

2024

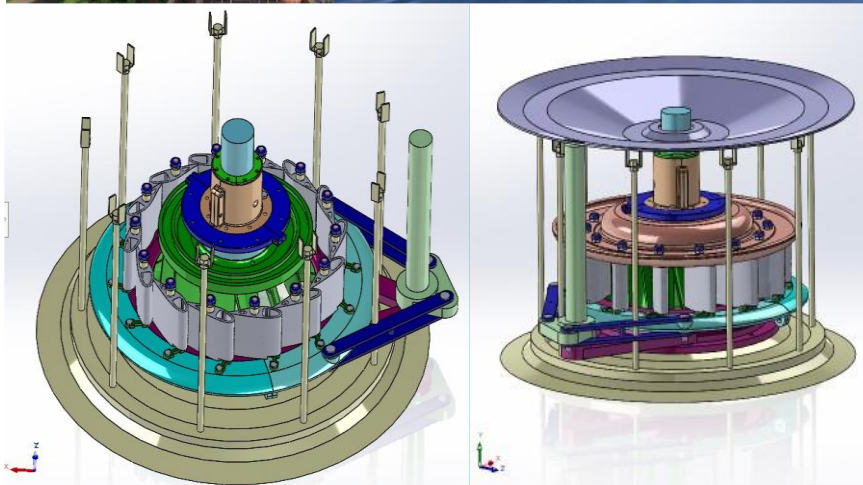
ADDITIONAL COSTED OPTION ANALYSIS SCENARIOS: Factorydale Turbine Project – Berwick Electric Commission



Prepared for



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EXECUTIVE SUMMARY

This report is a complement of the Condition Assessment and costed option analysis report HSV - 2024 - 043 - CA01 and should be read and understood as an additional part of it.

On this case, we are analysis different scenarios of water flow through the Factorydale plant, understanding that there are no current or old hydrology data available. In this case, the good practice is to prepare additional flow duration curves based on hydrology data from relatively close rivers on the region, or rivers with similar behavior.

Two rivers where identified, the Cornwallis River, and the Beaverbank River. Cornwallis River is relatively close to the area and have a hydrologic station from NRCan in place (Cambridge Station). Beaverbank River at Keniac is used as an additional reference hydrology station, which has a similar behavior than the river at Factorydale and as well have data available.

3 scenarios were analyzed for the new unit option and like for like replacements, for each manufacturer that we got quotes. A very pessimistic scenario where only 10% of the time or more the water flow is above 3.39 cubic meters per second, a pessimistic scenario where the water flow is above 3.39 cubic meters per second 30% of the time or more, and an optimistic scenario where that flow is present above 70% of the time.

That was done twice, once for each flow duration curve, using the extrapolated flow duration for each hydrology station as a reference.

In general, the results are in line with the results already obtained in the first iteration of the energy and financial analysis, and our recommendations are the same. In fact, this additional analysis reinforces our recommendation and make a stronger case for a new unit at the Factorydale plant.

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SECTION 1 – HYDROLOGY WATER STATIONS USED FOR REFERENCE

As it was mentioned before, there is no data available about the hydrology of the Factorydale site. Unfortunately, NRCan does not have a station in place, and the BEC does not register the water flow through the penstock over the years. With that scenario, first we used on our first iterations a flow duration curve from a river in NS, using the database from RETScreen. To improve our estimates, we now used the data of two hydrological stations: one close to the site, and another one in the province with similar behaviour than the expected from Factorydale. In both cases, we used stations with current data and currently working.

