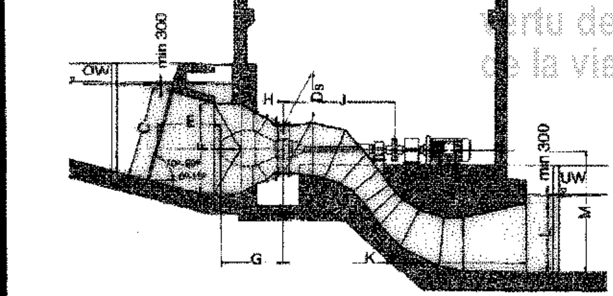

Ontario
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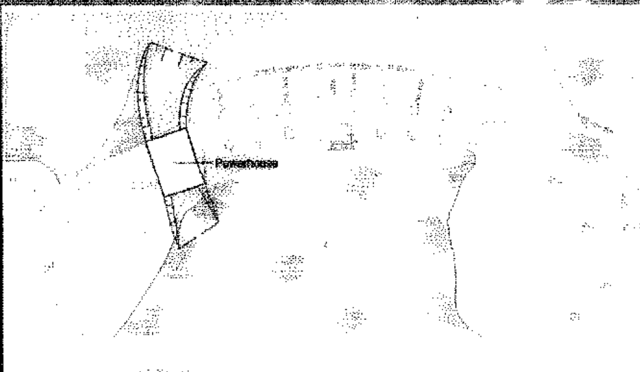
Southcentral Region
Parry Sound District



Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown

Dams in Parry Sound District - Work Package A

May 2000

Acres International

Ontario
Ministry of Natural Resources
Southcentral Region
Parry Sound District

Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown

Dams in Parry Sound District - Work Package A

May 2000

Acres International

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Executive Summary

Executive Summary

A pre-feasibility assessment was undertaken for 10 dams located in the Parry Sound District in order to determine the hydroelectric potential of the sites. The intention of the study was to establish demonstrable potential for hydroelectric generation at some or all of these existing water-retaining structures in order to enhance the opportunities for divestiture.

The results of the studies, assuming a rather conservative estimate of capital cost and a premium rate for green energy, show that a reasonable potential exists at the following damsites.

Dam	Optimum Installed Capacity (MW)	Internal Rate of Return (%)	Net Present Value of Benefit ($)
Baysville	0.50	14.2	1,350,000
Bala North	2.50	10.6	3,650,000
Go Home Lake	3.00	9.3	3,350,000
South River	0.60	10.6	1,050,000
Naiscoot	0.05	12.6	125,000

However, there are uncertainties associated with pricing in the upcoming deregulated market that, in the short to medium term, may discourage investors. To further enhance divestment potential, the following strategies were recommended for consideration.

(a) Individual facilities with, possibly, dam safety improvements completed could be handed over to cottage associations. However, it would be difficult to do this if significant dam safety issues existed. If development costs could be reduced (by providing an upgraded dam with a design life of 25 years or greater at low or no cost), risks would be reduced which could induce divestment. As well, in the deregulated market, development costs for a small hydro scheme might be made back in the initial ±10-yr period of semi-controlled prices with a cooperative operating strategy that allows 'running the meter backwards' (commonly referred to as 'net billing' for small developments/cooperatives) during periods of generation and purchasing power at the going rate when demand exceeds supply.

(b) As a second alternative, a series of upgraded dams could be offered as a portfolio opportunity to the market. The portfolio approach would allow a prospective developer a means of reducing the risks associated with the inevitable price fluctuations that will occur after deregulation, and the chance that premium prices may not be paid for small hydro as they have in other jurisdictions. As well, this approach may allow an individual developer the opportunity to acquire all of the facilities along a given river system thereby maximizing the benefit potential (and again reducing risk).

1 Introduction

1 Introduction

A preliminary analysis was undertaken to establish the feasibility of hydro power generation for 10 damsites located within the Muskoka watershed as shown in Figure 1.1. The intention of the study was to establish demonstrable potential for hydroelectric generation at some or all of these existing water-retaining structures in order to enhance the opportunities for divestiture.

At four of the damsites, data collected in the preliminary phases of the assessment indicated that, due to various extraneous factors, hydro development would not be economic. These factors are summarized as follows.

Burk's Falls Dam
There is an existing power generation facility at this dam

Noganosh Dam
The Noganosh Dam is a remote site that would require extensive access improvements, and is distant from the electrical grid which would result in high transmission line construction costs.

Dollars Dams
The small drainage basin at the Dollars dams, combined with a relatively remote location (and associated access and transmission costs) would render a hydro development uneconomic.

Kawagama
The Kawagama Dam has similar drawbacks to the Dollars dams. In addition, it is situated in a sensitive fishery which would further drive up development costs.

For these reasons, these damsites were eliminated from further consideration. At the remaining six sites,

- Baysville Dam
- South River Dam
- Naiscoot Dam
- Bala North Dam

- Bala South Dam
- Go Home Lake Dam,

the preliminary screening phase of the study indicated that hydro development may be feasible and detailed analyses were performed.

These analyses were undertaken using available information, hydrotechnical and layout details for the sites, and additional information obtained during site inspections performed in the fall of 1999. The work involved a preliminary screening assessment of all of the sites followed by determination of average flows and energy generation potential using Acres HYDRO 180 computer model and operating rule curves for the reservoirs (where curves were available). Economic analyses were then performed to provide an indication of the optimum installed capacity and rate of return.

The results of the analyses are summarized herein.

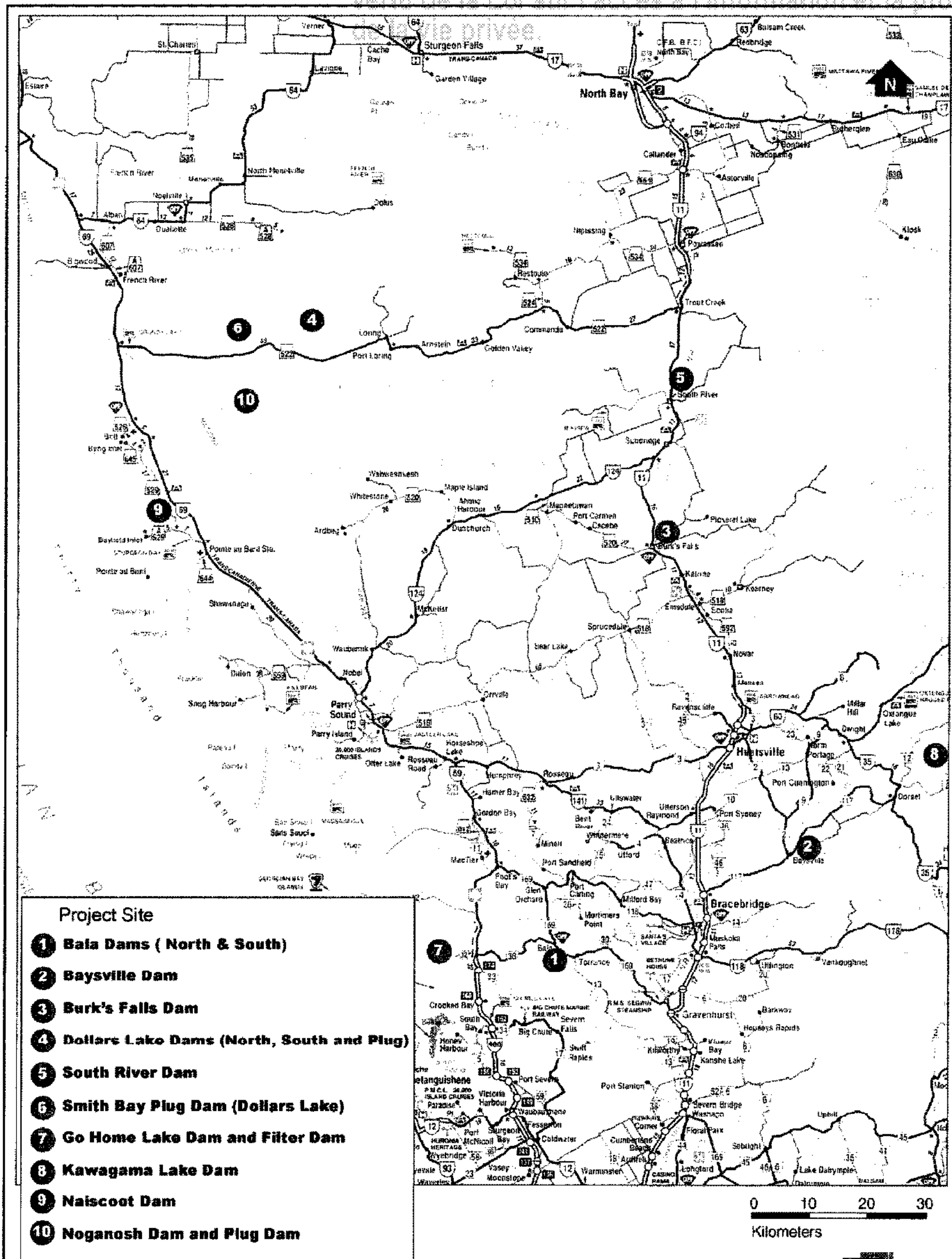


Figure 1.1
Ministry of Natural Resources
Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown
Location of Dams

ACRES

2 Study Approach and Inputs

2 Study Approach and Inputs

2.1 Power and Energy Calculations

A preliminary optimization was carried out at each of the six sites identified for evaluation. The installed capacity was derived based on the following equation:

$$I.C. = 9.81 \times Q \times H \times e$$

where,

I.C.	=	installed capacity (kW)
Q	=	design (or rated) flow (m^3/s)
H	=	design head (m)
e	=	combined turbine/generator efficiency.

The various input data required to assess the generation potential at each of the sites were established as follows.

Flow
The available flows were determined from Environment Canada hydrometric gauging station records that were generally available for gauges located at or near the dams. In the case of the South River and Naiscoot Dams, where the gauges were located at some distance from the sites, flow data was established by prorating based on drainage areas. These flow records represent between 35 and 58 years of data, which is considered to be a good data record for the purposes of evaluating small hydro.

Head
The generation head available at each of the dams was taken from available drawings and surveys (gross head). To determine the net head available for generation, a nominal 2% head loss was used to account for anticipated entrance and trashrack losses.

Efficiency

A combined turbine/generator efficiency of 0.8 was adopted to approximate an anticipated average turbine efficiency of 90% and a generator efficiency of 90%.

These data were then input into Acres HYDRO 180 model to estimate the annual energy yield recognizing the seasonal reservoir operating levels and the rudimentary reservoir storage parameters.

2.2 Economic Evaluations (Costs and Benefits)

Revenues were based on energy sales only (i.e., no capacity benefit) using an assumed energy rate of $0.58/kW·h. The Grand River Conservation Authority (GRCA), in an evaluation of the hydro potential of their Parkhill dam, recently determined that this was a reasonable assumed energy rate for small hydro developments on the basis that there would be a premium available for 'green power' in the future deregulated market. The results of the energy calculations based on this energy benefit and the results of the Acres HYDRO 180 model were then tabulated for each of the damsites allowing annual benefits (energy revenues) to be determined.

Capital costs for each of the potential generation sites were approximated using direct ratios for costs (i.e., cost per installed kilowatt) adjusted as necessary for the specifics of the layout for each site. In general, a budget project cost of $3,000/kW was adopted except at South River where the provision of a lengthy penstock raised this value to $3,500/kW and at Go Home Lake where anticipated rock excavation and access issues increased the costs to $3,200/kW. These values are in-line with published estimates for capital costs of small hydro developments for the purposes of relative ranking and pre-feasibility level assessments.

A preliminary economic evaluation was then carried out to establish basic screening parameters as follows.

- **Internal Rate of Return (IRR)** - determines the discount rate that results in the project's net present value (NPV) being zero. The screening decision criterion is to reject projects whose IRR is less than the expected cost of financing.

- **Benefit/Cost Ratio (B/C)** - compares the present value of future cash inflows (benefits) against the present value of the initial and all subsequent cash flows (costs). The decision rule is to reject projects that have B/C ratios of less than one.

- **Net Present Value (NPV)** - determines the present value of the future stream of net benefits. The screening decision criterion is to reject the project if the NPV is less than or equal to zero.

These analyses were undertaken to evaluate the present value of costs and benefits over a 30-yr project life with an assumed discount rate of 6%. Estimated operation and maintenance costs are also accounted for in the analysis. These costs were derived on the basis of precedent experience for small hydro facilities with consideration for site-specific issues that could affect costs. Other considerations such as water leases, sales taxes, business taxes, depreciation, municipal taxes and financing costs are intentionally excluded from the evaluations since these, to varying degrees, are specific to the Owner's unique situation.

These economic analyses are the primary tool for initial optimizations to select the preferred installed capacities. In such studies, the NPV is used as the primary screening parameter.

2.3 Generation Equipment

There are a variety of equipment options available for generating hydroelectric power at the selected sites. At this preliminary study stage, and for consistency, a modern 'S type' turbine was adopted for the sake of comparative evaluations and optimizations. This type of installation involves a propeller turbine that can have a horizontal or inclined axis depending upon site characteristics. It is a typical and popular choice for small hydro developments. A plan and cross section of a typical powerhouse arrangement is shown in Figure 2.1.

