NORTHWEST TERRITORIES POWER CORPORATION

Empowering Communities

Bluefish Hydroelectric System

Operations, Maintenance and Surveillance Manual

Volume 1 of 2

2020

CONTENTS

1 General

This Operations, Maintenance and Surveillance Manual for the Bluefish Hydroelectric System is comprised of two volumes. Volume 1 refers to the OMS of the Bluefish hydroelectric plants, Duncan spillway, and forecasting methodology. Volume 2 is specific to the OMS of the Main Bluefish Dam, including spillway system. It is labeled Bluefish Dam Operation, Maintenance, and Surveillance (OMS) Manual by Klohn Crippen Berger, December 2017. Some pertinent information and data regarding the main dam have been included in Volume 1 for ease of reference.

1.1 Description of Facilities

1.1.1 Geographical Setting

The Bluefish Lake Hydro System is owned and operated by the Northwest Territories Power Corporation (NTPC). It is located approximately 20 kilometers (km) north of Yellowknife (62° 40' North and 114° 15' West) on the Yellowknife River. A map showing the location of the facility is provided in Figure 1. The Bluefish Hydro facility makes use of regulated water from the Duncan Lake drainage basin (McCrea and Nicholson Rivers) and the natural flow of the remainder of the Yellowknife River drainage basin.

Duncan Lake is a large lake to the northeast of Bluefish Lake where the hydro facility's primary storage dam is located. Water flows from Duncan Lake through the McCrea River to Neck Lake, then to Short Point and Angle Lake. Water from Angle Lake flows into Quyta Lake where it joins the main stem of the Yellowknife river and then into Bluefish Lake.

1.1.2 History

Prior to the damming of Bluefish Lake in 1940 and subsequent diversion of the Yellowknife River through the Bluefish penstock, the Yellowknife River connecting Bluefish and Prosperous Lakes went over a waterfall at the outlet from Bluefish Lake. The water level elevation of Prosperous Lake is approximately 38m lower than Bluefish Lake.

Construction of the new Bluefish Dam and Spillway commenced in March 2011 at a site 400 meters (m) downstream of the existing dam. Dam construction and decommissioning of the old dam was completed in November 2012. The OMS manual for this structure is in Volume 2

The Duncan Lake control dam was originally built in 1942, rebuilt in 1974 using concrete, and repaired in 1994 due to erosion in the left abutment. The maximum drawdown at the dam is to 209.3 m. The top of the spillway is at 212.49 m, while the top of the dam is at 213.41 m.