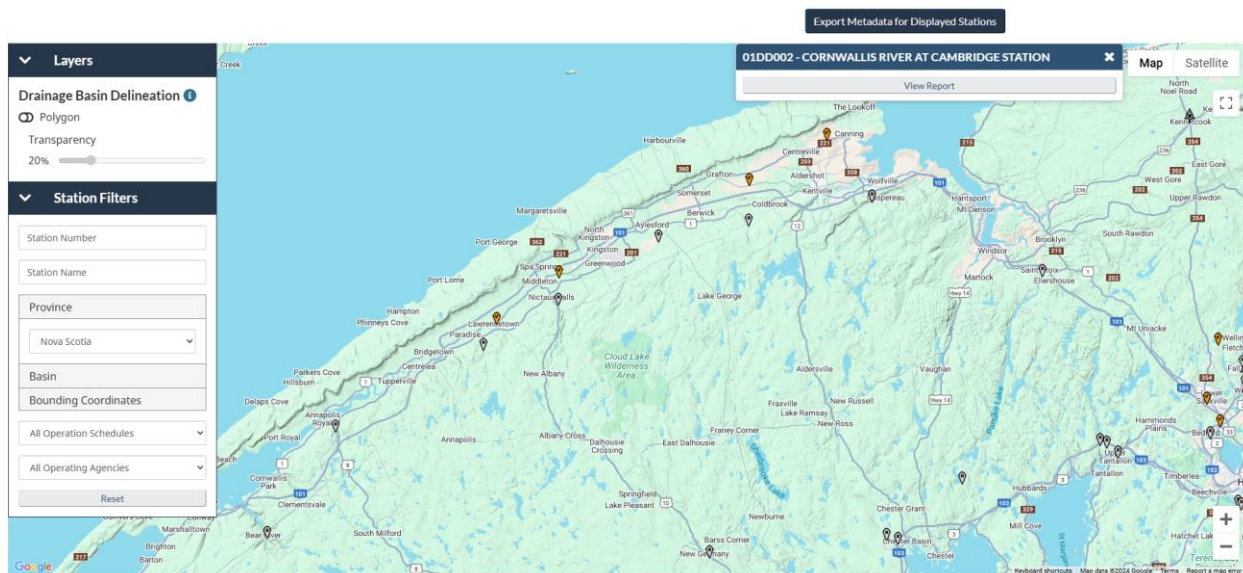


Figure 1: Cornwallis River at Cambridge Station

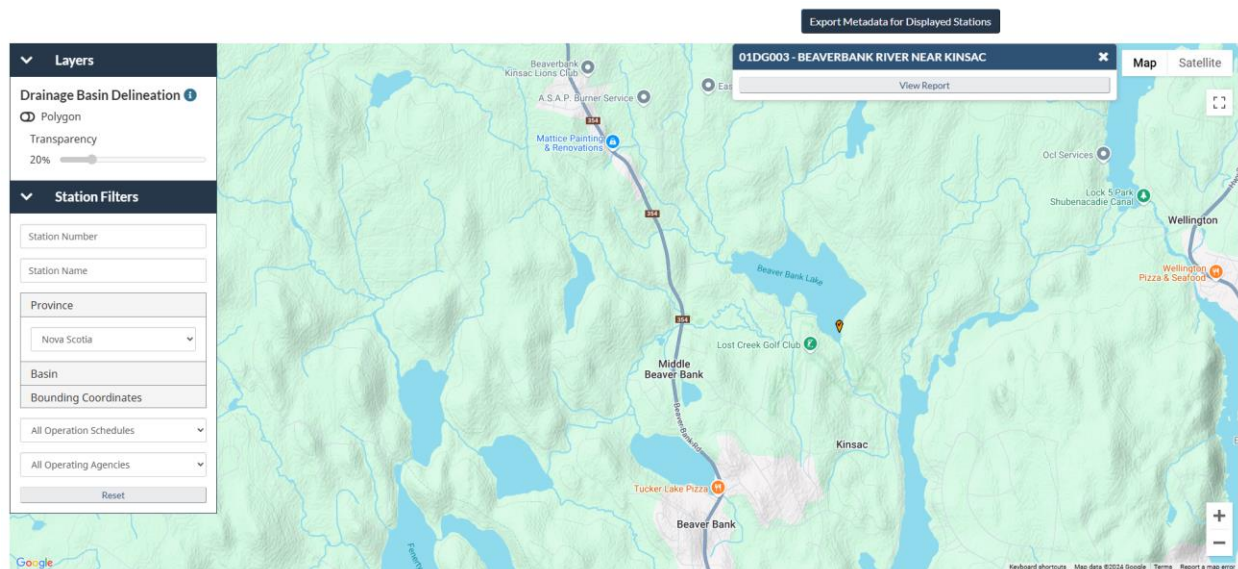


Figure 2: Beaverbank River near Kinsac



With the data obtained, we proceeded to create the

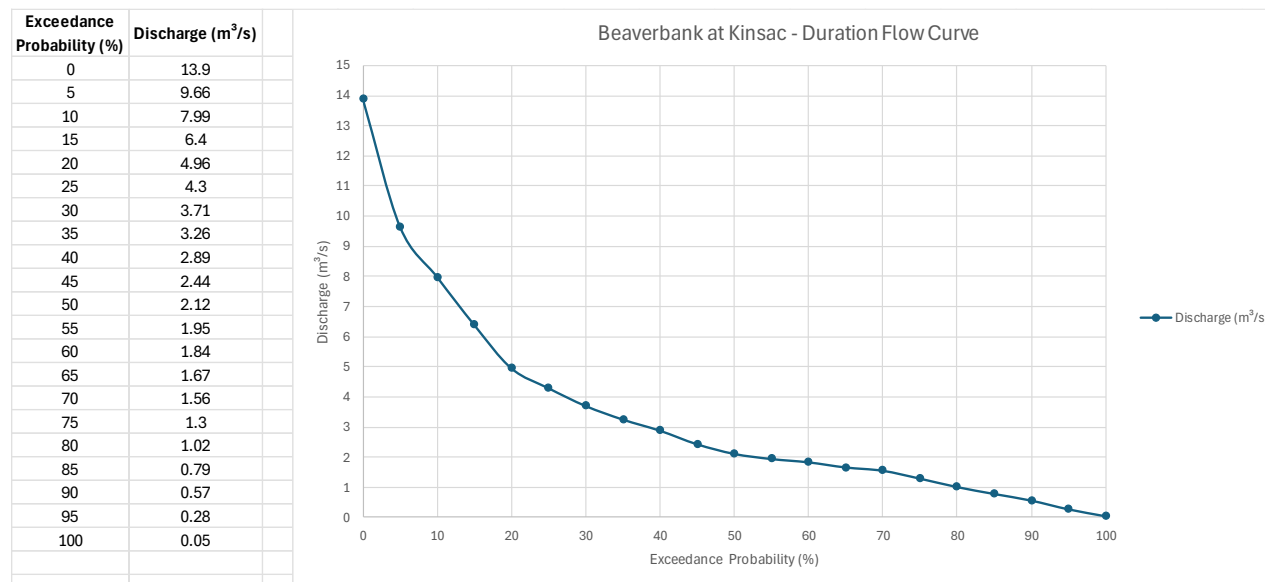


Figure 3: Flow Duration Curve - Beaverbank

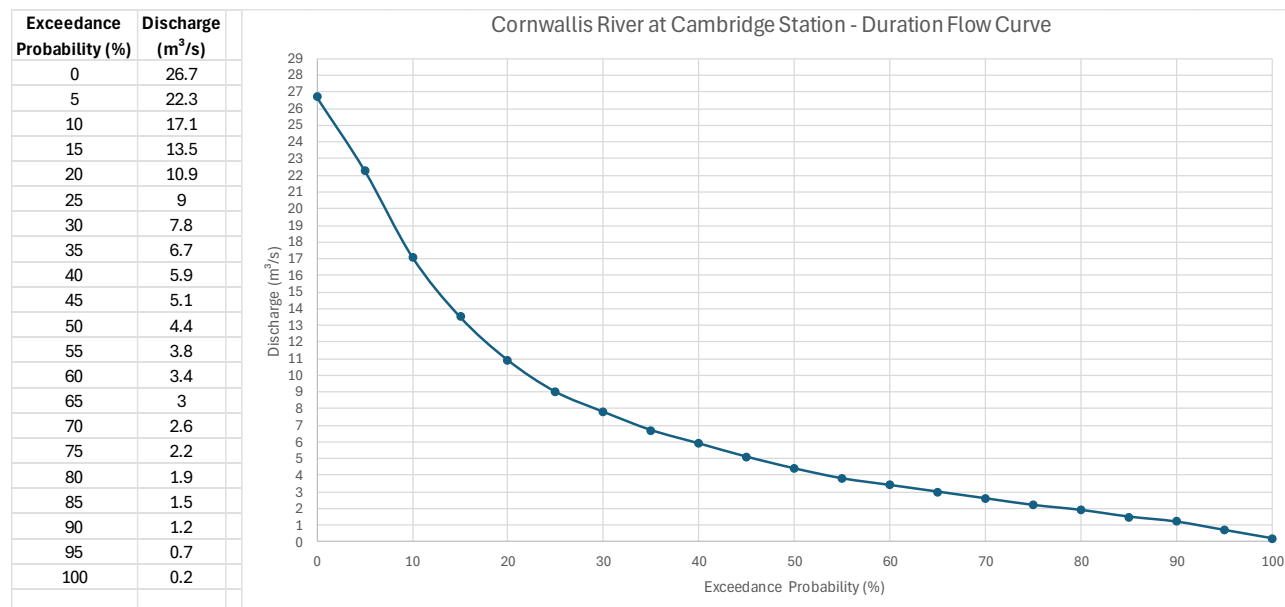


Figure 4: Duration flow Curve - Cornwallis



Now, we know that at some point the flow through the penstock can reach $3.39 \text{ m}^3/\text{s} = 120 \text{ cfs}$ so, we created 3 scenarios based on each of the two flow duration curves, this way:

- **Very Pessimistic scenario:** on this one, the flow exceeds $3.39 \text{ m}^3/\text{s}$ only 10% of the time. Here are the curves for that scenario.

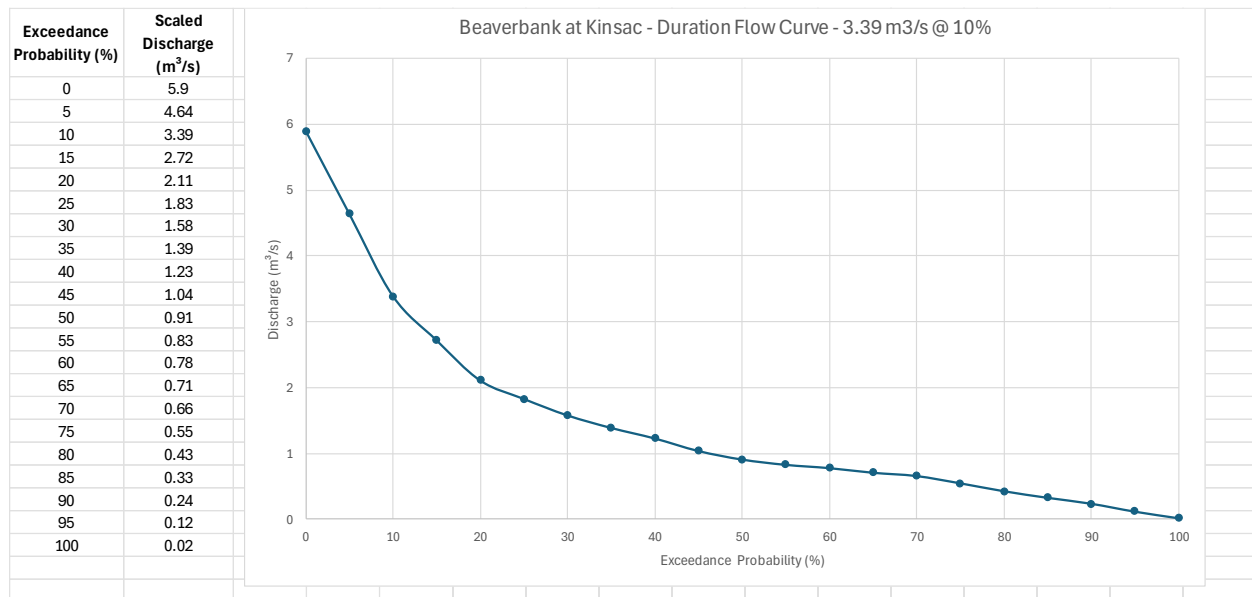


Figure 5: Very Pessimistic Scenario using Beaverbank data – $3.39 \text{ m}^3/\text{s}$ @ 10%

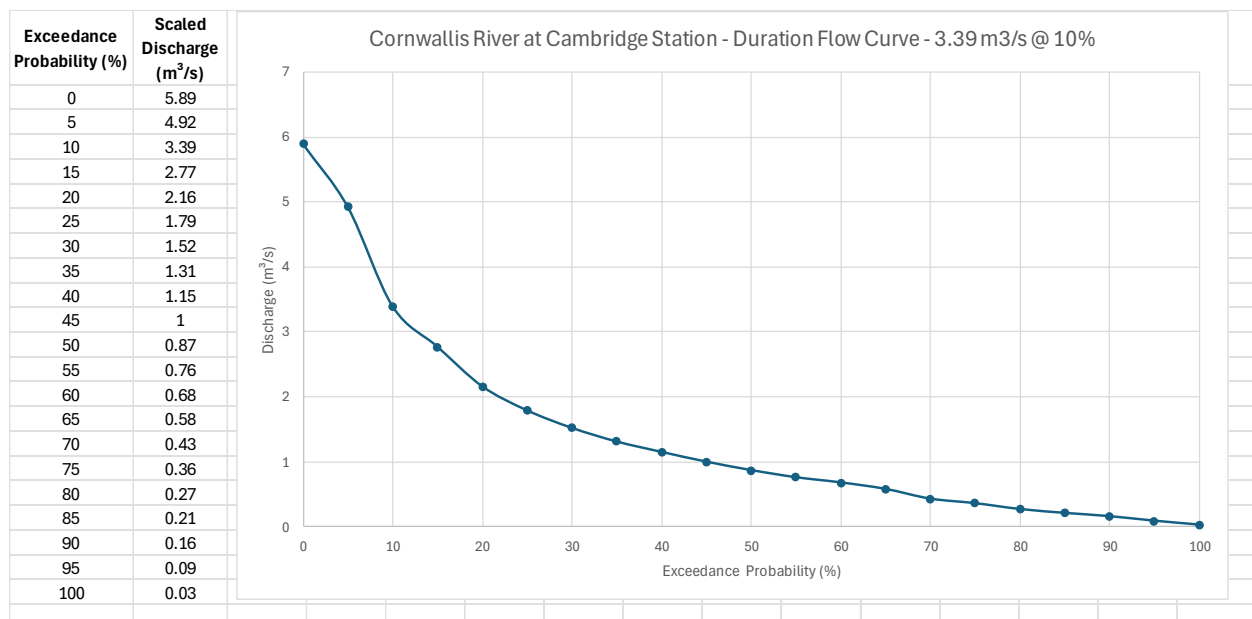


Figure 6: Very Pessimistic Scenario using Cornwallis data – $3.39 \text{ m}^3/\text{s}$ @ 10%



- **Pessimistic to realistic scenario:** on this one, the flow exceeds 3.39 m³/s only 30% of the time. Here are the curves for that scenario.