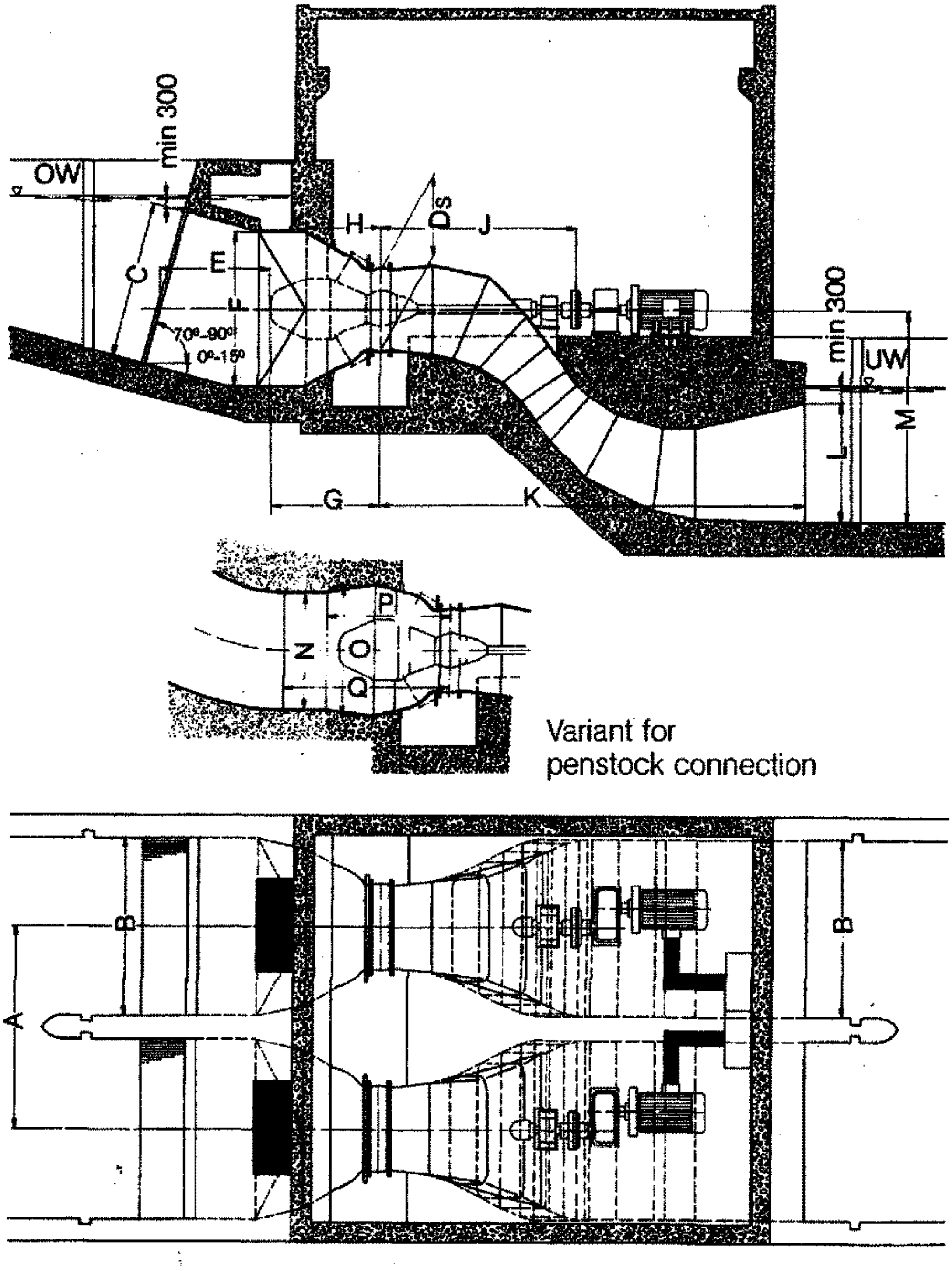


Figure 2.1
Ministry of Natural Resources
Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown
S-Type Turbine

after Voith Hydro Inc.

3 Baysville Dam

3 Baysville Dam

3.1 Description of the Watershed

The Baysville Dam is located in the village of Baysville on the South Muskoka River at the outlet of Lake of Bays. The dam controls a total watershed area of 1481 km^2. The lake surface area of the Lake of Bays is 68.4 km^2.

Upstream of the dam, there are two other existing dams that control the inflow to Lake of Bays

- Tea Lake Dam located on the Oxongue River that has a controlled drainage area of 344 km^2
- Kawagama Dam located on the Hollow River that has a controlled drainage area of 380 km^2.

3.2 Flow Records

Station 02EB008, located immediately downstream of the Baysville Dam, has long-term flow records for the 55-yr period from 1941 to 1995. These records were analyzed to compute the mean annual energy production for the site.

The mean annual flow was determined to be 23 m^3/s and was found to vary from 10.0 m^3/s in August to 40.8 m^3/s in April. For the purposes of this analysis, the available flow records were used to estimate the power and energy of the plant. The monthly mean flows for the site are summarized in Table 3.1. The daily flow duration curve is shown in Figure 3.1.

3.3 Estimation of Potential Energy Development

The normal operating water level of the Lake of Bays is 315.24 m with an average tailwater level of 312.10 m. Hence, the gross design head is 3.1 m. Using this head, and the available flow data, Acres HYDRO 180 program was used to estimate the installed capacity and potential energy. The daily flow data recorded at Station 02EB008 (Lake of Bays outflow) was used as input flow to the reservoir. (From the point of view of annual total flow volume, this treatment is sufficiently accurate although the time distribution may be slightly different.) The

Table 3.1
Baysville - Station 02EB008
Monthly Mean Flow Data

Station : 02EB008 SOUTH BRANCH MUSKOKA RIVER AT BAYSVILLE Prov-Terr-State : ON
Latitude:45°8'50"N Longitude:79°6'50"W
Region : Guelph Drainage Area : 1390 (km²) Parameter : Flow (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1941	-------	-------	-------	-------	-------	-------	-------	-------	12.4	9.35	14.5	19.2	-------
1942	13.2	14.0	24.5	45.5	44.8	24.6	12.7	11.7	12.1	11.4	18.3	21.8	21.2
1943	17.9	27.4	35.2	33.4	91.5	24.0	16.6	16.5	14.4	16.6	13.8	15.7	27.0
1944	17.7	15.4	10.8	10.9	16.9	11.5	11.0	12.0	12.4	13.9	16.1	19.7	14.0
1945	15.2	13.9	27.3	32.6	31.[illegible]	31.9	14.1	13.2	12.6	14.6	16.8	19.1	20.2
1946	25.2	36.2	39.4	19.0	11.9	14.9	14.1	13.2	11.5	10.6	11.6	15.2	18.5
1947	20.3	28.3	33.5	60.5	85.4	45.0	16.4	14.5	13.7	11.9	11.5	11.6	29.4
1948	11.9	12.6	29.7	61.0	32.5	17.8	12.7	15.0	10.9	8.74	13.5	21.8	20.7
1949	22.5	35.7	33.4	66.9	21.9	13.9	13.4	13.5	11.1	8.41	6.07	9.80	21.2
1950	37.7	43.5	27.1	32.7	24.7	11.5	10.0	11.4	12.1	9.98	10.7	18.8	20.7
1951	23.6	25.6	31.2	92.9	62.5	10.1	9.55	9.33	8.37	9.10	36.7	36.5	29.6
1952	29.3	26.7	24.7	59.2	29.2	18.3	9.75	9.89	12.8	12.0	7.72	11.9	20.9
1953	13.1	23.6	47.3	46.0	22.5	12.4	12.0	15.0	11.2	6.88	6.18	5.83	18.5
1954	8.64	13.8	33.3	50.5	23.4	24.7	7.63	9.96	15.5	54.3	33.7	15.5	24.3
1955	20.8	35.8	24.5	56.5	18.2	7.38	7.08	7.46	5.88	7.49	20.7	10.7	18.4
1956	14.3	23.5	23.8	16.0	44.4	22.1	28.3	12.5	21.2	21.1	14.3	20.1	21.8
1957	19.9	31.6	29.6	24.4	10.6	21.4	67.8	13.7	17.6	12.3	39.2	43.8	27.6
1958	49.0	28.8	26.4	12.3	2.91	6.89	9.29	10.4	13.4	12.4	15.2	20.0	17.2
1959	15.7	23.1	29.2	43.9	49.3	15.3	9.90	12.1	15.5	15.2	35.6	31.8	24.7
1960	25.4	24.0	25.6	72.0	49.2	19.9	19.7	11.5	26.6	10.7	13.6	12.3	25.8
1961	10.5	12.5	19.6	27.1	23.0	15.1	15.4	12.3	12.3	14.3	8.94	10.8	15.2
1962	14.2	24.0	14.1	18.9	15.8	4.21	2.91	6.36	10.9	22.4	9.13	15.4	13.1
1963	14.9	12.6	16.4	27.8	28.3	13.0	4.24	9.18	17.2	16.9	13.0	17.0	15.9
1964	17.2	22.4	18.2	10.8	18.8	7.84	4.28	5.35	10.6	13.3	9.32	14.5	12.7
1965	26.9	23.6	22.2	26.6	45.7	7.25	4.67	10.7	28.2	62.0	30.2	57.7	28.9
1966	33.0	27.6	29.7	34.5	21.2	18.4	6.96	6.68	12.5	14.7	35.3	65.6	25.5
1967	29.6	33.5	28.9	42.8	14.1	29.2	20.0	13.3	26.8	32.9	62.8	29.9	30.2
1968	28.7	41.7	32.6	22.6	4.68	3.50	8.02	12.6	22.5	15.5	6.11	16.3	17.8
1969	21.2	24.1	31.0	38.6	45.6	17.9	12.3	8.56	10.4	18.8	27.5	23.7	23.3
1970	20.2	22.2	22.3	28.3	43.6	13.8	49.9	20.4	11.2	30.9	21.3	25.6	25.9
1971	19.7	27.3	36.1	47.5	33.6	11.1	5.18	5.79	13.2	7.55	8.36	10.4	18.7
1972	19.2	24.0	31.6	40.1	64.3	18.5	26.1	31.9	16.0	24.7	31.9	21.8	29.2
1973	29.5	40.9	57.3	58.8	34.7	31.9	17.6	16.5	15.9	16.8	10.7	25.5	29.6
1974	25.9	33.3	40.6	57.1	64.7	19.7	7.64	6.83	12.3	26.1	28.4	22.5	28.7
1975	20.3	23.1	40.1	35.5	31.5	4.62	3.38	5.06	13.8	20.1	10.4	32.0	20.0
1976	25.0	27.6	50.5	69.1	24.0	8.49	18.6	6.31	6.18	11.8	8.17	12.9	22.4
1977	15.4	13.8	41.5	38.7	13.9	4.04	3.04	3.29	14.4	33.7	24.1	27.5	19.5
1978	29.7	19.5	27.7	25.1	53.4	11.3	3.97	6.32	19.7	25.6	14.7	21.4	21.6
1979	21.5	30.7	50.1	57.4	44.7	15.8	5.09	9.52	22.1	28.3	43.1	40.1	30.6
1980	30.2	25.1	23.0	78.5	20.6	22.5	17.0	22.8	24.3	33.9	30.3	24.3	29.3
1981	20.9	37.1	52.6	31.8	22.3	13.6	5.24	3.96	61.8	37.5	14.6	16.7	26.4
1982	16.3	27.7	31.1	55.3	25.3	14.9	10.3	6.62	11.2	15.6	40.2	61.8	26.3
1983	44.3	28.9	34.6	21.5	65.8	23.1	4.88	2.32	6.58	21.6	17.0	28.1	24.9

Table 3.1
Baysville - Station 02EB008
Monthly Mean Flow Data

Canadian Hydrological Data (c)1997 Environment Canada
Station : 02EB008 SOUTH BRANCH MUSKOKA RIVER AT BAYSVILLE Prov-Terr-State : ON
Latitude:45°8'50"N Longitude:79°6'50"W
Region : Guelph Drainage Area : 1390 (km²) Parameter : Flow (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1984	21.9	44.1	44.6	37.1	30.6	27.9	13.2	4.27	14.5	18.6	17.9	23.9	24.8
1985	47.9	31.3	58.4	75.9	39.4	14.3	6.23	7.16	35.0	21.0	23.5	22.5	31.8
1986	23.3	25.8	32.7	40.2	23.8	24.3	7.31	9.32	24.9	37.9	12.6	11.7	22.8
1987	13.6	22.8	27.4	25.0	9.32	9.85	4.72	1.34	1.92	13.4	10.4	27.9	13.9
1988	22.0	32.8	30.3	57.5	28.3	6.70	2.10	1.84	11.5	20.7	27.0	18.2	21.5
1989	20.9	18.6	39.4	-------	35.0	28.1	11.8	-------	-------	12.4	9.65	-------	-------
1990	17.7	28.4	45.1	41.1	27.5	14.7	3.62	2.70	6.23	24.3	24.3	46.3	23.5
1991	29.4	20.1	43.1	66.9	14.4	11.0	2.95	2.18	11.7	19.1	22.0	37.1	23.3
1992	23.5	21.4	34.9	34.9	21.4	5.70	7.29	12.5	40.6	34.3	67.7	37.3	28.4
1993	31.7	32.5	21.3	34.6	15.0	32.5	21.6	1.95	22.8	53.8	38.4	39.1	28.7
1994	19.7	16.3	24.3	8.20	30.0	24.7	17.0	11.2	18.8	11.1	39.8	34.6	21.3
1995	41.6	36.1	40.1	11.3	34.6	-------	-------	-------	-------	-------	-------	-------	-------
Mean	23.1	26.2	32.4	40.8	32.3	16.7	12.4	10.0	16.2	20.2	21.4	24.6	23.0
Maximum	49.0	44.1	58.4	92.9	91.5	45.0	67.8	31.9	61.8	62.0	67.7	65.6	31.8
Minimum	8.64	12.5	10.8	8.20	2.91	3.50	2.10	1.34	1.92	6.88	6.07	5.83	12.7

A - Manual Gauge
D - Dry
R - Revised within the last two years
T - Revised (and Ice Condition)
W - Revised (and Estimated)
* - Asterik-occurs more than once
P - Partially Dry

B - Ice Conditions
E - Estimated
S - Revised (and Manual Gauge)
V - Revised (and Dry)
- no symbol
d - Complete and Some Dry

operating rule curve for Baysville Dam reservoir developed by the Ministry of Natural Resources (MNR) was applied to determine the flow release policies in the daily operation. The preliminary estimate of potential installed capacity, on the basis of head and flow, is about 0.6 MW. To bracket this preliminary estimate, annual energy and incremental annual energy benefits were determined for installed capacities ranging from 0.25 MW to 1.5 MW as detailed in Table 3.2.