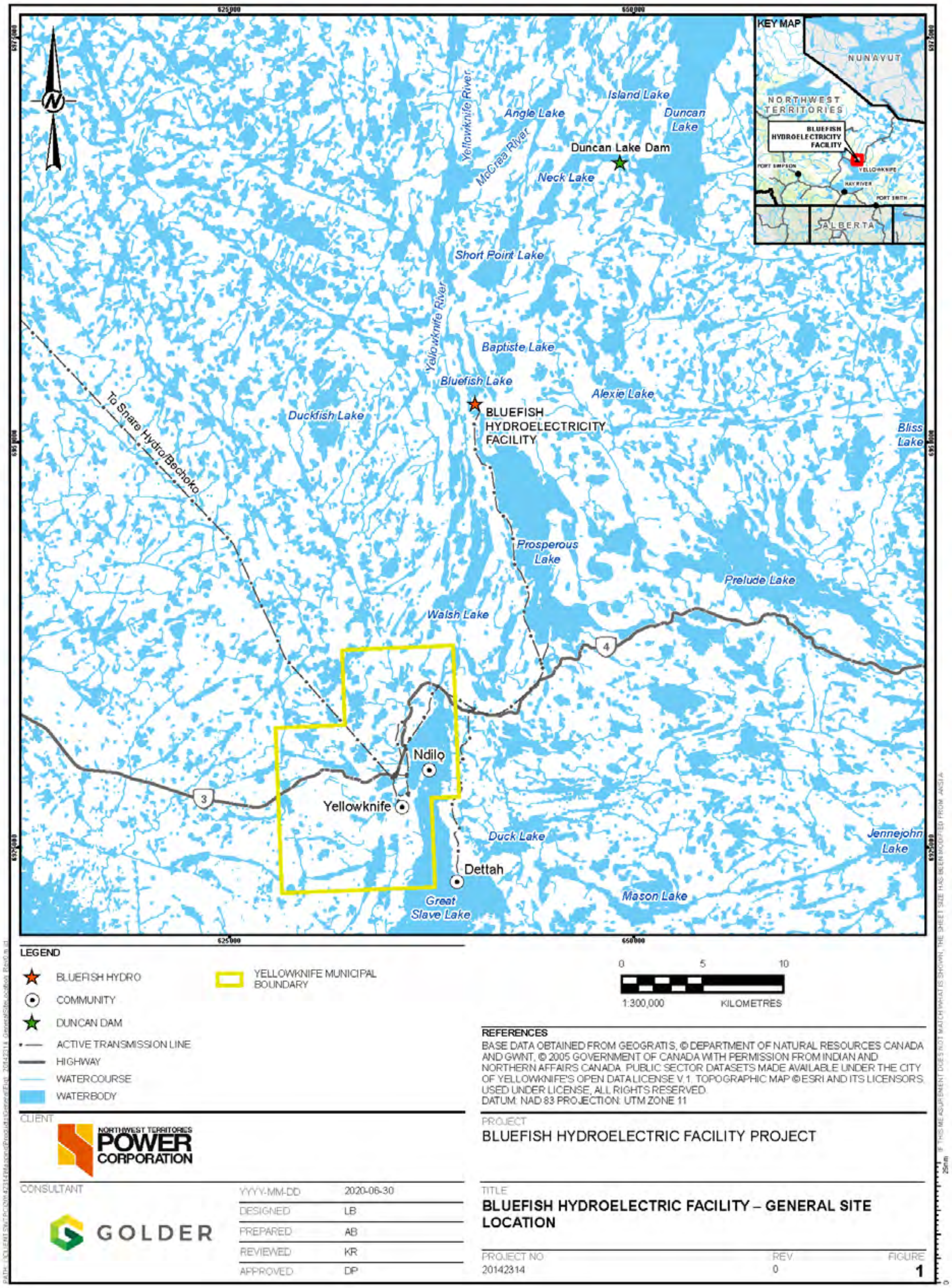

Figure 1: Bluefish Hydroelectric Facility Site Location

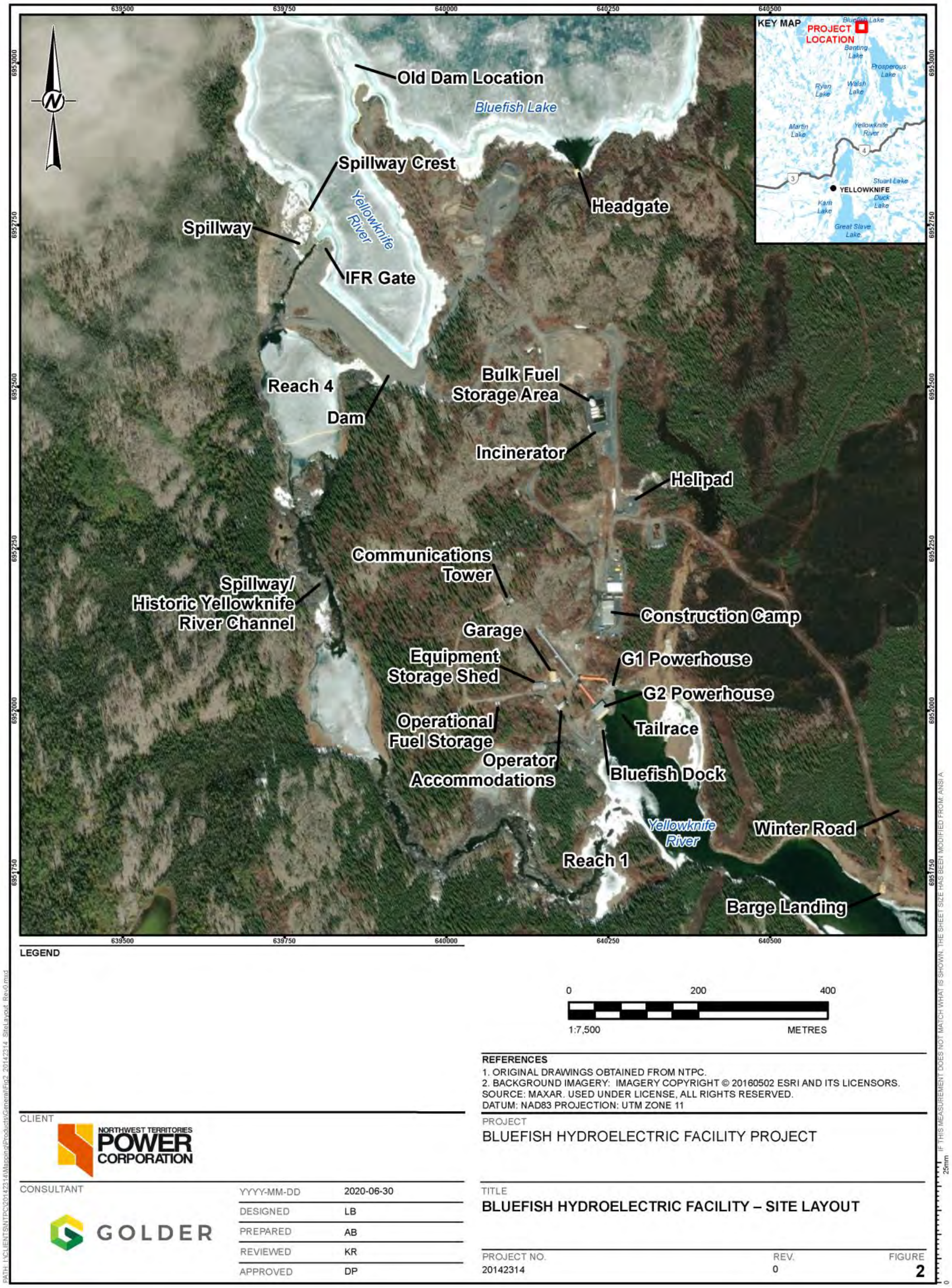

Figure 2: Bluefish Hydroelectric Facility Site Layout

1.1.3 Operational Overview

The main control structure is on the outlet of Bluefish Lake. The flow of the Yellowknife River is diverted through an intake (forebay gate). The amount of water entering the intake is controlled by the two generators. Both units at full load will pass 28.4 m3/s or 1003 cfs. The intake leads to a 760 m long unlined rock tunnel. From the tunnel, a 3 m diameter, 150 m long penstock connects to two powerhouses. The old power plant has a generating capacity of 3200 kilowatts, while the new plant has a capacity of 4000 kilowatts. The Bluefish Hydro facility operates on the new plant and utilizes the old plant as a variable flow unit to optimize flows that exceed the requirements of the new unit. There are several additional buildings located near the powerhouses, including a transient house and two trailers used to house operations employees. A site layout diagram is provided in Figure 2.

The main water storage area for the Bluefish Hydro facility is at Duncan Lake. A storage dam constructed near the south end of Duncan Lake can vary the water level of the lake between 209.3 and 212.4 m. This 3.1 m difference in the Duncan Lake water level represents a volume of 207.2 million m^3. The primary purpose of the Duncan Lake dam is to store water and regulate levels in Bluefish Lake.

The operator on duty at the Bluefish Hydro facility inspects the Bluefish dam, spillway and headgate daily. The Duncan Lake dam is inspected at least quarterly.

Figure 3: Bluefish Lake and Hydroelectric Site

Figure 4: Bluefish Hydroelectric Plants