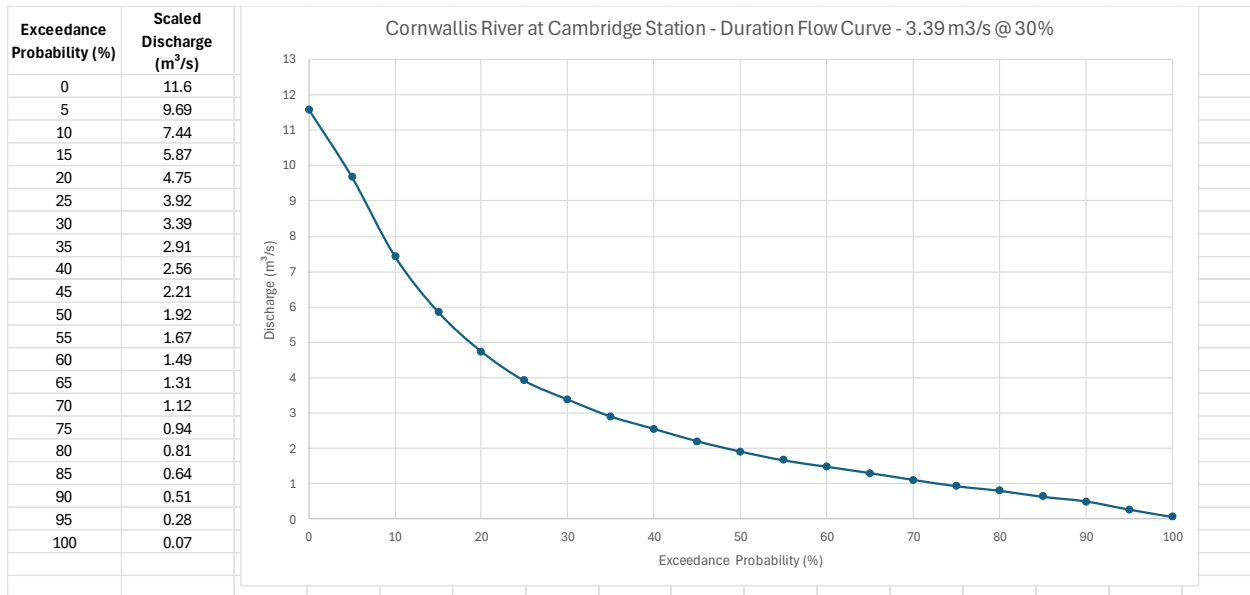


Figure 7: Pessimistic to Realistic Scenario using Cornwallis data – 3.39 m³/s @ 30%

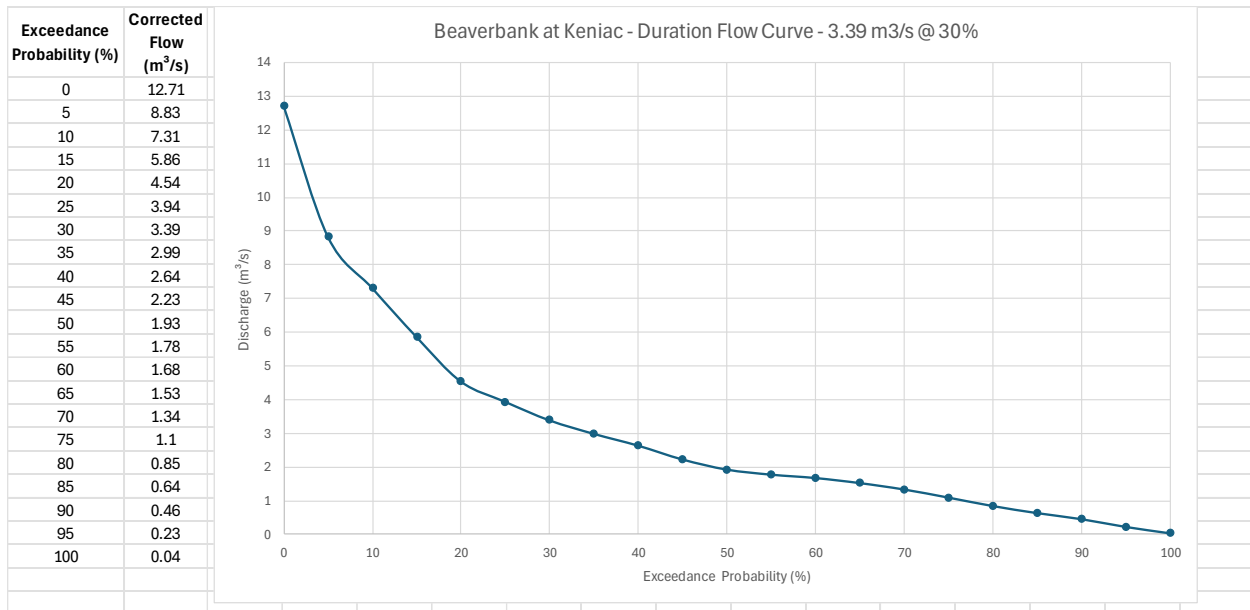


Figure 8: Pessimistic Scenario using Beaverbank data – 3.39 m³/s @ 30%

- **Optimistic scenario:** on this one, the flow exceeds 3.39 m³/s around 70% of the time. Here are the curves for that scenario.

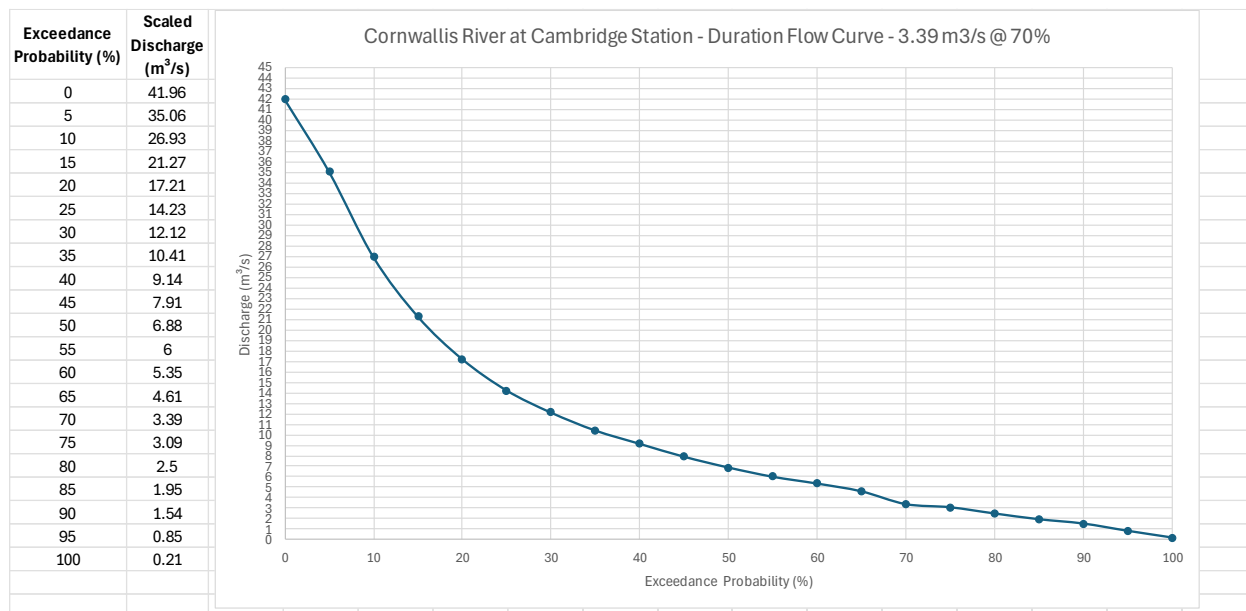


Figure 9: Optimistic Scenario using Cornwallis data – 3.39 m³/s @ 70%

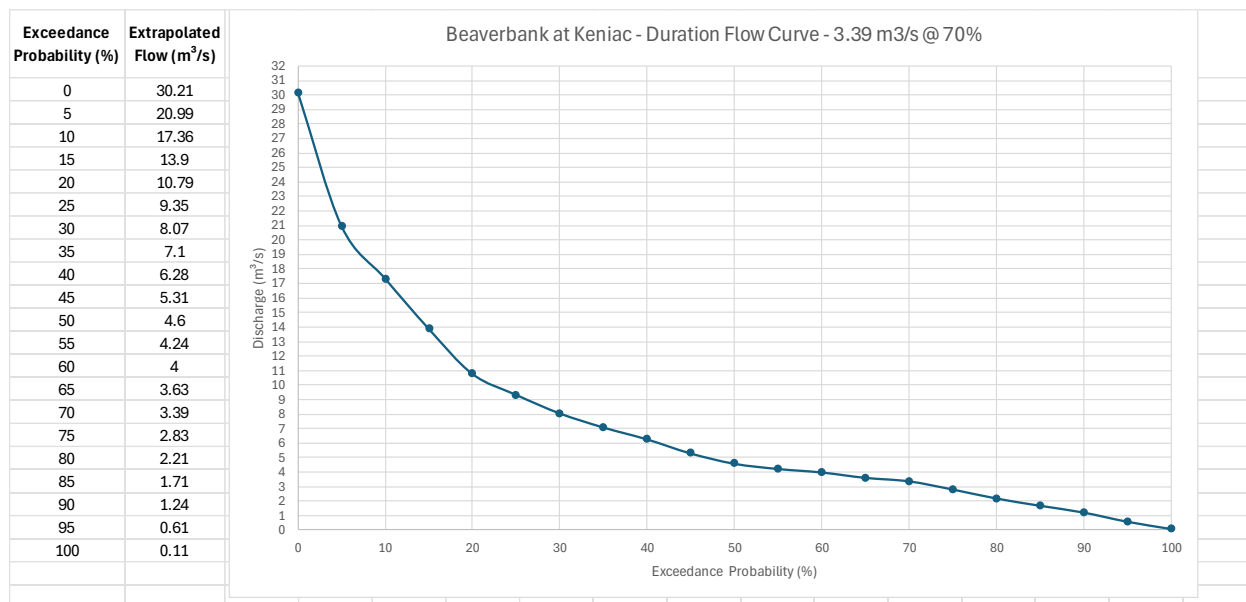


Figure 10: Optimistic Scenario using Beaverbank data – 3.39 m³/s @ 70%

SECTION 2 – COSTED OPTION ANALYSIS

On the condition assessment and costed option analysis report we already described the methodology used. On this case, we will discuss the results on each scenario.