Baysville Plant Power and Energy Estimates						
Installed Capacity (MW)	Rated Flow (m^3/s)	Average Annual Power Flow (m^3/s)	Average Annual Spill (m^3/s)	Average Total Energy (GW·h/yr)	Estimated Annual Revenue ($/yr)	Incremental Annual Revenue ($/yr)
0.25	10.5	7.9	15.0	2.2	127,600	0
0.50	21.0	14.8	8.2	3.8	220,400	92,800
0.75	31.5	19.3	3.7	4.6	266,800	46,400
1.00	41.9	21.5	1.4	4.9	284,200	17,400
1.25	52.4	22.3	0.6	5.0	290,000	5,800
1.50	62.9	22.7	0.2	5.0	290,000	0

Table 3.2

Gross Design Head = 3.1 m Assumed Energy Value = $0.058/kW·h

3.4 Layout Considerations

All spillway bays are required for spilling high flood flows, and accordingly, any power facilities would have to be located to the immediate left or right of the main spillway. Rock excavation will be required in both the approach and tailrace channels. A potential powerhouse location is depicted in Figure 3.2.

3.5 Optimum Installed Capacity

Using capital costs estimated on the basis of the above considerations and the energy benefits established in Table 3.2, economic analysis would indicate an optimum installed capacity of about 0.5 MW as summarized in Table 3.3.

Table 3.3

Baysville Economic Evaluation

Installed Capacity (MW)	Average Power Flow (m^3/s)	Rated Flow (m^3/s)	Average Spill Flow (m^3/s)	Estimated Annual Energy (MW.h)	Plant Factor	Estimated Annual Revenue ($)	Approx. Capital Cost at $3,000/kW ($)	IRR (%)	B/C	NPV ($)
0.25	7.9	10.5	15	2200	1.00	127,600	750,000	17.0	2.05	922,277
0.50	14.8	21.0	8.2	3800	0.87	220,400	1,500,000	14.2	1.78	1,354,119 <= choose
0.75	19.3	31.5	3.7	4600	0.70	266,800	2,250,000	10.7	1.43	1,132,067
1.00	21.5	41.9	1.4	4900	0.56	284,200	3,000,000	7.6	1.14	501,519
1.25	22.3	52.4	0.6	5000	0.46	290,000	3,750,000	5.2	0.93	(292,477)
1.50	22.7	62.9	0.2	5000	0.06	290,000	4,500,000	3.3	0.85	(805,433)

Gross Head = 3.1 m
Assumed Energy Value = $0.058/kW.h

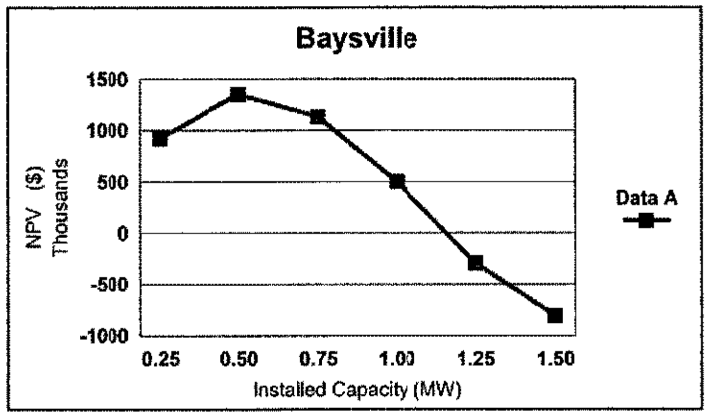
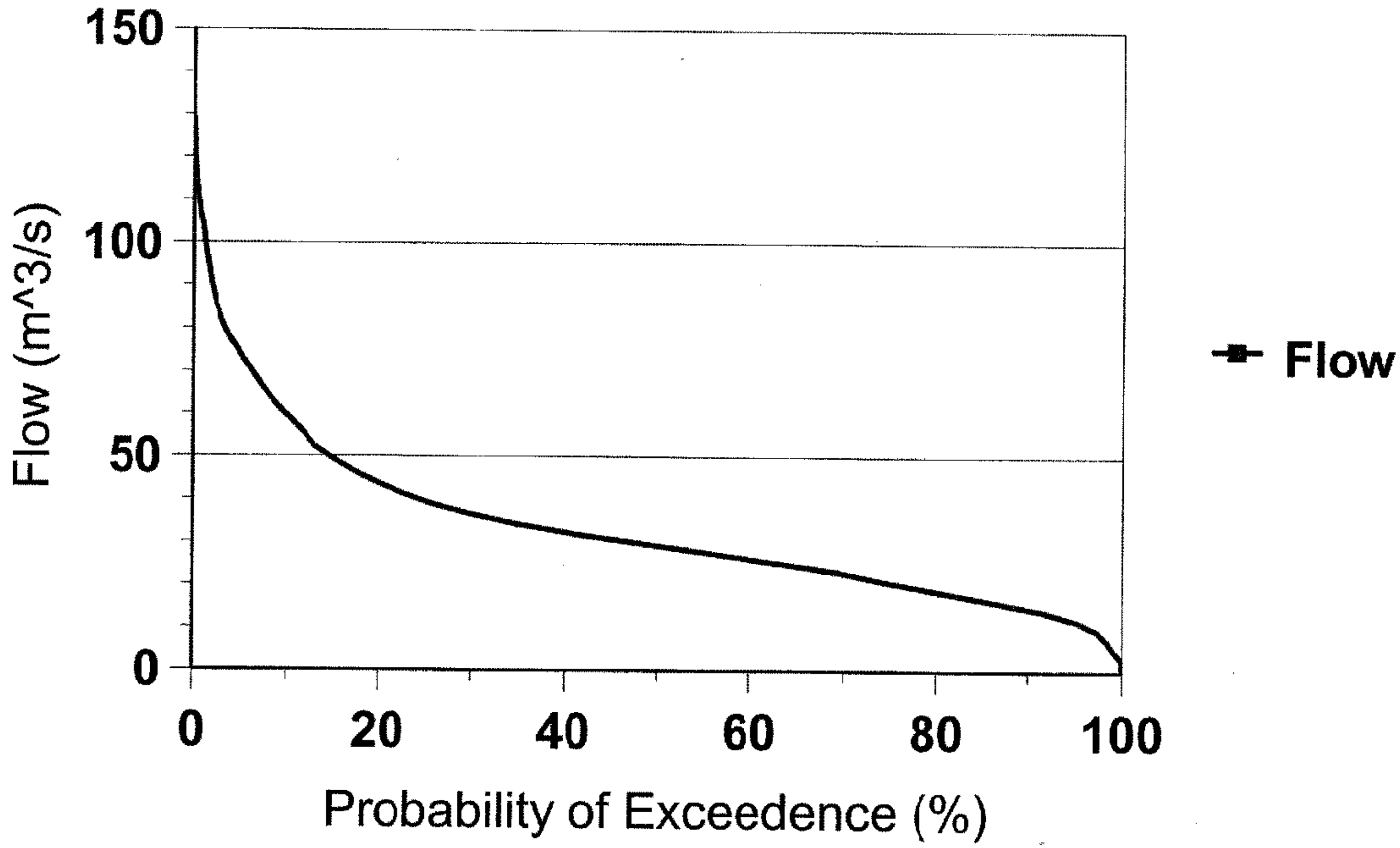


Figure 3.1 - Flow Duration Curve, 02EB008
Below Baysville Dam



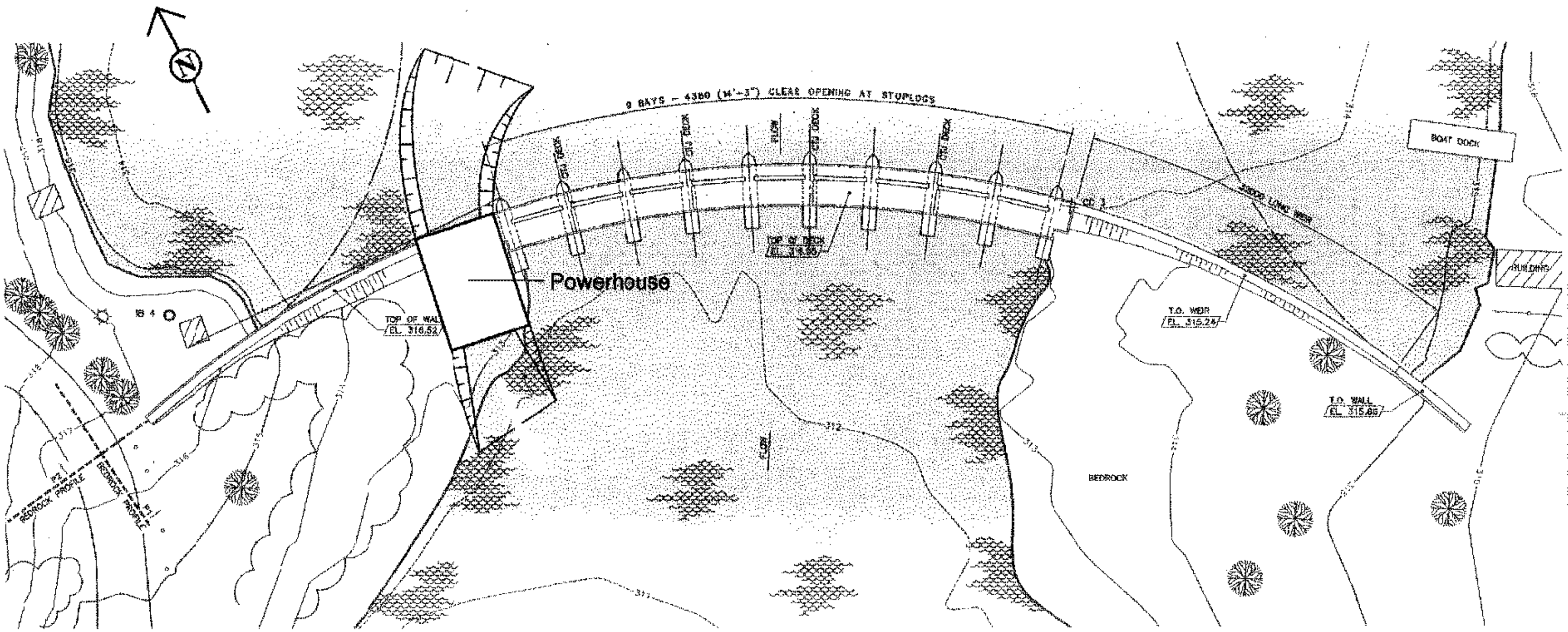


Figure 3.2
Ministry of Natural Resources
Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown
Conceptual Hydro Layout at Baysville Dam

ACRES

4 Bala Dams

4 Bala Dams

4.1 Description of the Watershed

The Bala dams (Bala North Dam and Bala South Dam) are located at the outlet of Lake Muskoka in the community of Bala for the purpose of controlling water levels and flow releases from the lake. Since these dams are in such close proximity, they were evaluated as one development for the purposes of this study.

There are three major inflows systems entering the lake

- the watershed upstream of Baysville Dam
- the North Muskoka River upstream of Port Sydney, and
- Port Carling, which controls the drainage area of Lake Joseph and Lake Rosseau.

The total area is 12 023 km^2 with local drainage area controlled by the dams of about 4683 km^2. The South Muskoka River, controlled by the Baysville Dam, was described in Section 3. There is a small 130-kW hydroelectric development on Mill Creek adjacent to the Bala South Dam in the town of Bala.

4.2 Flow Records

Gauging Station 02EB008, that was described previously in Section 3, records the flow from the South Muskoka River subsystem. Flow from the North Muskoka River subwatershed is monitored by Station 02EB004 downstream from the Port Sydney Dam. However, since there are no hydrometric stations on the Port Carling subsystem, accurate estimates for the inflow to Muskoka Lake cannot be made directly. However, downstream of the Bala dams, Station 02EB006 does have a long-term flow record. The mean annual flow for this station is a good indicator of the total flow into Muskoka Lake (although the time distribution may be different from the inflow hydrograph due to the storage routing effects). For the purpose of the present analysis, Station 02EB006 is considered to be sufficiently accurate for estimating annual power and energy production, and was used for the estimates. The mean flow pattern of 02EB006 is summarized in Table 4.1. The daily flow duration curve is presented in Figure 4.1.