Figure 5: Duncan Lake Dam

Figure 6: Duncan Lake Control Structure

1.1.4 Generating Station #1 (Old Plant)

The Bluefish #1 generating station is the oldest hydro facility in the Northwest Territories; built in 1942 to supply the needs of Cominco Mine at Yellowknife. This plant is shown in Figure 7. The powerhouse contains a horizontal axis Allis Chalmers, Francis turbine, with a capacity of 4700 horsepower, with a 33.53 m head. The generator is a Westinghouse 3 phase, 2300 volt with a kVA rating of 4200. A 2.13 m. (84 inch) diameter butterfly valve is provided to permit shutdown and dewatering of the turbine. Tailrace stop logs are also provided.

Figure 7: Bluefish # 1 Generating Station

1.1.5 Generating Station #2 (New Plant)

The Bluefish #2 generating station, constructed in 1994 is a Francis type horizontal shaft penstock intake direct connected to a generator via a geared flexible coupling. The runner is a double runner Francis with a common spiral case and distributor to control the amount of flow through the turbine and two draft tubes. The turbine shaft passes through both draft tubes and is supported by pedestal bearings at each end. Shaft seals are provided where the shaft passes through the draft tubes. The unit is operated as a base load plant.

The synchronous generator is a horizontal brushless generator manufactured by General Electric Company and rated at 4444 kVA,4000 KW, 0.90 power factor, three phase 60 hertz, 2300-volt, wye connected, six leads, 80°C rise by resistance above 40°C ambient, continuous duty, class F insulation, and 1.15 service factor. The turbine has an operating net head of 110 feet (33.53 meters). The power plant has a 300 kW standby diesel generator for blackstart.