2.1 Individual option analyses – New units

In this case, the potential for new units is different depending on the manufacturer. We will analyze then each high-level quote individually.

- Norcan Hydro: They estimate that they can reach 1,129 kW with their design, the estimated cost is 3,625,000 +/- 15%, we will take the +15% = \$4,168,750 CAD.
- Canyon Hydro: they estimate that they can reach 750 kW with their design, the estimated cost is \$2,325,460 USD +/- 50%, let's take the +50% = \$3,488,190 USD = \$4,883,466 CAD.
- Dive turbine: They estimate that they can reach 616 kW with their design, their estimated cost is \$2,500,000 CAD +/- 25%, we will take the +25% = 3,125,000 CAD.

On all scenarios, we will add \$500,000 for a new draft tube, including the necessary civil work on that case. As well, we will need to replace the transformer, so we will add \$500,000 more for a new transformer.

As well, this scenario qualifies for a loan of 80% of the cost, plus a grant of 15% over that loan, through the Green Municipal Fund. This will be applied on all financial models.

NORCAN Option – 1,129 kW - \$4,168,750 CAD.

Norcan took an approach more radical than the other OEMs, configuring their unit as close as possible to the maximum flow that the pipe can handle, in this case they choose to go to 4.9 m³/s. But their unit can go higher than that.



Hydro turbine - Level 2

Resource assessment

Proposed project		Reservoir
Gross head	m	24.384
Maximum tailwater effect	m	1.8288
Residual flow	m ³ /s	0
Percent time firm flow available	%	70%
Firm flow	m ³ /s	0.66

Hydro turbine

Design flow	m ³ /s	4.9
Type		Francis
Turbine efficiency		Standard
Number of turbines		1
Manufacturer		NORCAN
Model		
Design coefficient		6.1
Efficiency adjustment	%	13.3%
Turbine peak efficiency	%	99.3%
Flow at peak efficiency	m ³ /s	4.1
Turbine efficiency at design flow	%	94.9%

Figure 11: New Turbine - NORCAN Resource and technical Specs, including provided turbine efficiency curve

The results, using the three scenarios on both main flow duration curves are as follows:

Table 1: NORCAN unit – results on the three different scenarios of water flow

	Capacity kW	Electricity KWh	Initial costs \$	Electricity export revenue \$	Fuel cost \$	O&M costs (savings) \$	Simple payback Yr
Factorydale - Beaverbank Ext -NEW - 3.39 m3/s (10%) - NORCAN	1,012.78	1,452,189.47	\$ 4,168,750.00	\$ 190,382.04	\$ -	\$91,656.54	42.2
Factorydale - Beaverbank Ext -NEW - 3.39 m3/s (30%) - NORCAN	1,012.78	3,264,446.20	\$ 4,168,750.00	\$ 427,968.90	\$ -	\$91,656.54	12.4
Factorydale - Beaverbank Ext -NEW - 3.39 m3/s (70%) - NORCAN	1,012.78	5,669,246.75	\$ 4,168,750.00	\$ 743,238.25	\$ -	\$91,656.54	6.4
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (10%) - NORCAN	1,012.78	1,439,509.60	\$ 4,168,750.00	\$ 188,719.71	\$ -	\$91,656.54	42.9
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (30%) - NORCAN	1,012.78	2,920,921.23	\$ 4,168,750.00	\$ 382,932.77	\$ -	\$91,656.54	14.3
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (70%) - NORCAN	1,012.78	6,131,119.51	\$ 4,168,750.00	\$ 803,789.77	\$ -	\$91,656.54	5.9

We can see that the scenarios are similar to each other, in terms of the flow duration curves that they are based on. The results are not too different between the Beaverbank and the Cornwallis stations and scaled flow duration curves. This is expected.

We observe that the optimistic scenario is very similar to what we originally estimated. Now, the most pessimistic scenario is too pessimistic that in fact is not realistic, especially considering the original flow duration curves for both stations.



In this case, we think that the pessimistic to realistic scenario is the one that will be the most probable one to occur during the life of the project. On that case, we go and analyze it in more detail.

We are adding the cost of a new draft tube on this case, as mentioned before, \$500,000 CAD, and the new transformer estimate of \$500,000 CAD.

Let's see how the model looks like with the Beaverbank extrapolated data.

RETScreen - Financial Analysis				Subscriber: Hysovent Limited - Professional		
Financial parameters				Costs Savings Revenue		
General				Initial costs		
Fuel cost escalation rate			2%	Initial cost	80.7%	\$ 4,168,750
Inflation rate	%		2%	New Transformer	9.7%	\$ 500,000
Discount rate	%		9%	New Draft tube	9.7%	\$ 500,000
Reinvestment rate	%		9%	Total initial costs	100%	\$ 5,168,750
Project life	yr		50	Incentives and grants		\$ 775,313
Finance				Yearly cash flows - Year 1		
Incentives and grants	\$		775,312.50	Annual costs and debt payments		
Debt ratio	%		80%	O&M costs (savings)	\$	91,657
Debt	\$		4,135,000	Debt payments - 30 yrs	\$	267,457
Equity	\$		1,033,750	Total annual costs	\$	359,113
Debt interest rate	%		4.95%	Annual savings and revenue		
Debt term	yr		30	Electricity export revenue	\$	427,969
Debt payments	\$/yr		267,457	GHG reduction savings	\$	0
Income tax analysis				CE production revenue	\$	0
			☐	Total annual savings and revenue	\$	427,969
Annual savings and revenue				Net yearly cash flow - Year 1	\$	68,856
Electricity export revenue				Financial viability		
Electricity exported to grid	MWh		3,264	Pre-tax IRR - equity	%	36.9%
Electricity export rate	\$/MWh		131	Pre-tax MIRR - equity	%	13.5%
Electricity export revenue	\$		427,969	Pre-tax IRR - assets	%	5.2%
Electricity export escalation rate	%		2%	Pre-tax MIRR - assets	%	7.3%
GHG reduction savings				Simple payback	yr	13.1
Gross GHG reduction	tCO ₂ /yr		2,187	Equity payback	yr	3.1
Gross GHG reduction - 50 yrs	tCO ₂		109,359	Net Present Value (NPV)	\$	1,716,968
GHG reduction savings	\$		0	Annual life cycle savings	\$/yr	156,634
Other revenue (cost)				Benefit-Cost (B-C) ratio		2.7
			☐	Debt service coverage		1.3
Clean Energy (CE) production revenue				GHG reduction cost	\$/tCO ₂	-13.75
			☐	Energy production cost	\$/kWh	0.12
Yearly cash flows						
Year	Pre-tax	Cumulative				
#	\$	\$				
0	-258,438	-258,438				
1	75,582	-182,855				
2	82,443	-100,413				
3	89,441	-10,972				
4	96,579	85,607				
5	103,860	189,467				
6	111,286	300,752				
7	118,861	419,613				
8	126,587	546,200				
9	134,468	680,668				
10	142,506	823,174				
11	150,706	973,880				
12	159,069	1,132,949				
13	167,599	1,300,548				
14	176,301	1,476,849				
15	185,176	1,662,024				
16	194,228	1,856,253				
17	203,462	2,059,715				
18	212,880	2,272,595				
19	222,487	2,495,082				
20	232,286	2,727,368				
21	242,281	2,969,649				
22	252,476	3,222,124				
23	262,874	3,484,999				
24	273,481	3,758,479				
25	284,300	4,042,779				
26	295,335	4,338,114				
27	306,591	4,644,704				
28	318,071	4,962,776				
29	329,782	5,292,558				
30	341,727	5,634,284				
31	621,367	6,255,651				
32	633,794	6,889,446				
33	646,470	7,535,916				
34	659,400	8,195,315				
35	672,588	8,867,903				
36	686,039	9,553,942				
37	699,760	10,253,702				
38	713,755	10,967,458				
39	728,030	11,695,488				

Figure 12: Financial Analysis – NORCAN –Beaverbank extrapolation - 3.39 m3/s at 30%

The simple payback of the project is 13.1 years, and the equity payback is 3.1 years.