Table 4.1
Bala - Station 02EB006
Monthly Mean Flow Data

Canadian Hydrological Data (c)1997 Environment Canada
Station : 02EB006 MUSKOKA RIVER BELOW BALA Prov-Terr-State : ON
Latitude:45°1'23"N Longitude:79°40'25"W
Region : Guelph Drainage Area : 4770 (km²) Parameter : Flow (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1937	-------	-------	-------	-------	-------	-------	19.8	25.0	24.1	38.1	112	84.3	-------
1938	44.0	48.9	140	272	95.1	71.3	20.9	18.1	34.4	44.7	53.5	61.8	75.2
1939	48.5	54.0	89.3	155	241	30.9	26.5	30.1	36.0	35.2	42.7	34.4	68.8
1940	37.3	35.7	36.0	67.4	150	73.1	28.7	32.2	57.3	54.2	38.6	93.2	61.2
1941	84.3	62.8	61.8	163	86.2	21.9	21.4	19.6	16.4	26.8	101	88.9	62.7
1942	86.0	58.6	92.4	189	135	80.5	28.2	23.6	14.9	46.3	103	87.2	78.6
1943	67.2	75.4	104	163	290	74.0	43.3	40.1	29.1	25.7	39.6	49.8	83.6
1944	40.5	48.3	47.1	88.5	95.9	41.2	38.5	34.2	27.7	40.2	57.4	64.8	52.0
1945	48.5	41.3	138	149	113	95.1	42.3	27.9	26.9	35.1	61.5	67.5	70.6
1946	81.0	102	166	103	69.9	54.1	25.4	14.0	16.1	23.5	22.1	55.7	60.8
1947	70.6	78.5	115	232	263	128	37.7	40.0	22.4	24.4	22.5	37.6	89.3
1948	42.0	57.7	116	253	92.6	54.8	27.6	21.4	16.9	18.7	61.3	79.1	69.8
1949	82.7	109	121	259	73.7	43.2	39.9	19.4	11.1	19.0	19.7	60.3	71.1
1950	182	137	72.2	138	83.2	36.4	22.6	17.5	16.9	19.2	41.7	95.1	71.4
1951	85.2	60.2	112	317	187	25.8	28.7	25.8	22.8	53.6	153	123	99.5
1952	112	78.5	67.9	211	99.0	46.5	26.9	24.1	46.2	26.0	45.1	101	73.5
1953	69.4	64.3	132	156	77.6	38.0	28.6	18.8	17.4	20.1	19.4	57.9	58.3
1954	52.1	55.8	133	170	94.7	68.9	23.6	20.1	43.9	176	118	73.0	85.9
1955	54.1	71.7	74.4	192	60.1	18.6	14.8	12.8	11.5	23.3	86.6	43.0	54.9
1956	42.4	46.0	69.7	78.3	164	82.4	68.2	21.7	57.3	51.6	45.7	78.4	67.3
1957	74.8	88.1	101	100	32.1	56.1	171	15.4	65.5	48.9	132	150	86.1
1958	133	79.1	85.7	65.5	8.06	15.3	27.8	17.3	34.5	45.4	58.9	61.0	52.5
1959	45.0	81.6	91.0	196	170	43.5	18.4	26.3	37.3	48.0	117	108	81.7
1960	85.2	70.6	77.1	260	200	61.6	57.0	29.2	28.2	28.3	54.3	42.5	82.7
1961	44.4	35.4	81.9	129	92.4	36.9	35.7	27.3	28.7	20.8	24.0	45.4	50.2
1962	52.2	80.8	64.6	108	69.7	16.6	6.79	10.6	15.2	36.3	26.5	42.6	43.9
1963	53.7	46.5	51.7	132	110	33.3	11.1	20.0	35.3	29.0	34.3	63.6	51.7
1964	56.3	79.9	83.0	53.6	76.7	15.2	8.58	10.9	25.8	32.0	21.8	58.8	43.5
1965	89.9	90.7	83.6	139	129	12.8	11.9	24.5	60.3	161	89.8	162	88.1
1966	111	78.8	105	81.7	55.8	44.3	12.2	8.86	20.1	28.6	117	240	75.3
1967	96.3	99.5	91.3	202	52.8	95.8	51.9	29.9	58.7	96.7	222	125	101
1968	101	121	115	111	26.3	18.8	26.7	30.3	51.6	33.7	35.0	77.6	62.1
1969	71.6	85.8	91.4	164	153	70.2	39.1	16.4	28.4	42.9	118	82.5	80.1
1970	71.1	68.4	70.0	135	136	34.9	106	50.6	37.9	86.3	89.7	88.7	81.5
1971	73.3	81.6	130	189	132	29.8	20.5	16.9	27.0	20.1	32.0	70.6	68.5
1972	81.5	85.3	94.6	176	170	47.5	58.3	72.8	46.4	57.5	103	88.5	90.1
1973	106	134	210	198	120	98.7	47.7	45.1	28.0	47.2	67.8	100	100
1974	85.3	105	150	203	203	52.5	25.6	16.5	42.5	97.0	117	95.6	99.4
1975	72.2	81.8	145	154	133	12.9	9.29	15.3	42.7	42.9	37.5	128	73.0
1976	87.5	93.3	168	233	88.3	32.3	42.3	17.5	22.5	22.2	34.4	79.8	76.6
1977	52.8	55.9	154	161	44.8	6.76	19.5	14.0	52.5	124	112	112	75.8
1978	97.6	74.6	70.2	113	142	50.3	14.3	16.7	49.4	69.3	60.9	84.7	70.2
1979	84.7	91.5	166	239	149	43.2	14.8	22.0	39.3	75.4	117	151	99.3

Table 4.1
Bala - Station 02EB006
Monthly Mean Flow Data

Canadian Hydrological Data (c)1997 Environment Canada
Station : 02EB006 MUSKOKA RIVER BELOW BALA Prov-Terr-State : ON
Latitude:45°1'23"N Longitude:79°40'25"W
Region : Guelph Drainage Area : 4770 (km^2) Parameter : Flow (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1980	112	82.2	88.7	258	77.5	68.1	59.8	58.2	72.9	118	117	92.0	100
1981	76.0	109	184	129	75.8	48.5	20.4	9.39	196	107	62.7	68.9	90.2
1982	68.5	79.7	96.6	199	92.0	65.4	24.3	15.2	41.4	63.9	121	205	89.2
1983	156	110	130	87.3	203	78.5	16.1	5.34	20.5	62.7	51.2	98.9	85.0
1984	83.6	136	154	161	84.8	92.6	40.2	11.6	35.7	44.2	77.8	103	85.1
1985	167	102	172	252	167	43.0	39.8	32.4	119	111	117	108	119
1986	90.0	96.9	111	192	83.8	73.5	29.2	29.2	57.9	134	48.5	75.1	84.9
1987	52.9	70.7	94.4	117	24.4	24.5	17.1	4.92	5.36	28.2	33.8	109	48.3
1988	95.1	116	115	200	92.6	23.7	4.17	8.92	34.8	71.4	140	77.6	81.2
1989	78.3	76.7	119	200	117	92.0	21.7	6.65	15.3	28.9	39.8	84.2	73.1
1990	78.4	112	149	165	94.3	48.3	12.3	10.6	8.24	83.1	90.1	156	83.7
1991	111	81.0	157	254	71.4	34.6	10.0	8.79	23.6	62.7	84.3	144	86.8
1992	86.0	73.9	127	150	75.3	13.0	28.6	29.9	111	123	231	149	99.7
1993	124	89.5	67.1	137	59.6	101	75.6	15.1	51.8	141	120	106	90.6
1994	72.6	60.5	80.7	71.1	103	73.8	76.7	34.2	49.8	44.4	119	124	75.9
1995	141	121	113	68.4	141	53.8	39.7	39.2	41.7	62.8	205	119	95.3
1996	96.3	138	124	160	151	71.4	61.1	43.7	50.6	62.0	134	100	99.0
Mean	82.1	82.2	109	164	113	51.2	33.8	23.4	39.4	57.4	81.8	93.6	77.6
Maximum	182	138	210	317	290	128	171	72.8	196	176	231	240	119
Minimum	37.3	35.4	36.0	53.6	8.06	6.76	4.17	4.92	5.36	18.7	19.4	34.4	43.5

A - Manual Gauge
D - Dry
R - Revised within the last two years
T - Revised (and Ice Condition)
W - Revised (and Estimated)
* - Asterik-occurs more than once
P - Partially Dry

B - Ice Conditions
E - Estimated
S - Revised (and Manual Gauge)
V - Revised (and Dry)
  - no symbol
d - Complete and Some Dry

4.3 Estimation of Potential Energy Development

The maximum water level in Lake Muskoka is 226.16 m with an average water level of 225.4 m, and an average tailwater level of 219.3 m. Therefore, the gross design head at this site is approximately 6.1 m. Using this head, and the available flow data, Acres HYDRO 180 program was used to estimate the installed capacity and potential energy. As discussed previously, the daily flow data recorded at Station 02EB006 (downstream of Baysville Dam) was used as means to estimate the total annual flow into the reservoir. The operation rule curve for Muskoka Lake, developed by MNR, was applied to determine the flow release policies during daily operation.

The preliminary estimate of potential installed capacity, on the basis of head and flow, is about 2.5 MW. To bracket this preliminary estimate, annual energy and incremental annual energy benefits were determined for installed capacities ranging from 1.5 MW to 5.0 MW as detailed in Table 4.2.

Bala Dams Power and Energy Estimates

Installed Capacity (MW)	Rated Flow (m^3/s)	Average Annual Power Flow (m^3/s)	Average Annual Spill (m^3/s)	Average Total Energy (GW·h/yr)	Estimated Annual Revenue ($/yr)	Incremental Annual Revenue ($/yr)
1.5	32.0	25.4	52.1	10.5	609,000	0
2.0	42.6	32.0	45.5	13.0	754,000	145,000
2.5	53.3	37.7	39.8	15.2	881,600	127,600
3.0	63.9	42.7	34.8	17.1	991,800	110,200
3.5	74.6	47.0	30.5	18.6	1,078,800	87,000
4.0	85.3	50.5	27.0	19.8	1,148,400	69,600
4.5	95.9	53.3	24.2	20.7	1,200,600	52,200
5.0	106.6	55.5	22.0	21.4	1,241,200	40,600

Table 4.2

Gross Design Head = 6.1 m Assumed Energy Value = $0.058/kW·h

4.4 Layout and Cost Considerations

The Bala North and Bala South Dams have equal available head; therefore, a plant could be constructed at either site.

At Bala South, the spill channel is fairly long and a penstock would be required to develop the full head at the site. In addition, the hydraulics at Bala South Dam is complicated by the existence of the old control structure/bridge downstream of the present dam.

As issues are less complicated at the Bala North Dam, this would be the preferred location for a generation facility. It was determined that all of the available spill capacity is required to pass the IDF at this site; therefore, a separate intake and tailrace is necessary. The optimum location for these excavations would be in the left bank at this site. In fact, this is the location of a former generation facility once operated by Ontario Hydro. This proposed powerhouse location is depicted in Figure 4.2.

Therefore, in establishing development costs for a hydroelectric station located at Bala North Dam, allowances were included for costs associated with local rock excavation in the approach and tailrace channels.

4.5 Optimum Installed Capacity

Using capital costs estimated on the basis of the above considerations, and the energy benefits established in Table 4.2, economic analysis would indicate an optimum installed capacity in the range of 2 MW to 2.5 MW, as shown in Table 4.3.