Figure 8: Bluefish Generating Unit # 2 (Plant #2)

1.2 Dam Description and Classification

The Yellowknife River System, at the Bluefish Hydro facility drains an area of approximately 11,300 km^2. Bluefish Lake has an area of almost 3 km^2. The mean annual rainfall (30 years) at the Bluefish hydro facility is 239 mm. The minimum historical Yellowknife River flow (50 year: 6.9 m3/s mean monthly) occurred in April 1977. The maximum flow (50 year: 152 m3/s maximum monthly) occurred in July 1991. Plant flow capacity with both units operating at maximum output is 28.4 m3/s. Typically maximum spillage over the Bluefish dam occurs during August and September. Low natural inflows generally occur during the second quarter of each year.

1.2.1 Bluefish Main Dam and Spillway

As noted previously the Bluefish Dam and Spillway are discussed in further detail in Volume 2.

Bluefish Dam is the primary dam that impounds a reservoir (Bluefish Lake) for hydroelectric generation and is located on the Yellowknife River approximately 1 km from the outlet into Prosperous Lake. The Bluefish Dam was constructed at the outlet of Bluefish Lake where a waterfall was located prior to dam construction. There is approximately 38 m of water head difference between the penstock intake and the turbines at the generating facility.

The penstock is located to the southeast of the left abutment of the dam. It is housed within a steel frame building. A vertical sliding gate and trash rack is present at the entrance to the penstock. The penstock consists of two segments; an initial unlined tunnel in bedrock (760 m long) and a steel penstock pipe *3* m in diameter (150 m long). The steel penstock bifurcates and then connects to two powerhouses capable of generating 4 MW (new powerhouse) and 3.2 MW (old powerhouse). There is an emergency bypass conduit that is connected to the penstock upstream of the powerhouses.

Important Note:

When the replacement Bluefish Dam and Spillway was designed and constructed from 2009-2012 a new Geodetic datum (permanent survey elevation) was established using modern methods. All elevations in Volume 2 of this OMS manual are in reference to the new datum. It became apparent that the historical datum created decades previous was 17.15m higher than actual. Since all historical records; Operations, Annual Reports, Water Survey of Canada Hydrometric Records, Surveillance Network Program Data, etc. are referenced to the old datum. A conversion chart for key elevation points on the dam and spillway is provided in Table 1.

Table 1: Salient Data - Bluefish Dam and Spillway

	New Geodetic elevation (m)	Miramar/NTPC Datum (m)
Minimum design operating level	165.73	*182.88*
Instream Fisheries Release (IFR) Bypass Elevation	165.15	*182.30*
IFR Design Discharge at Minimum design operating level	7.6 m^3/s	
Normal Operating Level or Full Supply Level (FSL)	168.78	*185.93*
Reservoir Volume at FSL	23,536,415 m^3	
Reservoir Area at FSL	292.6 ha	
Overflow Spillway Elevation	168.78	*185.93*
Dam Consequence Classification (EBA 2011)	High	
Maximum allowable flood level	170.22	*187.37*
Inflow Design Flood @170.22	387 m^3/s	
Head on overflow spillway crest	1.44 m	
Minimum freeboard to crest of dam	1.0 m	
Dam Crest Elevation	171.22	*188.37*
Probable Maximum Flood (PMF) discharge@170.87	662 m^3/s	

The water storage capacity of Bluefish Lake at various elevations is illustrated in Figure 9.