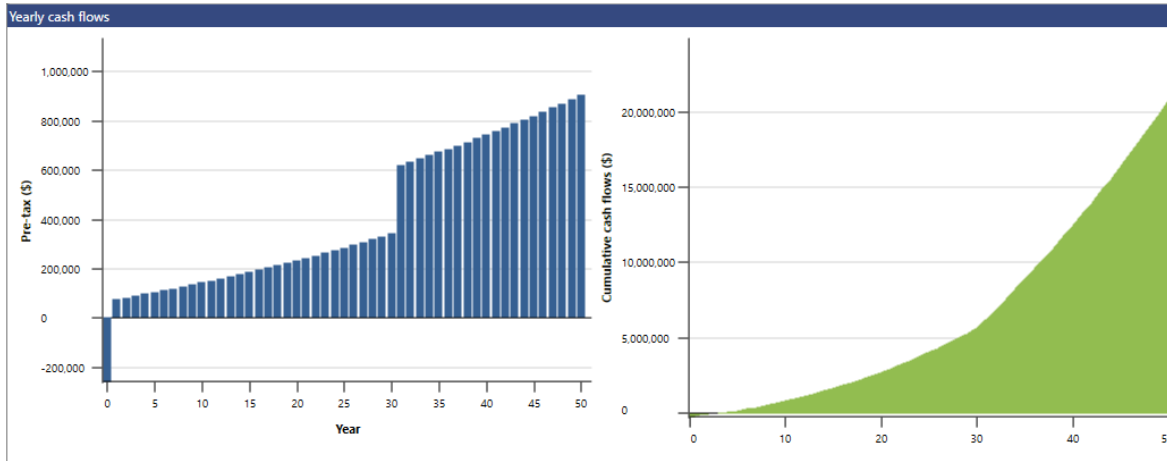


Figure 13: Yearly Cash Flows – NORCAN –Beaverbank extrapolation - 3.39 m3/s at 30%

Now let's see with the Cornwallis extrapolated data:

RETScreen - Financial Analysis

Subscriber: Hysovent Limited - Professional

Financial parameters			Costs Savings Revenue			Yearly cash flows		
General			Initial costs			Year	Pre-tax	Cumulative
Fuel cost escalation rate		2%	Initial cost	80.7%	\$ 4,168,750	#	\$	\$
Inflation rate	%	2%	New Transformer	9.7%	\$ 500,000	0	-258,438	-258,438
Discount rate	%	9%	New Draft tube	9.7%	\$ 500,000	1	29,645	-228,792
Reinvestment rate	%	9%	Total initial costs	100%	\$ 5,168,750	2	35,587	-193,205
Project life	yr	50	Incentives and grants		\$ 775,313	3	41,648	-151,557
Finance			Yearly cash flows - Year 1			4	47,830	-103,727
Incentives and grants	\$	775,312.50	Annual costs and debt payments			5	54,136	-49,591
Debt ratio	%	80%	O&M costs (savings)	\$	91,657	6	60,568	10,977
Debt	\$	4,135,000	Debt payments - 30 yrs	\$	267,457	7	67,128	78,106
Equity	\$	1,033,750	Total annual costs	\$	359,113	8	73,820	151,926
Debt interest rate	%	4.95%	Annual savings and revenue			9	80,646	232,571
Debt term	yr	30	Electricity export revenue	\$	382,933	10	87,608	320,179
Debt payments	\$/yr	267,457	GHG reduction savings	\$	0	11	94,709	414,888
Income tax analysis			CE production revenue	\$	0	12	101,952	516,840
			Total annual savings and revenue	\$	382,933	13	109,340	626,180
Annual savings and revenue			Net yearly cash flow - Year 1	\$	23,820	14	116,876	743,056
Electricity export revenue			Financial viability			15	124,563	867,619
Electricity exported to grid	MWh	2,921	Pre-tax IRR - equity	%	22.8%	16	132,403	1,000,023
Electricity export rate	\$/MWh	131	Pre-tax MIRR - equity	%	12.7%	17	140,401	1,140,423
Electricity export revenue	\$	382,933	Pre-tax IRR - assets	%	4.2%	18	148,558	1,288,981
Electricity export escalation rate	%	2%	Pre-tax MIRR - assets	%	6.5%	19	156,878	1,445,859
GHG reduction savings			Simple payback	yr	15.1	20	165,365	1,611,223
Gross GHG reduction	tCO ₂ /yr	1,957	Equity payback	yr	5.8	21	174,021	1,785,245
Gross GHG reduction - 50 yrs	tCO ₂	97,851	Net Present Value (NPV)	\$	1,084,482	22	182,851	1,968,095
GHG reduction savings	\$	0	Annual life cycle savings	\$/yr	98,934	23	191,857	2,159,952
Other revenue (cost)			Benefit-Cost (B-C) ratio		2	24	201,043	2,360,995
Clean Energy (CE) production revenue			Debt service coverage		1.1	25	210,413	2,571,408
			GHG reduction cost	\$/tCO ₂	14.11	26	219,970	2,791,378
			Energy production cost	\$/kWh	0.134	27	229,719	3,021,097
						28	239,662	3,260,760
						29	249,805	3,510,565
						30	260,150	3,770,715
						31	538,159	4,308,873
						32	548,922	4,857,795
						33	559,900	5,417,696
						34	571,098	5,988,794
						35	582,520	6,571,314
						36	594,171	7,165,485
						37	606,054	7,771,539
						38	618,175	8,389,714
						39	630,539	9,020,253

Figure 14: Financial Analysis – NORCAN –Cornwallis extrapolation - 3.39 m3/s at 30%

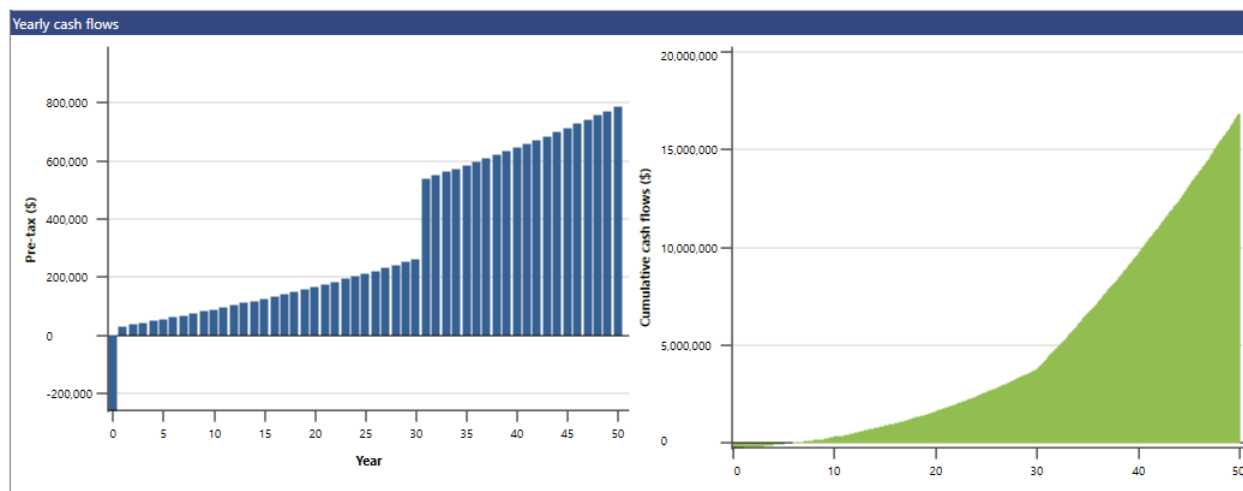


Figure 15: Yearly Cash Flows – NORCAN –Cornwallis extrapolation - 3.39 m3/s at 30%

The simple payback of the project is 15.1 years, and the equity payback is 5.8 years.

CANYON Option – 750 kW - \$4,883,466 CAD

It is important to note that Canyon estimates that, because the current design is quite ill (something that we agree with) the flow through the penstock is in fact restrained. The penstock has the capacity to direct flows from 3.5 to 5 m3/s, and currently only had managed to peak 3.39 m3/s as per the recollections from interviews (no historical logs available). In this case, CANYON estimates that if there is a flow of 4 m3/s through the pipe, the unit can reach 750 kW. This is something that we believe can be achieved during the freshet season. The unit can work of course with less water.



Hydro turbine - Level 2

Resource assessment

Proposed project: Reservoir

Gross head: 24.384 m

Maximum tailwater effect: 1.8288 m

Residual flow: 0 m³/s

Percent time firm flow available: 70%

Firm flow: 4 m³/s

Hydro turbine

Design flow: 4 m³/s

Type: Francis

Turbine efficiency: User-defined

Number of turbines: 1

Manufacturer: CANYON

Model:

Design coefficient: 6.1

Efficiency adjustment: 6.4%

Turbine peak efficiency: 92.1%

Flow at peak efficiency: 3.3 m³/s

Turbine efficiency at design flow: 87.8%

Figure 16: New Turbine - CANYON Resource and technical Specs

The results, using the three scenarios on both main flow duration curves are as follows:

Table 2: CANYON unit – results on the three different scenarios of water flow

	Capacity kW	Electricity KWh	Initial costs \$	Electricity export revenue \$	Fuel cost \$	O&M costs (savings) \$	Simple payback Yr
Factorydale - Beaverbank Ext -NEW - 3.39 m3/s (10%) - CANYON	750.20	1,315,779.14	\$ 4,883,466.00	\$172,498.64	\$ -	\$67,892.95	46.7
Factorydale - Beaverbank Ext -NEW - 3.39 m3/s (30%) - CANYON	750.20	2,857,437.69	\$ 4,883,466.00	\$374,610.08	\$ -	\$67,892.95	15.9
Factorydale - Beaverbank Ext -NEW - 3.39 m3/s (70%) - CANYON	750.20	4,857,558.53	\$ 4,883,466.00	\$636,825.92	\$ -	\$67,892.95	8.6
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (10%) - CANYON	750.20	1,287,308.82	\$ 4,883,466.00	\$168,766.19	\$ -	\$67,892.95	48.4
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (30%) - CANYON	750.20	2,756,477.10	\$ 4,883,466.00	\$361,374.15	\$ -	\$67,892.95	16.6
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (70%) - CANYON	750.20	4,999,464.64	\$ 4,883,466.00	\$655,429.81	\$ -	\$67,892.95	8.3

Relatively similar results than for the NORCAN case. In this case the ROIs are higher. We would proceed, similar to what we did on the other case.