Table 4.3

Bala Economic Evaluation

Installed Capacity (MW)	Average Power Flow (m^3/s)	Rated Flow (m^3/s)	Average Spill Flow (m^3/s)	Estimated Annual Energy (MW.h)	Plant Factor	Estimated Annual Revenue ($)	Approx. Capital Cost at $3,000/kW ($)	IRR (%)	B/C	NPV ($)	
1.50	25.4	32.0	52.1	10500	0.80	609,000	4,500,000	12.8	1.63	3,326,826	
2.00	32.0	42.6	45.5	13000	0.74	754,000	6,000,000	11.6	1.51	3,618,102	<= choose
2.50	37.7	53.3	39.8	15200	0.69	881,600	7,500,000	10.6	1.42	3,664,702	<= choose
3.00	42.7	63.9	34.8	17100	0.65	991,800	9,000,000	9.6	1.33	3,465,781	
3.50	47.0	74.6	30.5	18600	0.61	1,078,800	10,500,000	8.7	1.24	2,940,262	
4.00	50.5	85.3	27.0	19800	0.57	1,148,400	12,000,000	7.7	1.15	2,169,472	
4.50	53.3	95.9	24.2	20700	0.53	1,200,600	13,500,000	6.5	1.05	695,572	
5.00	55.5	106.6	22.0	21400	0.49	1,241,200	15,000,000	5.5	0.95	(784,128)	

Gross Head = 6.1 m
Assumed Energy Value = $0.058/kW.h

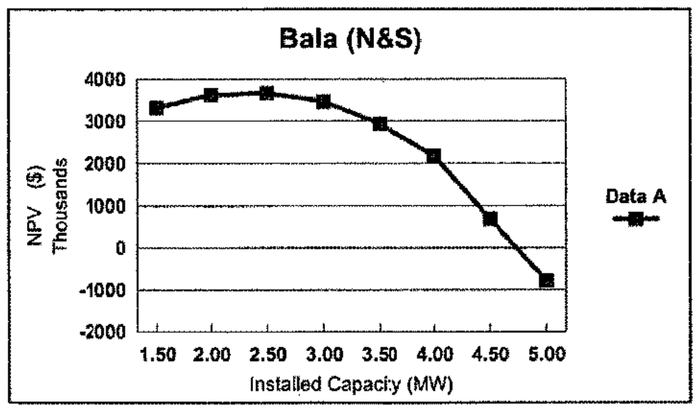
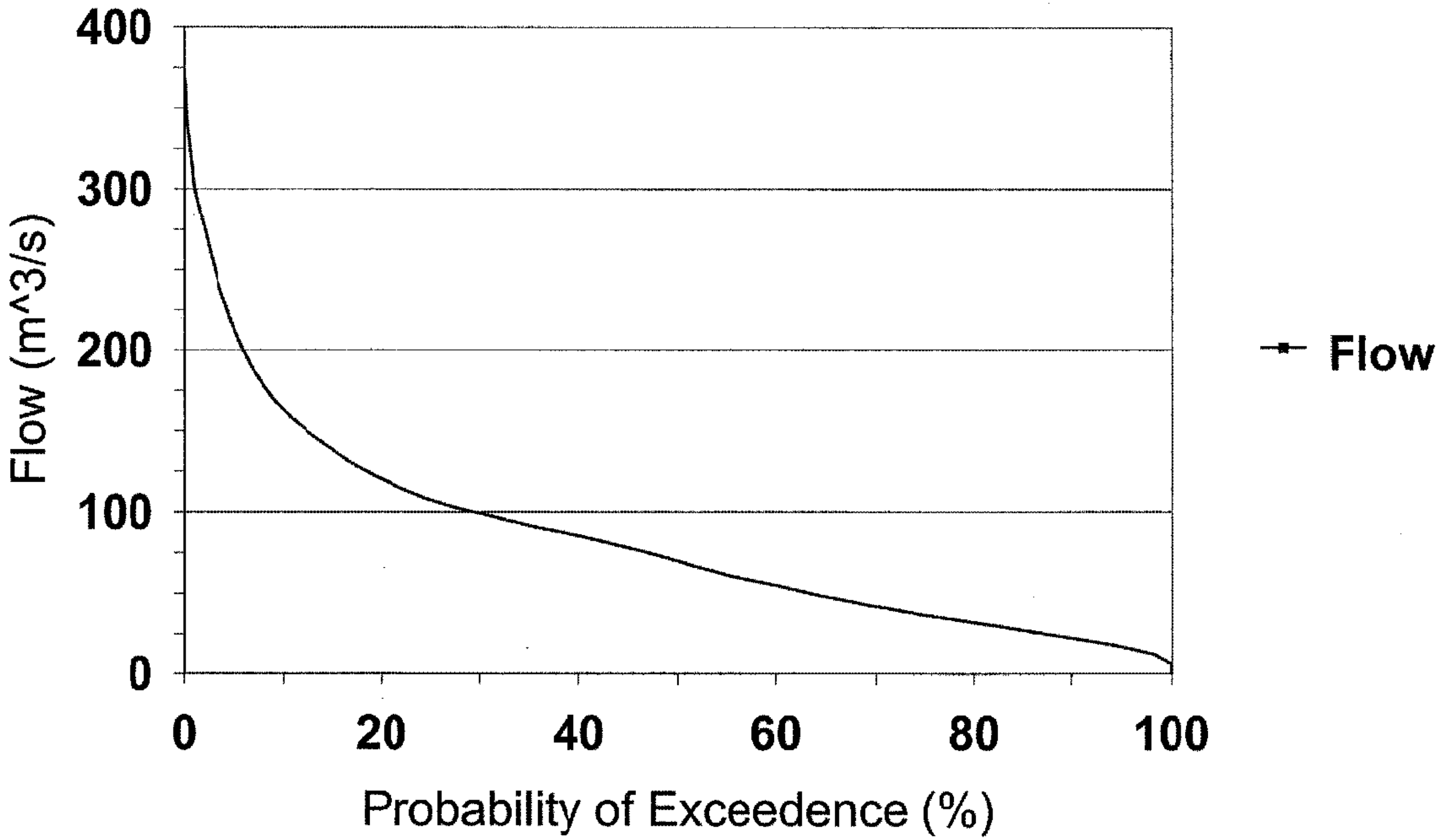


Figure 4.1 - Flow Duration Curve, 02EB006 Below Bala Dams



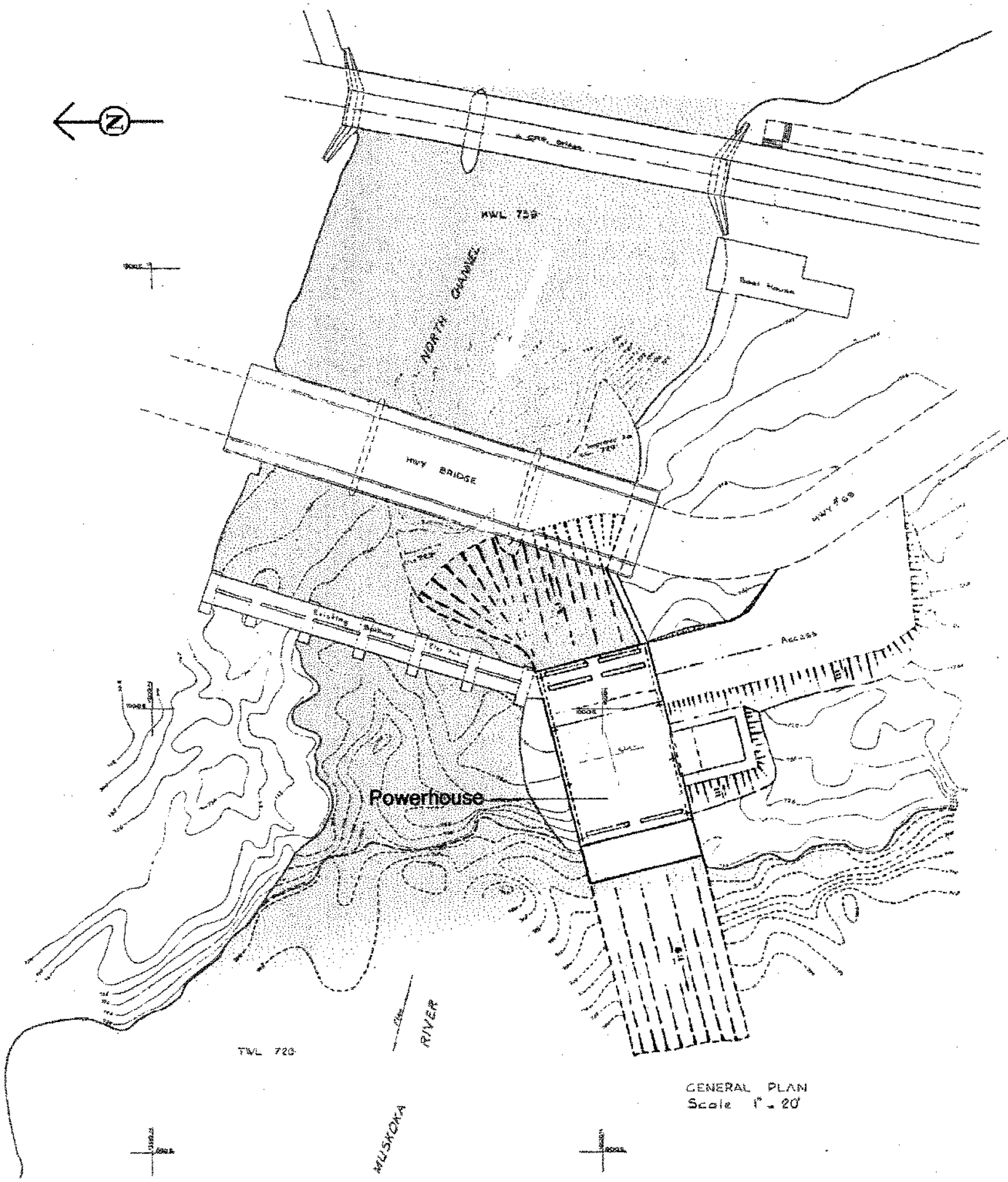


Figure 4.2
Ministry of Natural Resources
Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown
Conceptual Hydro Layout at Bala North Dam

ACRES

5 Go Home Lake Dams

5 Go Home Lake Dams

5.1 Description of the Watershed

Go Home Lake is located downstream from the Bala dams. Inflow to the lake comes via the Musquash River and consists primarily of releases from the Bala dams, passing through two Ontario Power Generation generating facilities at Ragged Rapids and Big Eddy. Excess flows are diverted to the Moon River. The total drainage area is 4802 km^2 with 4683 km^2 controlled by upstream dams and 119 km^2 of local uncontrolled drainage inflow to Go Home Lake.

Go Home Lake has two outlets: the main dam which has four sluiceway bays, and a low 'filter dam' which is a porous rock-fill structure. The filter dam is uncontrolled and release estimates vary from 1.4 m^3/s to 3 m^3/s. This flow is not measured and is considered to be less than 5% of the main dam releases. Accordingly, this flow is small enough to be ignored at this stage.

5.2 Flow Records

Inflow is measured by Station 02EB012 (Table 5.1) which has 32 years flow data. The mean annual inflow was determined to be 63.4 m^3/s with a minimum of 21.9 m^3/s in August and a maximum of 88.2 m^3/s in April. Figure 5.1 shows the flow duration characteristics of the site.

5.3 Estimation of Potential Energy Development

The average water level in Go Home Lake is 185.3 m with a mean tailwater level downstream from the filter dam of about 176.5 m. Therefore, the gross available head is approximately 8.8 m.

Using this head, and the available flow data, Acres HYDRO 180 program was used to estimate the installed capacity and potential energy. The daily flow data recorded at Station 02EB012 were input into the model to establish flow into the reservoir. The reservoir operation rule curve for Go Home Lake developed by MNR was used to determine the flow release policies during daily operation. The preliminary estimate of potential installed capacity, on the basis of head and flow, is about 4.3 MW. To bracket this preliminary estimate, annual energy and

Table 5.1
Go Home - Station 02EB012
Monthly Mean Flow Data

Station : 02EB012 MUSKOKA RIVER AT HIGHWAY NO. 69 Prov-Terr-State : ON
Latitude:45°1'30"N Longitude:79°46'30"W
Region : Guelph Drainage Area : -------- (km²) Parameter : Flow (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1965	-------	-------	-------	-------	-------	-------	-------	-------	50.1	85.4	82.4	83.7	-------
1966	83.5	77.9	83.7	72.9	52.5	43.9	12.0	8.33	19.3	27.7	76.3	89.9	53.8
1967	91.3	94.5	81.6	98.2	47.7	68.2	50.9	28.7	56.7	73.0	94.7	96.0	73.2
1968	94.9	97.7	96.2	70.2	21.2	17.0	26.1	29.5	50.7	32.9	34.0	75.2	53.7
1969	70.2	84.4	73.2	101	106	54.8	37.1	15.6	27.5	42.3	65.8	78.5	64.6
1970	68.8	66.1	67.4	83.1	112	29.2	67.5	49.1	37.5	85.3	67.8	86.9	70.2
1971	72.1	80.4	93.3	97.3	88.5	12.8	19.8	16.0	25.1	14.6	31.1	68.4	51.5
1972	80.0	84.0	91.4	95.5	92.3	27.9	57.6	71.8	45.6	52.5	76.8	86.4	71.9
1973	99.2	96.8	98.0	116	104	81.4	44.3	41.4	24.2	44.3	63.6	92.0	75.3
1974	81.4	94.2	92.8	105	121	37.0	21.2	12.2	40.0	82.3	97.6	89.3	72.7
1975	69.3	79.4	95.8	97.9	74.1	10.1	8.50	14.0	41.5	42.1	36.1	96.5	55.3
1976	85.5	90.9	92.8	85.4	69.3	28.1	37.7	13.1	18.3	18.8	30.2	75.2	53.8
1977	48.8	51.7	95.1	97.5	41.9	5.81	18.2	12.3	50.7	92.3	81.1	98.1	57.8
1978	94.7	72.4	68.0	82.0	108	43.8	13.0	15.5	48.1	68.0	58.7	82.4	62.8
1979	82.3	89.6	95.8	94.3	92.9	39.2	10.5	21.1	38.2	72.3	95.7	100	69.2
1980	96.0	79.8	84.9	98.6	34.9	39.5	45.9	48.5	50.9	85.0	83.1	85.3	69.3
1981	70.8	83.4	96.9	88.1	57.5	42.3	15.3	8.43	95.7	89.7	57.4	63.9	63.9
1982	64.2	75.9	85.3	95.8	43.4	56.8	22.9	14.4	40.5	62.9	86.5	97.0	61.9
1983	94.4	94.6	93.3	65.6	93.2	55.2	15.5	4.50	19.4	61.3	49.3	96.4	61.8
1984	81.8	84.8	93.7	89.9	46.3	57.7	39.0	10.5	34.1	43.0	72.1	94.2	62.1
1985	94.1	93.4	90.9	93.0	84.4	36.6	37.7	31.1	87.7	86.4	96.4	102	77.7
1986	84.9	92.3	89.3	92.3	64.6	69.8	28.4	28.3	56.4	87.7	46.2	72.9	67.6
1987	51.1	69.2	83.1	78.7	7.43	19.5	16.7	4.04	4.55	27.3	31.9	79.3	39.2
1988	90.6	91.8	89.3	100	70.2	18.7	3.36	7.45	33.3	68.5	102	74.4	62.3
1989	74.7	73.8	91.0	92.1	91.7	64.5	19.3	5.53	14.8	28.4	37.7	82.6	56.2
1990	73.8	88.1	86.7	88.2	70.6	41.9	11.8	9.59	7.09	78.3	80.2	95.3	60.8
1991	86.5	77.5	82.9	93.9	50.3	21.1	9.26	7.76	22.4	46.3	74.9	85.6	54.7
1992	79.5	70.2	84.3	77.9	52.3	12.3	27.9	29.2	80.0	90.7	99.3	92.8	66.3
1993	89.7	60.7	61.3	82.0	42.4	84.3	57.1	11.0	46.7	86.0	89.1	87.1	67.9
1994	67.2	55.1	72.3	60.8	59.6	67.6	75.6	33.0	49.0	43.4	87.3	89.8	63.4
1995	87.6	69.9	88.8	54.5	85.9	47.2	37.3	36.5	38.9	59.3	89.5	88.7	66.9
1996	83.2	86.1	81.5	85.4	69.7	62.0	54.8	39.4	45.9	57.9	89.9	86.4	70.1
Mean	80.4	82.1	86.5	88.2	69.6	41.8	30.4	21.9	40.7	60.5	72.0	86.6	63.4
Maximum	99.2	97.7	98.0	116	121	84.3	75.6	71.8	95.7	92.3	102	102	77.7
Minimum	48.8	51.7	61.3	54.5	7.43	5.81	3.36	4.04	4.55	14.6	30.2	63.9	39.2