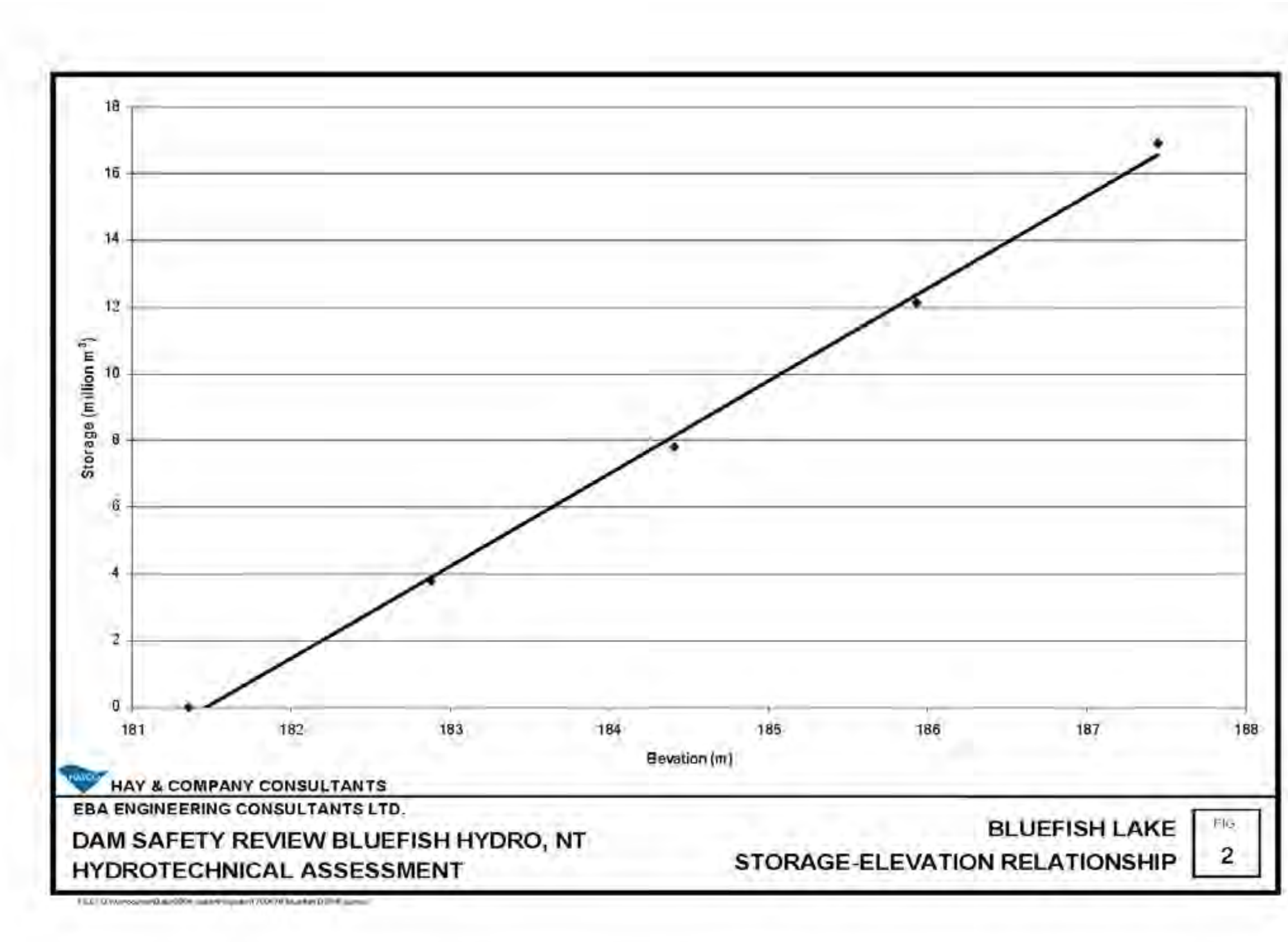

Figure 9: Bluefish Lake Water Storage Capacity

1.2.2 Duncan Lake Dam and Spillway

Duncan Dam is a secondary dam upstream of Bluefish Dam that was constructed to regulate water levels in Bluefish Lake. The reservoir for Duncan Dam is Duncan Lake and to a lesser extent, Graham Lake. Duncan Dam is approximately 20 km north east of Bluefish Dam. However, the flow path from Duncan Dam passes through, in downstream order, Neck Lake, Short Point Lake, Angle Lake and Quyta Lake. The total length of flow path from Duncan Dam to Bluefish Dam is 35 km.

Duncan Dam was originally constructed as a timber crib dam in 1942 and replaced with a reinforced concrete gravity dam in 1974. The new dam was built 20 m down stream from the old dam site. Duncan Dam is located in a narrow draw that constitutes the outlet of Duncan Lake.