Let's start with the Beaverbank extrapolated model:



RETScreen - Financial Analysis

Subscriber: Hysovent Limited - Professional

Financial parameters			Costs Savings Revenue			Yearly cash flows		
General			Initial costs			Year	Pre-tax	Cumulative
Fuel cost escalation rate		2%	Initial cost	83%	\$ 4,883,466	#	\$	\$
Inflation rate	%	2%	New Transformer	8.5%	\$ 500,000	0	-294,173	-294,173
Discount rate	%	9%	New Draft tube	8.5%	\$ 500,000	1	8,412	-285,761
Reinvestment rate	%	9%	Total initial costs	100%	\$ 5,883,466	2	14,669	-271,092
Project life	yr	50	Incentives and grants		\$ 882,520	3	21,051	-250,041
Finance			Yearly cash flows - Year 1			4	27,561	-222,480
Incentives and grants	\$	882,519.90	Annual costs and debt payments			5	34,201	-188,279
Debt ratio	%	80%	O&M costs (savings)	\$	67,893	6	40,974	-147,305
Debt	\$	4,706,773	Debt payments - 30 yrs	\$	304,439	7	47,882	-99,423
Equity	\$	1,176,693	Total annual costs	\$	372,332	8	54,929	-44,494
Debt interest rate	%	4.95%	Annual savings and revenue			9	62,116	17,622
Debt term	yr	30	Electricity export revenue	\$	374,610	10	69,447	87,069
Debt payments	\$/yr	304,439	GHG reduction savings	\$	0	11	76,925	163,994
Income tax analysis ☐			CE production revenue	\$	0	12	84,552	248,546
Annual savings and revenue			Total annual savings and revenue	\$	374,610	13	92,332	340,877
Electricity export revenue			Net yearly cash flow - Year 1			14	100,267	441,145
Electricity exported to grid	MWh	2,857	Financial viability			15	108,361	549,506
Electricity export rate	\$/MWh	131	Pre-tax IRR - equity	%	17.4%	16	116,617	666,124
Electricity export revenue	\$	374,610	Pre-tax MIRR - equity	%	12.1%	17	125,039	791,162
Electricity export escalation rate	%	2%	Pre-tax IRR - assets	%	3.6%	18	133,628	924,790
GHG reduction savings			Pre-tax MIRR - assets	%	5.9%	19	142,390	1,067,180
Gross GHG reduction	tCO ₂ /yr	1,914	Simple payback	yr	16.3	20	151,326	1,218,506
Gross GHG reduction - 50 yrs	tCO ₂	95,724	Equity payback	yr	8.7	21	160,441	1,378,947
GHG reduction savings	\$	0	Net Present Value (NPV)	\$	885,648	22	169,739	1,548,686
Other revenue (cost) ☐			Annual life cycle savings	\$/yr	80,795	23	179,223	1,727,909
Clean Energy (CE) production revenue ☐			Benefit-Cost (B-C) ratio		1.8	24	188,896	1,916,805
			Debt service coverage		1	25	198,763	2,115,567
			GHG reduction cost	\$/tCO ₂	33.04	26	208,827	2,324,394
			Energy production cost	\$/kWh	0.14	27	219,092	2,543,486
						28	229,563	2,773,048
						29	240,243	3,013,291
						30	251,136	3,264,427
						31	262,287	3,526,714
						32	273,699	3,799,413
						33	285,378	4,082,791
						34	297,321	4,376,112
						35	309,534	4,679,646
						36	322,013	4,993,659
						37	334,754	5,318,413
						38	347,754	5,653,167
						39	360,999	5,998,166

Figure 17: Financial Analysis – CANYON –Beaverbank extrapolation - 3.39 m3/s at 30%

The ROI of the project is 16.3 Years, and the equity payback is 8.7 years.

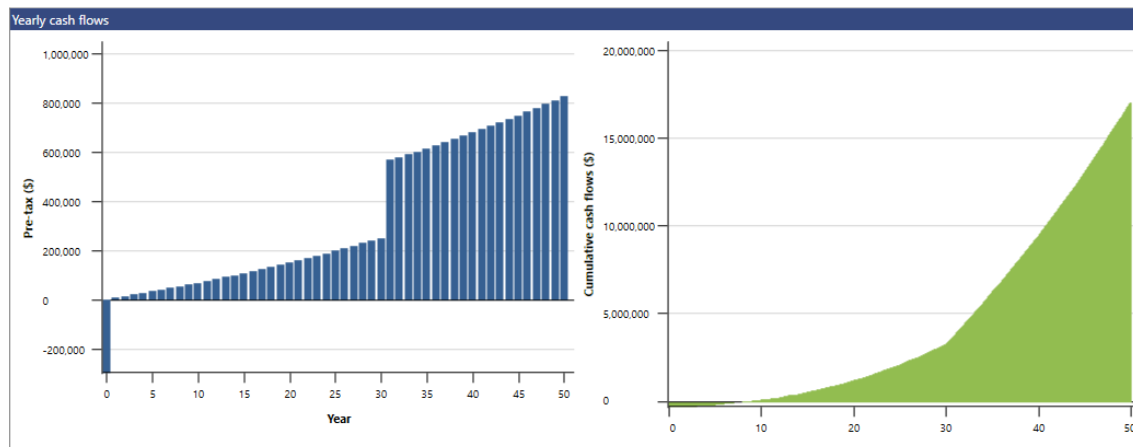


Figure 18: Yearly Cash Flows - CANYON –Beaverbank extrapolation - 3.39 m3/s at 30%



Now, let's see the Cornwallis extrapolated model:

RETScreen - Financial Analysis

Subscriber: Hysovent Limited - Professional

Financial parameters			Costs Savings Revenue			Yearly cash flows		
General			Initial costs			Year	Pre-tax	Cumulative
Fuel cost escalation rate		2%	Initial cost	83%	\$ 4,883,466	#	\$	\$
Inflation rate	%	2%	New Transformer	8.5%	\$ 500,000	0	-294,173	-294,173
Discount rate	%	9%	New Draft tube	8.5%	\$ 500,000	1	-5,089	-299,262
Reinvestment rate	%	9%	Total initial costs	100%	\$ 5,883,466	2	898	-298,364
Project life	yr	50	Incentives and grants		\$ 882,520	3	7,005	-291,358
Finance			Yearly cash flows - Year 1			4	13,234	-278,124
Incentives and grants	\$	882,519.90	Annual costs and debt payments			5	19,588	-258,537
Debt ratio	%	80%	O&M costs (savings)		\$ 67,893	6	26,068	-232,469
Debt	\$	4,706,773	Debt payments - 30 yrs		\$ 304,439	7	32,678	-199,790
Equity	\$	1,176,693	Total annual costs		\$ 372,332	8	39,421	-160,370
Debt interest rate	%	4.95%	Annual savings and revenue			9	46,298	-114,072
Debt term	yr	30	Electricity export revenue		\$ 361,374	10	53,313	-60,760
Debt payments	\$/yr	304,439	GHG reduction savings		\$ 0	11	60,468	-292
Income tax analysis ☐			CE production revenue		\$ 0	12	67,766	67,474
Annual savings and revenue			Total annual savings and revenue		\$ 361,374	13	75,210	142,683
Electricity export revenue			Net yearly cash flow - Year 1			14	82,803	225,486
Electricity exported to grid	MWh	2,756	Financial viability			15	90,548	316,034
Electricity export rate	\$/MWh	131	Pre-tax IRR - equity	%	15.1%	16	98,447	414,481
Electricity export revenue	\$	361,374	Pre-tax MIRR - equity	%	11.7%	17	106,505	520,986
Electricity export escalation rate	%	2%	Pre-tax IRR - assets	%	3.3%	18	114,724	635,710
GHG reduction savings			Pre-tax MIRR - assets	%	5.5%	19	123,107	758,817
Gross GHG reduction	tCO ₂ /yr	1,847	Simple payback	yr	17	20	131,658	890,476
Gross GHG reduction - 50 yrs	tCO ₂	92,342	Equity payback	yr	11	21	140,380	1,030,856
GHG reduction savings	\$	0	Net Present Value (NPV)	\$	699,763	22	149,277	1,180,132
Other revenue (cost) ☐			Annual life cycle savings	\$/yr	63,837	23	158,351	1,338,483
Clean Energy (CE) production revenue ☐			Benefit-Cost (B-C) ratio		1.6	24	167,607	1,506,090
			Debt service coverage		0.98	25	177,048	1,683,137
			GHG reduction cost	\$/tCO ₂	43.43	26	186,677	1,869,815
			Energy production cost	\$/kWh	0.145	27	196,500	2,066,314
						28	206,518	2,272,833
						29	216,738	2,489,570
						30	227,161	2,716,732
						31	242,233	2,958,964
						32	253,077	3,212,041
						33	264,139	3,476,180
						34	275,422	3,751,602
						35	286,930	4,038,532
						36	298,669	4,337,200
						37	310,642	4,647,842
						38	322,855	4,970,697
						39	335,312	5,306,009

Figure 19: Financial Analysis – CANYON –Cornwallis extrapolation - 3.39 m3/s at 30%

The ROI is 17 years and the equity payback is 11 years.

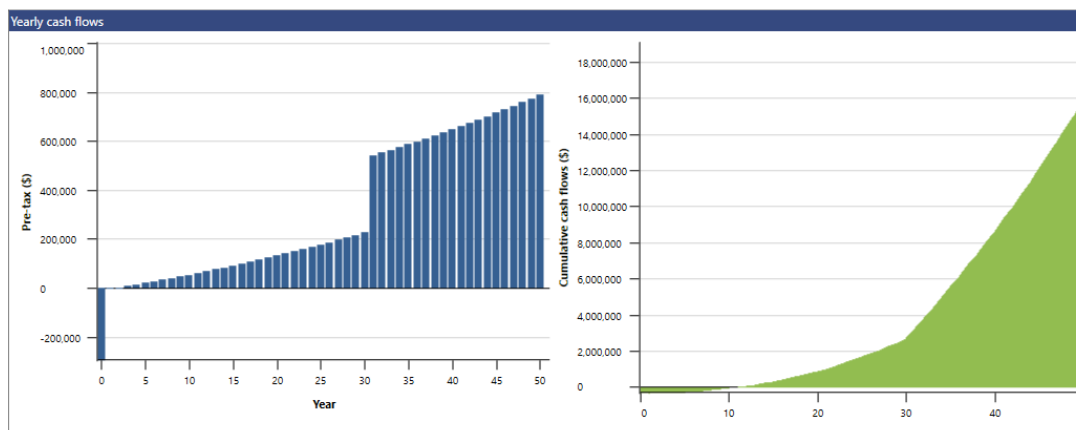


Figure 20: Yearly Cash Flows - CANYON –Cornwallis extrapolation - 3.39 m3/s at 30%



DIVE TURBINEN Option – 616 kW - \$2,500,000 CAD

Dive Turbinen took a little bit more conservative approach, reducing the gross head, and keeping the design flow at 3.398 m³/s.