A - Manual Gauge
D - Dry
R - Revised within the last two years
T - Revised (and Ice Condition)
W - Revised (and Estimated)
* - Asterik-occurs more than once
P - Partially Dry

B - Ice Conditions
E - Estimated
S - Revised (and Manual Gauge)
V - Revised (and Dry)
  - no symbol
d - Complete and Some Dry

incremental annual energy benefits were determined for installed capacities ranging from 1.0 MW to 3.5 MW, as detailed in Table 5.2.

Go Home Plant Power and Energy Estimates						
Installed Capacity (MW)	Rated Flow (m^3/s)	Average Annual Power Flow (m^3/s)	Average Annual Spill (m^3/s)	Average Total Energy (GW·h/yr)	Estimated Annual Revenue ($/yr)	Incremental Annual Revenue ($/yr)
1.0	14.8	13.2	49.9	7.0	290,000	0
1.5	22.2	19.1	44.0	10.1	406,000	116,000
2.0	29.6	24.6	38.6	12.8	516,200	110,200
2.5	36.9	29.6	33.5	15.4	609,000	92,800
3.0	44.3	34.4	28.8	17.7	696,000	87,000
3.5	51.7	38.9	24.3	19.9	771,400	75,400

Table 5.2

Gross Design Head = 8.8 m Assumed Energy Value = $0.058/kW·h

5.4 Layout and Cost Considerations

To develop the full head at the site, the generation facilities are best located at Go Home Lake Dam since Go Home Lake Filter Dam has a series of rapids below which would require a lengthy penstock. As well, seepage and foundation issues at the filter dam could complicate construction.

The main dam is founded on competent bedrock. As it would not be possible to utilize one of the existing sluiceways for power generation, it is also necessary to construct approach and tailrace channels at this site. The left bank, at the dam, consists of an abrupt cliff of some height that could not be easily developed. Accordingly, the proposed powerhouse would be located on the right bank of the spillway dam and would have to be excavated in rock. A proposed layout for the site is presented as Figure 5.2.

In establishing costs for this site, as was discussed in Section 2.2, the unit costs were increased to account for additional costs of a relatively large amount of deep rock excavation that would require the use of controlled perimeter blasting as well as access difficulties associated with the site.

5.5 Optimum Installed Capacity

Using capital costs estimated on the basis of the above considerations and the energy benefits established in Table 5.2, economic analysis would indicate an optimum installed capacity of just under 3 MW, as shown in Table 5.3.

Table 5.3

Go Home Economic Evaluation

Installed Capacity (MW)	Average Power Flow (m^3/s)	Rated Flow (m^3/s)	Average Spill Flow (m^3/s)	Estimated Annual Energy (MW.h)	Plant Factor	Estimated Annual Revenue ($)	Approx. Capital Cost at $3,200/kW ($)	IRR (%)	B/C	NPV ($)
1.00	13.2	14.8	51.5	7000	0.80	406,000	3,200,000	11.8	1.55	2,017,571
1.50	19.1	22.2	46.3	10050	0.76	582,900	4,800,000	11.1	1.48	2,659,058
2.00	24.6	29.6	41.6	12820	0.73	743,560	6,400,000	10.5	1.41	3,071,097
2.50	29.6	36.9	37.2	15400	0.70	893,200	8,000,000	9.9	1.36	3,328,154
3.00	34.4	44.3	33.0	17700	0.67	1,026,600	9,600,000	9.3	1.30	3,356,138 <= choose
3.50	38.9	51.7	29.2	19900	0.65	1,154,200	11,200,000	8.8	1.25	3,302,703

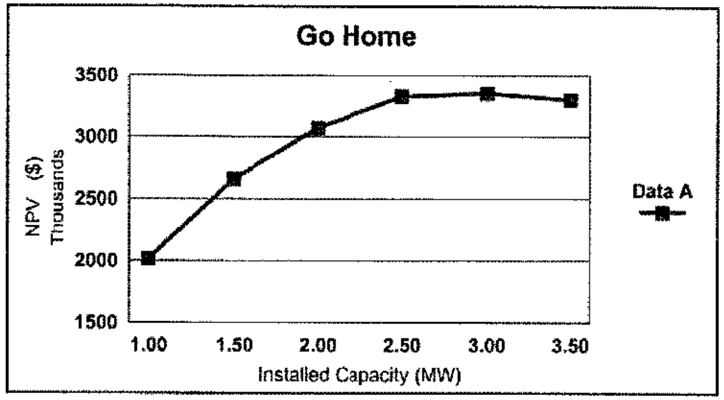
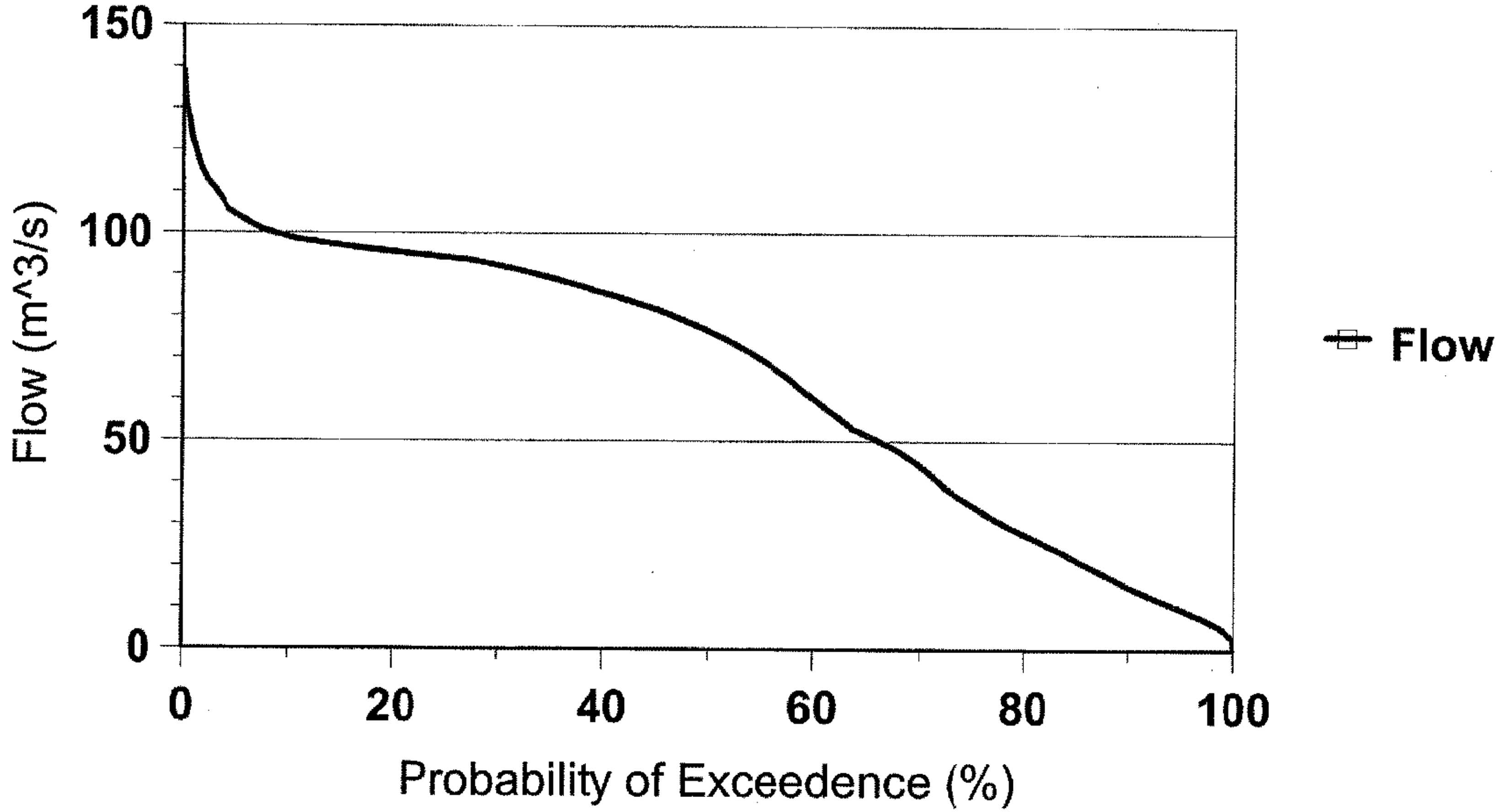


Figure 5.1 - Flow Duration Curve, 02EB012 Above Go Home Dam



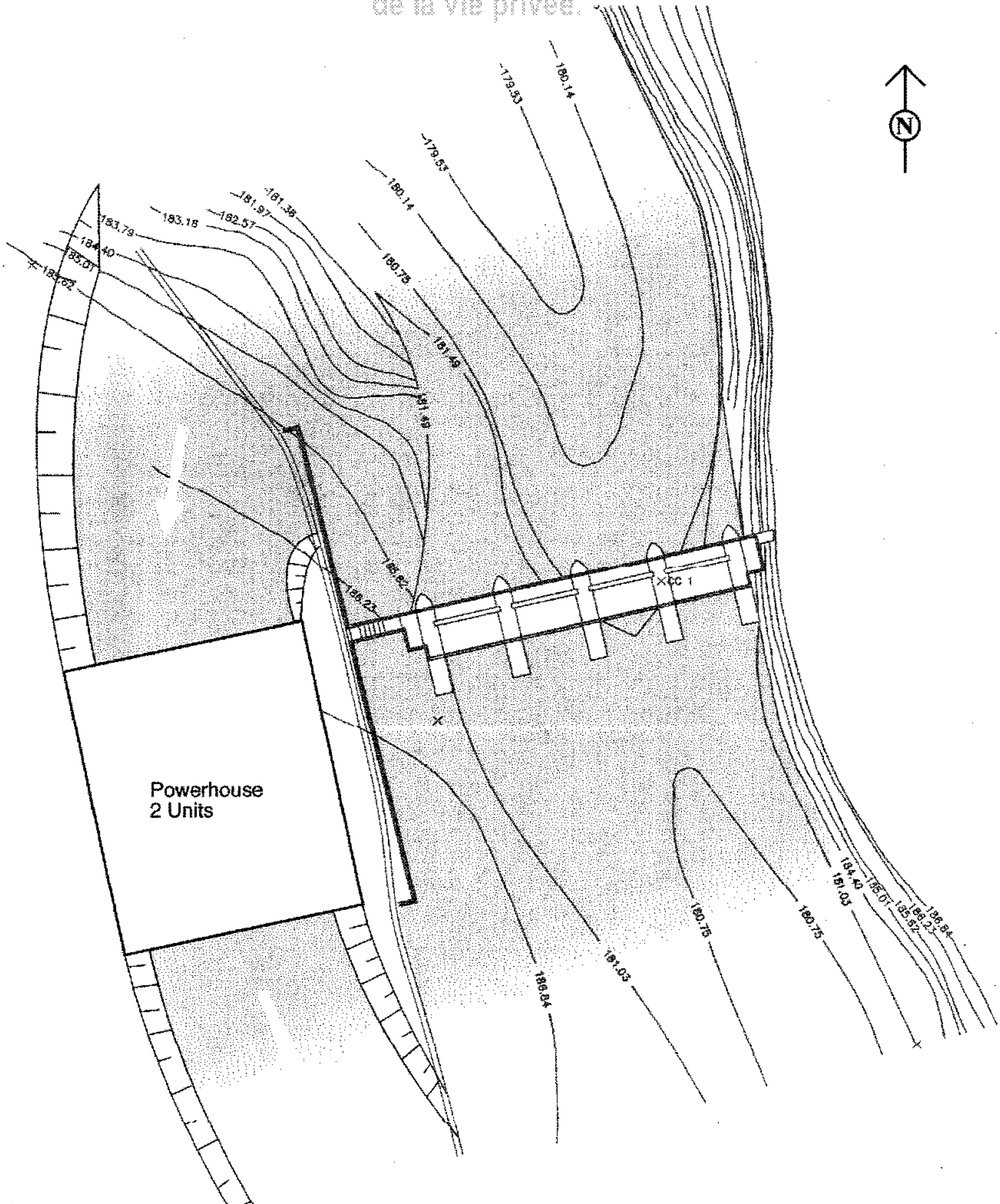


Figure 5.2
Ministry of Natural Resources
Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown
Conceptual Hydro Layout at Go Home Lake Dam

6 South River Dam

6 South River Dam

6.1 Description of the Watershed

The South River Dam impounds Forest Lake near the town of South River. It is a 5-m high control structure having three spillway bays and two overflow sections. At the dam, the South River has a total drainage area of 310.4 km^2 with a lake surface area of 3.4 km^2.