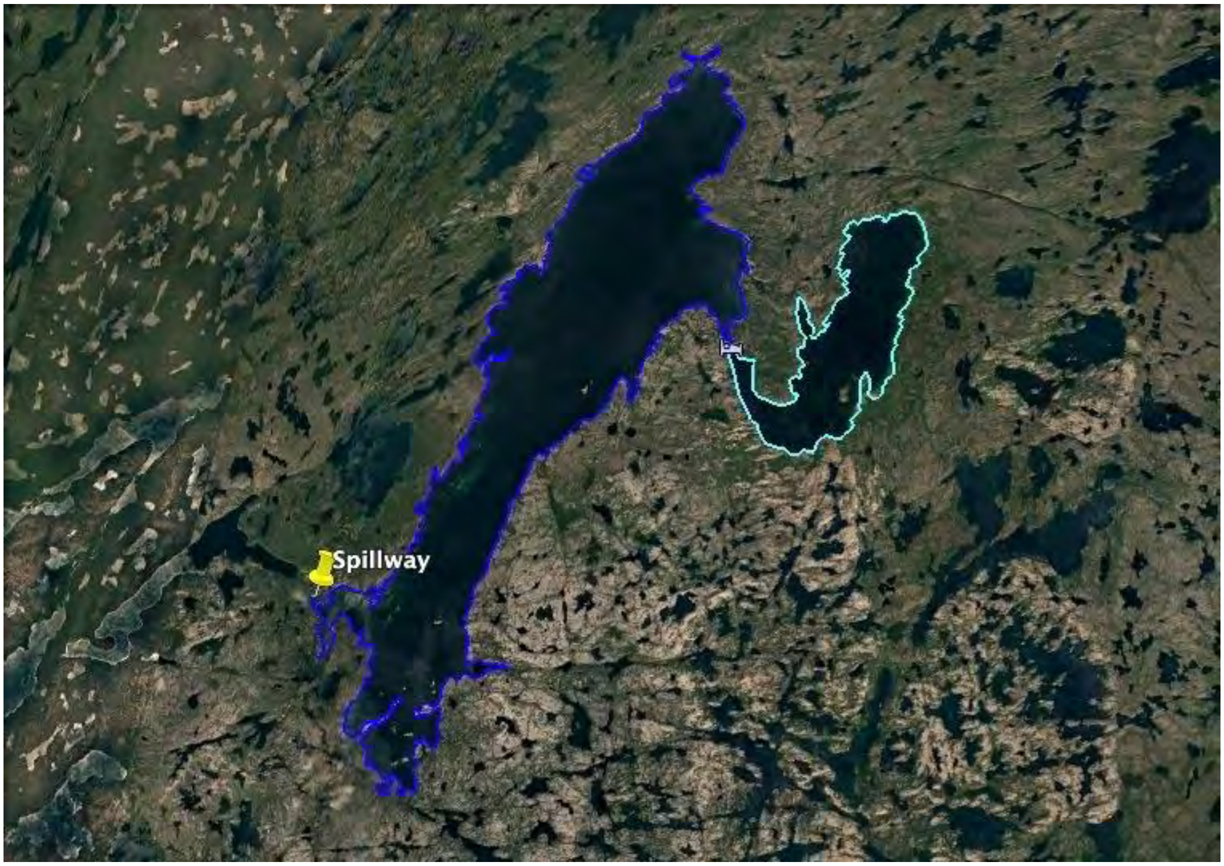

Figure 10: Duncan Lake and Graham Lake

Figure 11: Duncan Lake Spillway Dam

1.2.3 Duncan Lake Reservoir

The main water storage area for the Bluefish Hydro facility is at Duncan Lake. Duncan Lake has an area of 69 km^2 and Graham Lake 17 km^2, as illustrated in Figure 10.

The volume of water stored in Duncan Lake is 207,224,949 m^3 (168,000 acre-feet). The McCrea River, Nicholson River and Duncan Lake drain an area of approximately 3900 km^2. This is the only regulated or controlled part of the Yellowknife River upstream of Bluefish hydro. The remaining 7400 km^2 is natural flow. The water storage capacity of the Duncan Lake reservoir is illustrated in Figure 12.