Hydro turbine - Level 2

Resource assessment

Proposed project: Reservoir

Gross head: m 23.77

Maximum tailwater effect: m 1.8288

Residual flow: m³/s 0

Percent time firm flow available: % 70%

Firm flow: m³/s 3.4

Hydro turbine

Design flow: m³/s 3.398

Type: Francis

Turbine efficiency: User-defined

Number of turbines: 1

Manufacturer: Dive Turbinen

Model:

Design coefficient: 6.1

Efficiency adjustment: % 4.3%

Turbine peak efficiency: % 89.5%

Flow at peak efficiency: m³/s 2.8

Turbine efficiency at design flow: % 85.4%

Figure 21: New Turbine – Dive Turbinen Resource and technical Specs

The results, using the three scenarios on both main flow duration curves are as follows:

Table 3: DIVE TURBINEN unit – results on the three different scenarios of water flow

	Capacity kW	Electricity KWh	Initial costs \$	Electricity export revenue \$	Fuel cost \$	O&M costs (savings) \$	Simple payback Yr
Factorydale - Beaverbank Ext - NEW - 3.39 m ³ /s (10%) - DIVE	613.82	1,286,552.74	\$ 2,500,000.00	\$168,667.06	\$ -	\$55,550.69	22.1
Factorydale - Beaverbank Ext - NEW - 3.39 m ³ /s (30%) - DIVE	613.82	2,570,863.71	\$ 2,500,000.00	\$337,040.23	\$ -	\$55,550.69	8.9
Factorydale - Beaverbank Ext - NEW - 3.39 m ³ /s (70%) - DIVE	613.82	3,965,820.03	\$ 2,500,000.00	\$519,919.01	\$ -	\$55,550.69	5.4
Factorydale - Cornwallis Ext - NEW - 3.39 m ³ /s (10%) - DIVE	613.82	1,243,047.98	\$ 2,500,000.00	\$162,963.59	\$ -	\$55,550.69	23.3
Factorydale - Cornwallis Ext - NEW - 3.39 m ³ /s (30%) - DIVE	613.82	2,468,555.77	\$ 2,500,000.00	\$323,627.66	\$ -	\$55,550.69	9.3
Factorydale - Cornwallis Ext - NEW - 3.39 m ³ /s (70%) - DIVE	613.82	4,070,239.71	\$ 2,500,000.00	\$533,608.43	\$ -	\$55,550.69	5.2



In this case, the results are slightly different. The extreme pessimistic scenario in fact don't look that bad compared to the other units, due to the fact that the cost is lower. In general, the 30% pessimist to realistic scenario is the most favourable one to continue to study.

Let's start with the Beaverbank extrapolated model:

RETScreen - Financial Analysis

Subscriber: Hysovent Limited - Professional

Financial parameters			Costs Savings Revenue			Yearly cash flows		
General			Initial costs			Year	Pre-tax	Cumulative
Fuel cost escalation rate		2%	Initial cost	71.4%	\$ 2,500,000	#	\$	\$
Inflation rate	%	2%	New Transformer	14.3%	\$ 500,000	0	-175,000	-175,000
Discount rate	%	9%	New Draft tube	14.3%	\$ 500,000	1	106,012	-68,988
Reinvestment rate	%	9%	Total initial costs	100%	\$ 3,500,000	2	111,755	42,767
Project life	yr	50	Incentives and grants		\$ 525,000	3	117,612	160,378
Finance			Yearly cash flows - Year 1			4	123,586	283,965
Incentives and grants	\$	525,000	Annual costs and debt payments			5	129,680	413,645
Debt ratio	%	80%	O&M costs (savings)	\$	55,551	6	135,896	549,540
Debt	\$	2,800,000	Debt payments - 30 yrs	\$	181,107	7	142,236	691,776
Equity	\$	700,000	Total annual costs	\$	236,658	8	148,703	840,479
Debt interest rate	%	4.95%	Annual savings and revenue			9	155,299	995,778
Debt term	yr	30	Electricity export revenue	\$	337,040	10	162,027	1,157,805
Debt payments	\$/yr	181,107	GHG reduction savings	\$	0	11	168,890	1,326,694
Income tax analysis			CE production revenue	\$	0	12	175,890	1,502,584
☐			Total annual savings and revenue	\$	337,040	13	183,030	1,685,614
Annual savings and revenue			Net yearly cash flow - Year 1	\$	100,382	14	190,312	1,875,926
Electricity export revenue			Financial viability			15	197,741	2,073,667
Electricity exported to grid	MWh	2,571	Pre-tax IRR - equity	%	65.7%	16	205,318	2,278,984
Electricity export rate	\$/MWh	131	Pre-tax MIRR - equity	%	14.6%	17	213,046	2,492,030
Electricity export revenue	\$	337,040	Pre-tax IRR - assets	%	7%	18	220,929	2,712,960
Electricity export escalation rate	%	2%	Pre-tax MIRR - assets	%	8.2%	19	228,970	2,941,929
GHG reduction savings			Simple payback	yr	10.6	20	237,171	3,179,101
Gross GHG reduction	tCO ₂ /yr	1,722	Equity payback	yr	1.6	21	245,537	3,424,638
Gross GHG reduction - 50 yrs	tCO ₂	86,124	Net Present Value (NPV)	\$	1,917,599	22	254,070	3,678,708
GHG reduction savings	\$	0	Annual life cycle savings	\$/yr	174,937	23	262,773	3,941,481
Other revenue (cost)			Benefit-Cost (B-C) ratio		3.7	24	271,651	4,213,132
☐			Debt service coverage		1.6	25	280,706	4,493,839
Clean Energy (CE) production revenue			GHG reduction cost	\$/tCO ₂	-51.81	26	289,943	4,783,781
☐			Energy production cost	\$/kWh	0.10	27	299,364	5,083,145
						28	308,973	5,392,118
						29	318,775	5,710,892
						30	328,772	6,039,664
						31	520,077	6,559,741
						32	530,478	7,090,220
						33	541,088	7,631,308
						34	551,910	8,183,218
						35	562,948	8,746,166
						36	574,207	9,320,373
						37	585,691	9,906,064
						38	597,405	10,503,469
						39	609,353	11,112,822

Figure 22: Financial Analysis – Dive Turbinen –Beaverbank extrapolation - 3.39 m3/s at 30%

On this case, the ROI is 10.6 years, and the equity payback is 1.6 years.

Figure 23: Yearly Cash Flows – Dive Turbinen –Beaverbank extrapolation - 3.39 m3/s at 30%

Now with the Cornwallis extrapolated model:

RETScreen - Financial Analysis

Subscriber: Hysovent Limited - Professional

Financial parameters				Costs Savings Revenue				Yearly cash flows				
General				Initial costs				Year	Pre-tax	Cumulative		
Fuel cost escalation rate			2%	Initial cost	71.4%	\$	2,500,000	#	\$	\$		
Inflation rate	%		2%	New Transformer	14.3%	\$	500,000	0	-175,000	-175,000		
Discount rate	%		9%	New Draft tube	14.3%	\$	500,000	1	92,331	-82,669		
Reinvestment rate	%		9%	Total initial costs	100%	\$	3,500,000	2	97,800	15,131		
Project life	yr		50	Incentives and grants		\$	525,000	3	103,378	118,510		
Finance				Yearly cash flows - Year 1				4	109,068	227,578		
Incentives and grants	\$		525,000	Annual costs and debt payments				5	114,871	342,449		
Debt ratio	%		80%	O&M costs (savings)				\$	55,551	6	120,791	463,240
Debt	\$		2,800,000	Debt payments - 30 yrs				\$	181,107	7	126,829	590,069
Equity	\$		700,000	Total annual costs				\$	236,658	8	132,988	723,057
Debt interest rate	%		4.95%	Annual savings and revenue								
Debt term	yr		30	Electricity export revenue				\$	323,628	9	139,270	862,326
Debt payments	\$/yr		181,107	GHG reduction savings				\$	0	10	145,677	1,008,004
Income tax analysis				CE production revenue				\$	0	11	152,213	1,160,216
				Total annual savings and revenue				\$	323,628	12	158,879	1,319,096
Annual savings and revenue				Net yearly cash flow - Year 1				\$	86,970	13	165,679	1,484,775
Electricity export revenue				Financial viability								
Electricity exported to grid	MWh		2,469	Pre-tax IRR - equity				%	58.3%	14	172,615	1,657,389
Electricity export rate	\$/MWh		131	Pre-tax MIRR - equity				%	14.3%	15	179,689	1,837,078
Electricity export revenue	\$		323,628	Pre-tax IRR - assets				%	6.6%	16	186,905	2,023,983
Electricity export escalation rate	%		2%	Pre-tax MIRR - assets				%	8%	17	194,265	2,218,249
GHG reduction savings				Simple payback				yr	11.1	18	201,773	2,420,021
Gross GHG reduction	tCO ₂ /yr		1,654	Equity payback				yr	1.8	19	209,430	2,629,452
Gross GHG reduction - 50 yrs	tCO ₂		82,697	Net Present Value (NPV)				\$	1,729,233	20	217,241	2,846,693
GHG reduction savings	\$		0	Annual life cycle savings				\$/yr	157,753	21	225,208	3,071,901
Other revenue (cost)				Benefit-Cost (B-C) ratio					3.5	22	233,334	3,305,235
				Debt service coverage					1.5	23	241,623	3,546,859
Clean Energy (CE) production revenue				GHG reduction cost				\$/tCO ₂	-43.57	24	250,078	3,796,936
				Energy production cost				\$/kWh	0.104	25	258,702	4,055,638
										26	267,498	4,323,136
										27	276,470	4,599,605
										28	285,621	4,885,227
										29	294,956	5,180,183
										30	304,477	5,484,660
										31	495,296	5,979,956
										32	505,202	6,485,158
										33	515,306	7,000,464
										34	525,612	7,526,076
										35	536,124	8,062,200
										36	546,847	8,609,047
										37	557,784	9,166,831
										38	568,939	9,735,770
										39	580,318	10,316,088

Figure 24: Financial Analysis – Dive Turbinen – Cornwallis extrapolation - 3.39 m³/s at 30%

On this case, the ROI is 11.1 years, and the return on equity is 1.8 years.