Power was once generated at this site, and portions of a deteriorated wood-stave penstock and an abandoned powerhouse remain from a previous installation once operated by the South River Hydroelectric Company.

6.2 Flow Records

Streamflow Station 02DD009 (Table 6.1) has a recording length of 36 years, from 1956 to 1991, and is located downstream of the dam. On the basis of analysis of data from this gauge, the mean annual flow was determined to be 5.3 m^3/s. The daily flow duration curve is shown in Figure 6.1.

6.3 Estimation of Potential Energy Development

The normal water level of the reservoir is 349.1 m. Downstream of the lake, there are rapid drops and it was estimated that the total gross that can be obtained is approximately 17.1 m.

Using this head, and the available flow data, Acres HYDRO 180 program was used to estimate the installed capacity and potential energy. The daily flow data recorded at Station 02EB012 were input into the model to establish flow into the reservoir. There is no water level operating rule curve available for this damsite. Therefore, for the purposes of this analysis, it was assumed that operation of the facility to provide a constant target water level of 349.0 m could be used for the power and energy estimates. The preliminary estimate of potential installed capacity, on the basis of head and flow, is about 0.7 MW. To bracket this preliminary estimate, annual energy and incremental annual energy benefits were determined for installed capacities ranging from 0.5 MW to 1.0 MW as detailed in Table 6.2.

Table 6.1
South River - Station 02DD009
Monthly Mean Flow Data

Canadian Hydrological Data (c)1997 Environment Canada
Station : 02DD009 SOUTH RIVER AT SOUTH RIVER Prov-Terr-State : ON
Latitude:45°50'54"N Longitude:79°22'46"W
Region : Guelph Drainage Area : 316 (km²) Parameter : Flow (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1956	-------	-------	-------	7.85	10.0	3.88	2.87	3.14	4.66	3.51	5.64	3.44	-------
1957	4.59	3.59	4.60	9.71	3.52	4.56	10.7	1.90	5.41	6.40	10.5	10.0	6.30
1958	5.73	4.43	4.31	7.27	2.81	3.95	9.70	2.58	4.05	3.78	3.08	4.18	4.66
1959	2.75	2.94	3.40	14.7	7.04	3.19	2.25	3.99	3.50	6.53	11.1	6.10	5.61
1960	4.90	4.88	5.02	20.1	11.2	3.38	4.37	2.69	1.93	3.68	3.69	2.72	5.71
1961	3.11	3.11	4.16	8.79	5.13	2.99	3.83	2.49	2.35	2.37	2.85	3.61	3.73
1962	3.63	3.64	4.10	10.3	6.02	2.39	1.89	1.32	1.35	1.67	1.69	1.64	3.29
1963	1.88	2.05	2.64	9.58	6.76	3.80	1.98	2.55	2.57	2.21	2.03	2.33	3.36
1964	2.23	3.64	3.61	7.73	4.39	2.16	1.92	1.89	1.66	1.60	1.98	2.50	2.93
1965	3.01	3.93	3.09	7.90	14.8	2.50	2.01	2.45	3.54	6.57	7.15	6.58	5.31
1966	6.62	6.14	6.53	10.4	6.28	4.75	1.87	1.61	1.36	1.70	4.44	10.7	5.19
1967	5.11	5.39	4.75	15.7	4.89	4.79	2.55	2.32	2.57	5.55	11.1	5.77	5.85
1968	4.93	6.26	5.72	12.6	3.97	3.40	2.90	2.68	2.51	1.93	2.12	2.97	4.31
1969	3.70	3.91	3.63	12.8	14.3	5.00	3.71	3.41	6.66	5.94	10.7	6.36	6.67
1970	4.62	4.15	3.38	10.2	9.97	5.38	3.18	3.56	3.90	5.01	4.87	5.27	5.71
1971	4.10	3.64	5.61	16.0	10.5	3.57	1.56	1.53	1.17	1.79	2.30	4.53	4.69
1972	4.05	4.87	4.47	10.6	21.0	7.49	6.01	5.76	4.96	5.49	7.56	5.57	7.33
1973	7.00	6.41	12.6	14.7	7.46	7.95	6.82	3.32	2.69	2.84	3.79	5.60	6.76
1974	5.04	7.68	6.34	18.1	13.0	4.71	-------	-------	2.88	3.99	7.05	4.51	-------
1975	5.78	5.48	4.93	9.07	11.3	2.73	2.25	1.76	2.96	4.33	4.47	9.48	5.38
1976	4.03	5.18	10.8	16.7	9.05	4.06	4.09	1.99	2.98	1.85	2.54	3.07	5.52
1977	3.62	3.59	7.20	14.6	3.87	1.63	1.70	2.07	-------	-------	6.86	6.37	-------
1978	3.43	3.37	3.23	7.35	11.3	3.50	1.28	1.88	2.14	5.39	4.34	4.51	4.32
1979	4.50	4.36	8.60	15.8	8.46	3.67	1.96	1.91	2.18	5.20	7.90	7.21	5.98
1980	6.43	3.71	4.13	17.5	5.03	7.78	5.61	5.72	6.27	8.54	7.86	5.19	6.97
1981	3.08	6.80	7.88	14.5	8.34	5.99	3.94	4.59	10.2	11.6	5.00	4.89	7.23
1982	4.13	4.29	4.40	15.0	5.89	2.63	1.55	1.02	2.89	4.34	7.78	11.3	5.43
1983	7.68	4.12	5.88	7.49	14.3	5.03	1.55	1.94	2.32	2.39	6.71	5.74	5.44
1984	3.25	7.18	5.95	14.5	8.26	7.88	5.26	2.14	2.43	3.30	7.98	6.19	6.17
1985	6.93	5.48	5.29	20.4	7.46	2.60	4.40	3.80	3.01	4.00	5.86	4.95	6.16
1986	4.20	3.77	6.06	16.6	6.69	5.63	2.41	2.11	1.52	3.15	2.20	3.01	4.77
1987	3.75	2.78	4.36	8.68	2.43	2.51	1.81	2.50	1.29	2.46	3.77	5.20	3.46
1988	4.15	5.36	4.26	16.7	6.25	1.85	1.69	2.76	2.06	7.08	9.57	5.75	5.60
1989	4.03	3.11	4.91	11.5	9.80	6.54	2.47	2.52	1.30	1.58	4.07	3.84	4.64
1990	3.70	3.68	10.8	11.9	9.83	3.54	1.86	1.41	2.86	7.90	8.72	9.52	6.33
1991	5.14	3.90	7.75	-------	3.81	2.27	2.36	-------	-------	-------	-------	-------	-------
Mean	4.42	4.48	5.55	12.7	8.20	4.16	3.47	2.63	3.12	4.28	5.69	5.45	5.34
Maximum	7.68	7.68	12.6	20.4	21.0	7.95	10.7	5.76	10.2	11.6	11.1	11.3	7.33
Minimum	1.88	2.05	2.64	7.27	2.43	1.63	1.28	1.02	1.17	1.58	1.69	1.64	2.93

A - Manual Gauge
B - Ice Conditions
D - Dry
E - Estimated
R - Revised within the last two years
S - Revised (and Manual Gauge)

South River Dam Potential Energy Production						
Installed Capacity (MW)	Rated Flow (m^3/s)	Average Annual Power Flow (m^3/s)	Average Annual Spill (m^3/s)	Average Total Energy (GW·h/yr)	Estimated Annual Revenue ($/yr)	Incremental Annual Revenue ($/yr)
0.5	3.8	3.2	2.0	3.7	214,600	0
0.6	4.6	3.6	1.7	4.2	243,600	29,000
0.7	5.3	3.8	1.4	4.5	261,000	17,400
0.8	6.1	4.0	1.2	4.7	272,600	11,600
0.9	6.8	4.2	1.0	4.9	284,200	11,600
1.0	7.6	4.3	0.9	5.0	290,000	5,800

Table 6.2

Gross Head = 17.1 m   Assumed Energy Value = $0.058/kW·h

6.4 Layout and Cost Considerations

The layout of the proposed hydro development would be generally similar to that which was once developed at the South River site. As shown in Figure 6.2, the intake would be incorporated immediately adjacent to the existing spillway dam, and a penstock would be built to the vicinity of the old powerhouse although it would be a simple, small structure.

6.5 Optimum Installed Capacity

Using capital costs estimated on the basis of the above considerations and the energy benefits established in Table 6.2, economic analysis would indicate an optimum installed capacity in the range of 0.5 MW to 0.6 MW, as shown in Table 6.3.

Table 6.3

South River Economic Evaluation

Installed Capacity (MW)	Average Power Flow (m^3/s)	Rated Flow (m^3/s)	Average Spill Flow (m^3/s)	Estimated Annual Energy (GW.h)	Plant Factor	Estimated Annual Revenue ($)	Approx. Capital Cost at $3,500/kW ($)	IRR (%)	B/C	NPV ($)
0.50	3.2	3.8	2.0	3700	0.84	214,600	1,750,000	11.4	1.51	1,022,393 <= choose
0.60	3.6	4.6	1.7	4200	0.80	243,600	2,100,000	10.6	1.43	1,030,468 <= choose
0.70	3.8	5.3	1.4	4500	0.73	261,000	2,450,000	9.4	1.31	875,551
0.80	4.0	6.1	1.2	4700	0.67	272,600	2,800,000	8.2	1.20	638,485
0.90	4.2	6.8	1.0	4900	0.62	284,200	3,150,000	7.2	1.11	401,913
1.00	4.3	7.6	0.9	5000	0.57	290,000	3,500,000	6.2	1.02	83,245

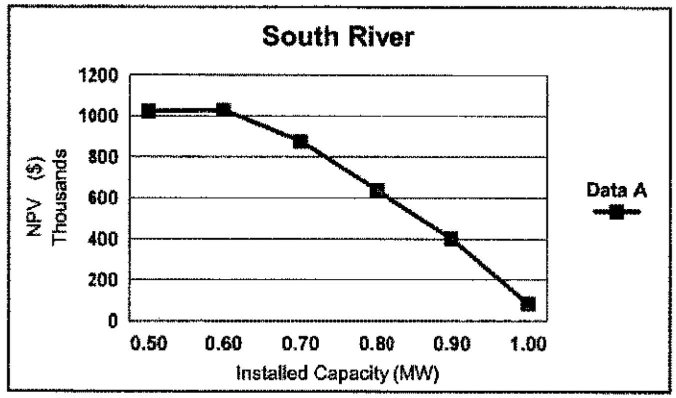
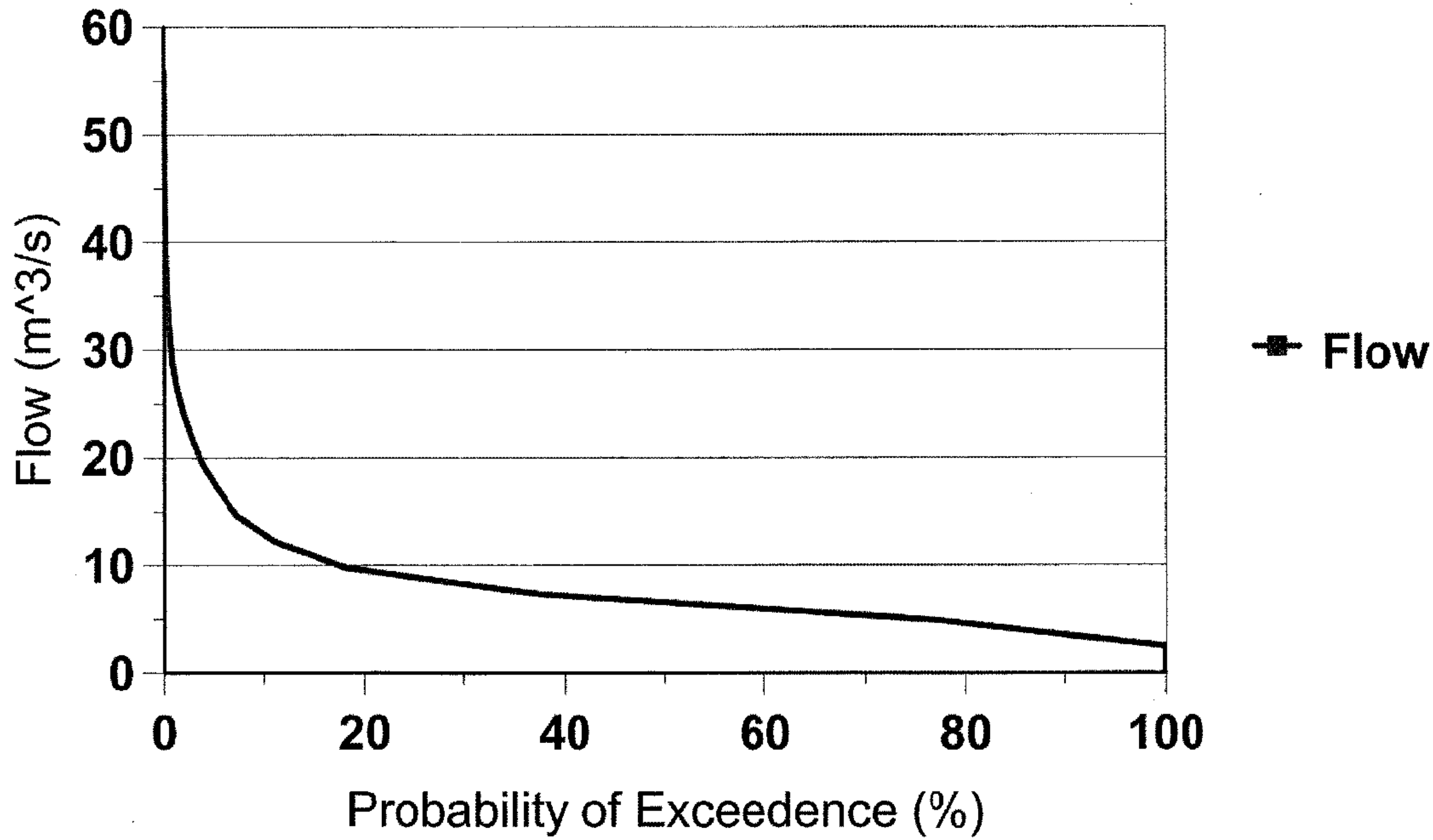