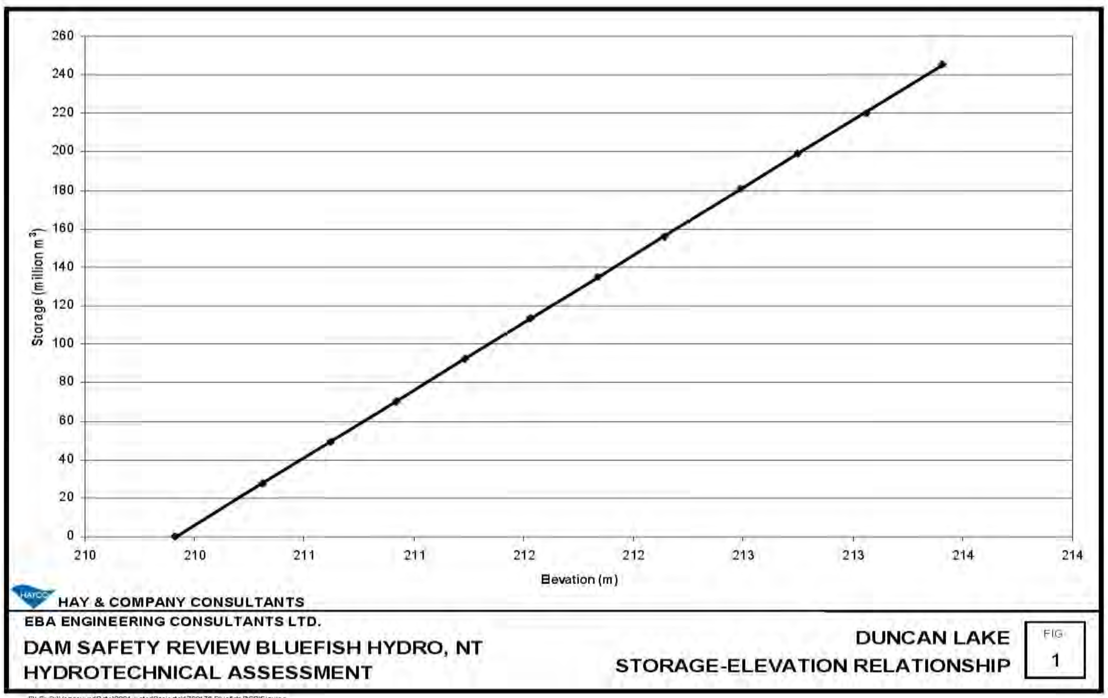

Figure 12: Duncan Lake Water Storage Capacity

1.2.4 Classification

The CDA Guidelines suggest that the classification of a dam be conducted in terms of the reasonably foreseeable incremental consequences of failure. The loss of life consequences should be evaluated separately from the socio-economic, financial and environmental consequences and the higher of the two classifications be used. The classification system suggested by the CDA Guidelines is presented below.

Table 2: Summary of CDA Guidelines for Consequences of Dam Failure

Category	**Potential Incremental Consequence of Failure**	
	Life Safety	Socio-economic, Financial and Environmental
Very High	Large numbers of fatalities	Extreme damages
High	Some fatalities	Large damages
Low	No fatalities anticipated	Moderate damages
Very Low	No fatalities	Minor damages beyond Owner's property

Incremental consequences are those over and above consequences that would have occurred for the same event or condition had the dam not failed. The evaluation of potential losses, resulting from a dam failure is based on the following:

(1) A flood inundation study in the event of failure of Bluefish and Duncan Dams was conducted by Dames & Moore in 1998, reviewed by HayCo. in 2005; (2) Helicopter reconnaissance of the Yellowknife River and Prosperous Lake area.

A discussion on the consequence rating of Duncan Dam during the latest *Dam Safety Review* is as follows;

It is understood that the extend of the flooding would cause adverse damages to the environment, therefore the minimum classification to be considered is “significant” for both dams. Since no risk of loss of life is expected, and the damages foreseen are only located at NTPC facilities close to Bluefish GS (the damages to the dam’s associated structures are not to be considered in the classification).

NTPC wants to consider Bluefish Dam as “High” consequences, due to the power shortage in Yellowknife caused by the dam failure consequences. Therefore, the IDF for a “high” consequence dam is 1/3 between 1000-year’ and the PMF, which is estimated to be 387 cms (m^3/s) for Bluefish Dam.

The failure of Duncan Dam would reduce the energy production temporally, but since its does not have a big impact, the dam failure consequences classification will be considered as “significant” with an IDF flow value between the 100-year and 1000-year’ recurrence. The 300-year’ recurrence is selected with an IDF value equal to 131 cms.

1.3 Spillway Description and Capabilities

As noted previously the Bluefish Dam and Spillway is discussed in further detail in Volume 2.

1.3.1 Bluefish Dam Main Spillway

The curved overflow spillway is referred to as a “bathtub-type” spillway that has a length of 102.9 m. It has a discharge capacity of 387m3/s when the reservoir is 1.44m above the spillway crest.

1.3.2 Bluefish Bottom-Outlet and Instream Fisheries Release (IFR) Structure

One bay of the bottom outlet structure was sealed after construction. The second bay was equipped with a 1.37m2 stainless steel slide gate. This allows for the downstream passage of 7.6 m3s of water even at minimum reservoir levels.

Standard operating procedures for the IFR gate and for planned shutdowns affecting the spillway are provided in Appendices A and B of this document.

1.3.3 Duncan Dam and Spillway

Duncan Dam is approximately. 5 m high and approximately 30 m long. Due to the upstream bathymetry, Duncan Dam provides 3.1 m of live storage in Duncan Lake. The upstream face of the dam is nearly vertical. The downstream face of the dam is sloped at an angle of 0.75H:1V. Excerpts from the design drawings showing plan, profile and section of Duncan Dam are presented in Appendix C.

