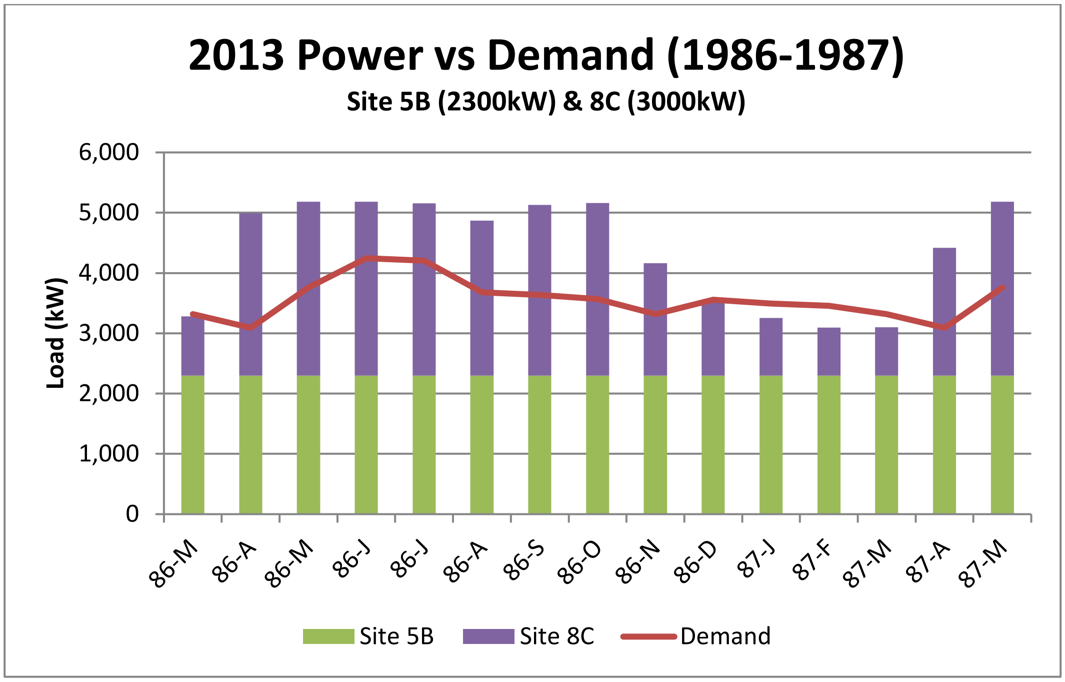

Figure 2-1: 2013 Power Assessment – Comparing power from Sites 5B and 8C with the demand from CHT/PHS/MHS/STL

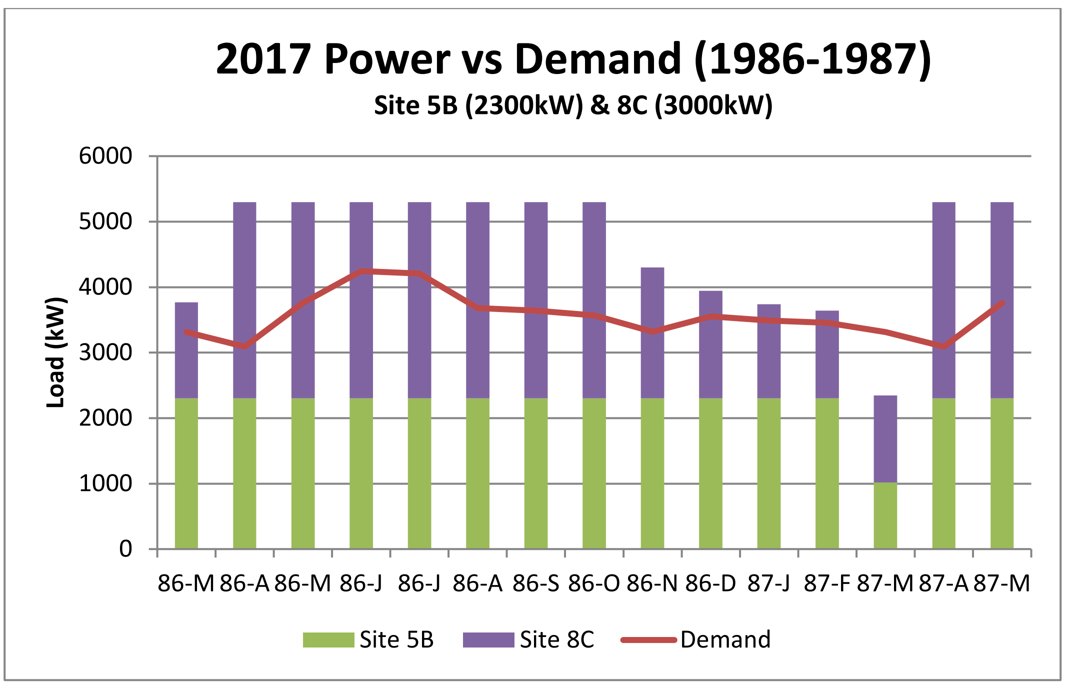

Figure 2-2: 2017 Power Re-Assessment – Comparing power from Sites 5B and 8C with the demand from CHT/PHS/MHS/STL

3. Conclusions

3.1 Site 5B

With the extrapolated monthly flow series of Site 5B the driest year remains the 1986-87 water year. Site 5B delivers firm power of 2300 kW throughout the driest year with the exception of only one month (March 1987). The analysis indicates that there is a simulated shortfall of 1284 kW during that month. The shortfall in demanded power would need to be supplied by additional generation (e.g., stand-by diesel); it should be noted that costs of such additional generation are not included in the Annex No. 1 cost estimates.

3.2 Site 8C

The run-of river operation of Site 8C generates more power than estimated in the 2013 analysis. This is generally because the extrapolated St. Lewis River flows in the 2017 analysis show slight increases in the months of November to April over those derived from the previous (2013) FDC synthesized mean daily flow data.

Although the 2017 analysis used monthly flows instead of daily flows as used in the 2013 analysis, and monthly flows tend to mask the daily flow variations which may in turn produce lower spill and higher power generation values, the analysis results in Section 2 are for the driest months in the flow sequence and spills are not expected to be a dominant factor in the driest year. Furthermore, the 2017 flows are higher than the synthesized flows used in 2013 (regardless of the choice of monthly or daily timestep), and are expected to be more accurate since they are based on site-specific gauge data.

3.3 Combined for Proposed Service

The re-assessed 2017 power for Sites 5B and 8C in the driest year under Generation Option #2 is greater than the amounts calculated in 2013. The combined result is that expected power demand is satisfied throughout the entire driest year with the exception of only one month (March 1987). Previously in the 2013 assessment, the simulations indicated shortfalls in four months (December 1986, January 1987, February 1987, March 1987). The shortfall in demanded power would need to be supplied by additional generation (e.g., stand-by diesel); it should be noted that costs of such additional generation are not included in the Annex No. 1 cost estimates.

80 Hebron Way, Suite 100
St. John's, Newfoundland, Canada A1A 0L9
Tel: +1 (709) 754 6933

HATCH

80 Hebron Way, Suite 100
St. John's, Newfoundland, Canada A1A 0L9
Tel: +1 (709) 754 6933