Figure 6.1 - Flow Duration Curve, 02DD009
Used for South River Dam and Naiscoot Dam



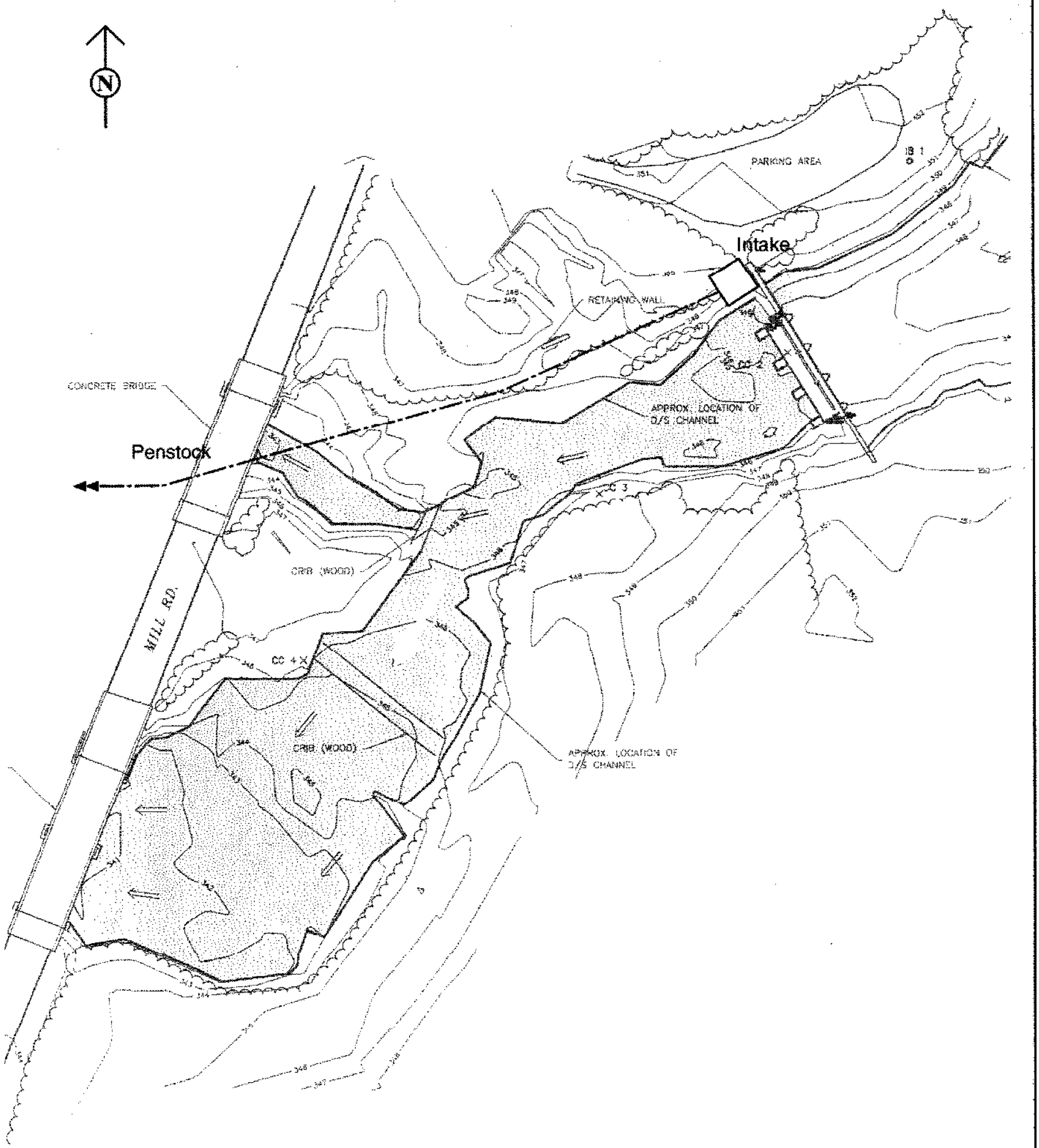


Figure 6.2
Ministry of Natural Resources
Evaluation of Small Hydro Potential for Selected Dams Owned by the Crown
Conceptual Hydro Layout at South River Dam

7 Naiscoot Dam

7 Naiscoot Dam

7.1 Description of the Watershed

The Naiscoot Dam controls a total drainage area of 176.4 km^2. It is located at the outlet of Six Mile Lake, where outflow discharges into the Naiscoot River. The lake surface area is 4.2 km^2.

7.2 Flow Records

For this site, there is no hydrometric station. Therefore, the inflow time series was prorated, based on drainage area ratio, from nearby Station 02DD009. The drainage area controlled by Station 02DD009 (Table 6.1) is 316 km^2, while the study site has a drainage area of only 176.4 km^2 resulting in a flow reduction factor of 0.56. Applying this adjustment to the flow duration curve for Gauge 02DD009 resulted in an average flow of about 2.97 m^3/s.

7.3 Estimation of Potential Energy Development

The normal reservoir level is approximately 181.98 m. The average downstream tailwater is 178.48 m. Accordingly, the gross head of the site is estimated to be about 3.5 m.

Using this head, and the available flow data, Acres HYDRO 180 program was used to estimate the installed capacity and potential energy. The daily flow data recorded at Station 02DD009 were input into the model to provide an estimate of flow into the reservoir. There is no water level operating rule curve available for the Naiscoot Dam reservoir. Therefore, for the purposes of this analysis, it was assumed that operation of the facility to provide a constant target water level of 181.8 m could be used for the power and energy estimates. Although this assumption may result in a slightly different solution for the total energy production, the differences would likely be negligible since the volume of the reservoir is fairly small compared with the inflow volume.

The preliminary estimate of potential installed capacity, on the basis of head and flow, is about 0.08 MW. To bracket this preliminary estimate, annual energy and incremental annual energy benefits were determined for installed capacities ranging from 0.05 MW to 0.1 MW as detailed in Table 7.1.

Naiscoot Dam Potential Energy Production						
Installed Capacity (MW)	**Rated Flow (m^3/s)**	**Average Annual Power Flow (m^3/s)**	**Average Annual Spill (m^3/s)**	**Average Total Energy (GW·h/yr)**	**Estimated Annual Revenue ($/yr)**	**Incremental Annual Revenue ($/yr)**
0.05	1.9	1.73	1.25	0.40	23,200	0
0.06	2.2	2.00	1.00	0.43	24,940	1,740
0.07	2.6	2.20	0.80	0.45	26,100	1,160
0.08	3.0	2.40	0.60	0.46	26,680	580
0.09	3.3	2.50	0.50	0.47	27,260	580
0.10	3.7	2.60	0.40	0.46	26,680	-580

Table 7.1

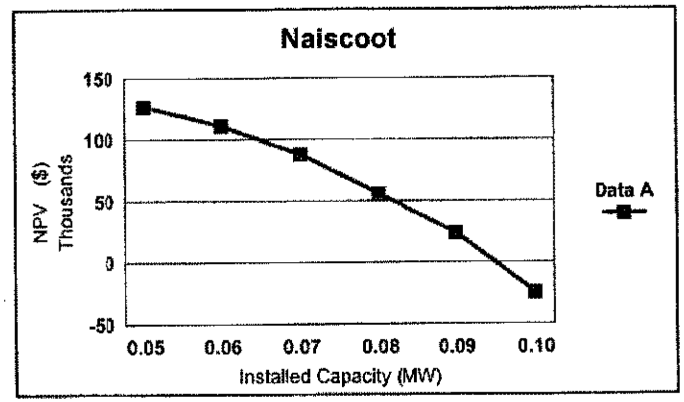
Gross Head = 3.5 m   Assumed Energy Value = $0.058/kW·h

On the basis of the results presented in Table 7.2, the capacity that can be installed for this site is very small (0.06 MW to 0.08 MW). Except, perhaps, for a cottagers' association (as is discussed in Section 8), this installed capacity was considered insufficient to make this site economically viable. For this reason, further assessments were not performed.

Table 7.2

Naiscoot Economic Evaluation

Installed Capacity (MW)	Average Power Flow (m^3/s)	Rated Flow (m^3/s)	Average Spill Flow (m^3/s)	Estimated Annual Energy (GW.h)	Plant Factor	Estimated Annual Revenue ($)	Approx. Capital Cost at $3,000/kW ($)	IRR (%)	B/C	NPV ($)
0.05	1.7	1.9	1.3	400	0.91	23,200	175,000	12.6	1.65	126,568 <= choose
0.06	2.0	2.2	1.0	430	0.82	24,940	210,000	10.9	1.46	111,007
0.07	2.2	2.6	0.8	450	0.73	26,100	245,000	9.4	1.32	87,617
0.08	2.4	3.0	0.6	460	0.66	26,680	280,000	7.9	1.19	55,797
0.09	2.5	3.3	0.5	470	0.60	27,260	315,000	6.7	1.06	23,925
0.10	2.6	3.7	0.4	460	0.53	26,680	350,000	5.3	0.95	(24,412)



8 Conclusions

8 Conclusions

The results of these analyses are summarized in Table 8.1. These results show that, on the basis on standard economic analyses, the following sites may be viable potential hydro sites:

- Baysville
- Bala North
- Go Home
- South River.

The analysis is based on an assumed energy benefit of $0.58/kW·h which is somewhat higher than the anticipated average price for energy in the upcoming market*. The use of such an energy benefit has precedent in recent small hydro studies in Ontario (the Parkhill dam for the GRCA, for example). In addition, all of the existing deregulated markets (e.g., Alberta, New Zealand, California) do have a 5% to 10% premium for 'green' energy. However, market forces will determine the actual energy rate, and if there is a premium that will be paid for energy produced by independent small hydro producers ('green power') in Ontario. Therefore, there is some risk that the energy benefit used in this study may be smaller than assumed.

On the other hand, there is some indication that cooperatives, such as cottage owner associations, may be provided with a very significant inducement for establishing small hydro facilities. The concept would involve allowing such groups to 'run the meter backwards' or 'net billing' during periods in which they generate and purchase power at the going rate when demand exceeds supply. Accordingly, energy produced has a retail value rather than a wholesale value. This may effectively double the wholesale rate for energy, with energy benefits of at least $0.76/kW·h possible for the initial period of deregulation when controls will be maintained on energy prices.

Note that the evaluations described herein are at a pre-feasibility level and use a simplified economic analysis and not a financial analysis. Therefore, details such as water leases, property issues, taxation, and the specifics of investment and

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* Presently, this rate has been pegged at $0.38/kW·h although this is the subject of ongoing discussions.

funding strategies are not considered. Accordingly, the results of the study at this stage provide a relative ranking of potential projects.

In terms of an inducement for divestment, the results of this study would indicate that, in the near term, two options are possible.

(a) Handing over individual facilities with, possibly, dam safety improvements completed to cottage associations. If development costs could be reduced by providing an upgraded dam with a design life of 25 years or greater at low or no cost, it may be possible to achieve very attractive returns on the investment by using the cooperative operating strategy that effectively doubles the market price for energy.

(b) Offer a portfolio of upgraded dams to the market. The portfolio approach would allow the developer a means of reducing the risks associated with the changes that will occur after deregulation and the chance that premium prices (for green power) may not be paid for small hydro. As well, this approach may allow an individual developer the opportunity to acquire all of the facilities along a given river system thereby maximizing the benefit potential (and again reducing risk).

Summary of Results of Analyses			
Dam	**Optimum Installed Capacity (MW)**	**Internal Rate of Return (%)**	**Net Present Value of Benefit ($)**
Baysville	0.50	14.2	1,350,000
Bala North	2.50	10.6	3,650,000
Go Home Lake	3.00	9.3	3,350,000
South River	0.60	10.6	1,050,000
Naiscoot	0.05	12.6	125,000

Table 8.1