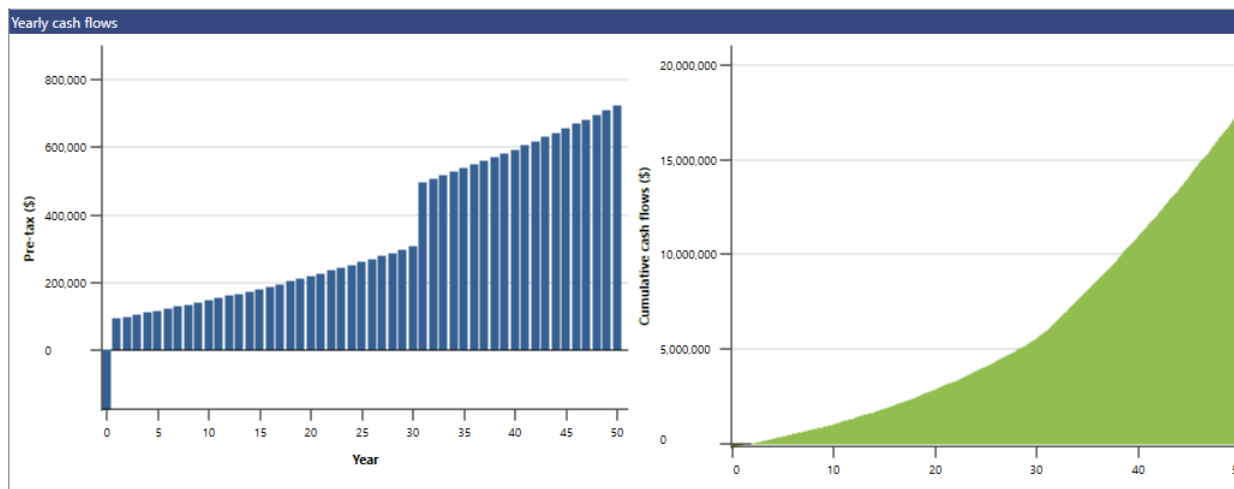


Figure 25: Yearly Cash Flows – Dive Turbinen – Cornwallis extrapolation - 3.39 m3/s at 30%



2.2 Summary – Additional Costed Option Analysis – New units

We ran all the models one by one, added the costs of the draft tube and the transformer (\$1,000,000 in total), and here is the summary of the results:

Table 4: Summary of costs, revenue, ROI and ROE for new units

Option to analyze	Capacity (kW)	Electricity (kWh)	Initial costs CAD	Electricity export revenue CAD	O&M costs (savings) CAD	Simple payback YEARS	Equity Payback YEARS
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (10%) - NORCAN	1,012	1,452,189	\$5,168,750	\$190,382	\$91,656	44.5	49.5
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (30%) - NORCAN	1,012	3,264,446	\$5,168,750	\$427,968	\$91,656	13.1	3.1
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (70%) - NORCAN	1,012	5,669,246	\$5,168,750	\$743,238	\$91,656	6.7	0.65
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (10%) - NORCAN	1,012	1,439,509	\$5,168,750	\$188,719	\$91,656	45.3	49.6
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (30%) - NORCAN	1,012	2,920,921	\$5,168,750	\$382,932	\$91,656	15.1	5.8
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (70%) - NORCAN	1,012	6,131,119	\$5,168,750	\$803,789	\$91,656	6.2	0.56
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (10%) - CANYON	750	1,315,779	\$5,883,466	\$172,498	\$67,892	47.8	+50
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (30%) - CANYON	750	2,857,437	\$5,883,466	\$374,610	\$67,892	16.3	8.7
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (70%) - CANYON	750	4,857,558	\$5,883,466	\$636,825	\$67,892	8.8	1.1
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (10%) - CANYON	750	1,287,308	\$5,883,466	\$168,766	\$67,892	49.6	+50
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (30%) - CANYON	750	2,756,477	\$5,883,466	\$361,374	\$67,892	17	11
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (70%) - CANYON	750	4,999,464	\$5,883,466	\$655,429	\$67,892	8.5	1
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (10%) - DIVE	614	1,286,552	\$3,500,000	\$168,667	\$55,550	26.3	34.3
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (30%) - DIVE	614	2,570,863	\$3,500,000	\$337,040	\$55,550	10.6	1.6
Factorydale - Beaverbank Ext - NEW - 3.39 m3/s (70%) - DIVE	614	3,965,820	\$3,500,000	\$519,919	\$55,550	6.4	0.6
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (10%) - DIVE	614	1,243,047	\$3,500,000	\$162,963	\$55,550	27.7	35.6
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (30%) - DIVE	614	2,468,555	\$3,500,000	\$323,627	\$55,550	11.1	1.8
Factorydale - Cornwallis Ext -NEW - 3.39 m3/s (70%) - DIVE	614	4,070,239	\$3,500,000	\$533,608	\$55,550	7.7	2.7

2.3 Individual option analyses – Like for Like replacements

For the Like for Like option we did a similar approach, simulating what would be the energy and financial model for the three cases already mentioned. Being exactly the same flow duration curves and exactly the same procedure for each case, we will proceed to show only the summary results.

Some important notes about this option:



- There are no additional costs added regarding a new draft tube or a new penstock.
- There is no access to grants for this option, because we are not increasing the renewable energy capacity of the plant.
- A line of credit to cover 50% of the costs, at 8% is added to the study.
- The rest of the parameters remain the same.

Table 5: Summary of costs, revenue, ROI and ROE for like for like replacement

Option to analyze	Capacity (kW)	Electricity (kWh)	Initial costs CAD	Electricity export revenue CAD	O&M costs (savings) CAD	Simple payback YEARS	Equity Payback YEARS
Factorydale - Beaverbank ext - L4L - 3.39 m3/s (10%) - CANYON	416	698,699	\$1,953,000	\$91,599.47	\$75,356.16	120	+50
Factorydale - Beaverbank ext - L4L - 3.39 m3/s (30%) - CANYON	416	1,627,706	\$1,953,000	\$213,392.24	\$75,356.16	14.1	13.4
Factorydale - Beaverbank ext - L4L - 3.39 m3/s (70%) - CANYON	416	2,649,140	\$1,953,000	\$347,302.29	\$75,356.16	7.2	4.8
Factorydale - Cornwallis ext - L4L - 3.39 m3/s (10%) - CANYON	416	687,256	\$1,953,000	\$90,099.27	\$75,356.16	132	+50
Factorydale - Cornwallis ext - L4L - 3.39 m3/s (30%) - CANYON	416	1,550,911	\$1,953,000	\$203,324.44	\$75,356.16	15.3	15.2
Factorydale - Cornwallis ext - L4L - 3.39 m3/s (70%) - CANYON	416	2,725,089	\$1,953,000	\$357,259.12	\$75,356.16	6.9	4.6
Factorydale - Beaverbank ext - L4L - 3.39 m3/s (10%) - NORCAN	416	698,699	\$2,472,500	\$91,599	\$75,356.16	152	+50
Factorydale - Beaverbank ext - L4L - 3.39 m3/s (30%) - NORCAN	416	1,627,706	\$2,472,500	\$213,392	\$75,356.16	17.9	20.1
Factorydale - Beaverbank ext - L4L - 3.39 m3/s (70%) - NORCAN	416	2,649,140	\$2,472,500	\$347,302	\$75,356.16	9.1	6.7
Factorydale - Cornwallis ext - L4L - 3.39 m3/s (10%) - NORCAN	416	687,256	\$2,472,500	\$90,099	\$75,356.16	168	+50
Factorydale - Cornwallis ext - L4L - 3.39 m3/s (30%) - NORCAN	416	1,550,911	\$2,472,500	\$203,324	\$75,356.16	19.3	23
Factorydale - Cornwallis ext - L4L - 3.39 m3/s (70%) - NORCAN	416	2,725,089	\$2,472,500	\$357,259	\$75,356.16	8.8	6.4



CONCLUSION

Once we see the numbers on different flow water duration scenarios, comparing it with the information available from the quotes received, it is even clearer than the best option is to go with a new unit.

The like for like replacement, even though have an ROI and ROE that competes with the new unit when we take the pessimistic to realistic scenario on count, and even the optimistic one, just don't have all the benefits than a new unit brings to the Berwick Electric Commission. And that is part of the analysis as well. A decision for a project like this should not be driven only on the ROI and ROE, but on the several other aspects that an endeavour like this one involves:

- Better and modern equipment
- Increased reliability
- Increased energy output
- Increased efficiency
- Better and more controlled use of water
- Better monitoring
- Training and learning opportunities for employees
- Extend the life of the assets
- Add controllable and dispatchable baseload to the local grid
- Opportunity to sell carbon credits, and renewable energy credits

These, and other benefits, are the ones that should be considered for a decision on projects of this magnitude.