Duncan Dam has a central stoplog spillway that extends to within 2 to 3. m of the base of the dam, In addition to this facility, the dam can spill water over its crest through two ogee spillways on either side of the stoplog spillway as well as over the stoplogs.

Duncan Dam is constructed on bedrock on the right abutment and on boulders on the left abutment. In 2007 the dam was grouted where the concrete meets the bedrock on the right abutment and where the concrete meets the boulders on the left abutment. A geomembrane liner was placed on the upstream side of the dam in 2007 to limit seepage beneath the dam. Stoplogs were replaced in 2014. Appendix C includes the operating and maintenance manual for the stoplog gate.

1.4 Operational Responsibilities

1.4.1 Reporting Structure

The Bluefish Plant Operator reports to the Manager, Plant Operations in Yellowknife who reports to the Director, Hydro Division. For technical assistance there is the Manager, System Control; Manager, Mechanical Services; and Manager, Electrical Services in Yellowknife and the Engineering Director in Hay River.

1.4.2 Duties and Qualifications of Operators

The Bluefish Operator does a visual inspection of each facility at least once a day. During the operator's tour of duty an observation checklist is filled out regarding conditions and unusual occurrences. (See 4.1.2 for check list)

Each Operator has gone over the checklist with the Manager, Plant Operations, Manager, System Control and has been shown what to look for. The operator will carry out day to day maintenance if they require assistance other personal will be brought to site, be it electrical or mechanical.

1.5 Revisions to Water Management and Reservoir Operating Plan

1.5.1 Responsibility

The System Control Manager located in Yellowknife is responsible for timely reviews, revisions and formal issues of the Water Management and Reservoir Operating Plan. The Plan is to be kept contained in a three-ring binder format to allow for replacement of pages or sections as needed. The Water Management and Reservoir Operating Plan is also available to all employees electronically on the computerized filing system. An example of Water Management and Reservoir Operating Plan is attached in Appendix D.

1.5.2 Timeframe

The Plan is to be revised as changes of personnel or organizational structure occurs and when modifications or events cause procedural changes. The Plan shall at a minimum be reviewed by the System Control & Hydro Planning Manager and the Maintenance Manager annually before June 30th of each year.

1.6 Permanent Record File

1.6.1 Location

The permanent Record file will be located in the office of the System Control Manager in Yellowknife. The Bluefish Hydro OMS will also be filed on the company computer Imanage system at: YKIDOC / Other Folders / Hydro Operations. Through the computer system the Bluefish Hydro OMS will be available to all employees.

1.6.2 Contents

At the end of each year, the logbook from each plant shall be reviewed for any reference to the dam or spillways and the appropriate pages copied, scanned and kept in the permanent record file. The plant inspections forms will be kept for one year in the plant then transferred to the Control Centre for one year, after which time they will be warehoused in Hay River.

2 Design and Operation

2.1 Inflow Design Flood (IDF)

The inflow design flood for Duncan Dam was selected based on the consequence classification assessment conducted by EBA and HayCo. It is currently classified as Low Consequence dam. A 1:300 year IDF was selected for it. A 1:300 year event represents the approximate mid point between the lower and upper limits of the range of flood events, 1:100 and 1:1,000 respectively, for a Low Consequence dam as suggested by the CDA Guidelines. However, as considered in the consequence classification assessment, the economic consequences of failure to NTPC and the future risks to life safety associated with a future decision to not implement a public safety management plan could result in Bluefish Dam becoming a High Consequence dam. Therefore, the 1:1,000 IDF was also modelled for both structures. A 1:1,000 event is the lower limit of the range of design events, 1:1,000 to PMF, suggested by the CDA Guidelines for a High Consequence structure.

The CDA Guidelines suggest that the dam crest be set at a level that satisfies both the normal operation conditions and the IDF conditions. For the normal operating condition, it was assumed that the reservoir is at the spillway crest elevation and there is a wind with a 1:1,000 annual exceedance probability. For the IDF conditions, the reservoir level is at the maximum level reached during the passage of the IDF combined with the mean maximum annual wind condition normally used for large reservoirs.

Results of the hydraulic analysis indicate that Duncan Dam will have a freeboard of approximately 0.25 m during the normal operating conditions and a 1:1,000 year wind.

Duncan Dam (with all stoplogs removed in the sluiceway) will have freeboard of about 0.60m and 0.35 m during the 1:300 IDF and 1:1,000 IDF condition, respectively. When all stoplogs are in place, Duncan Dam will be overtopped by 0.71 m during the 1:300 IDF condition and 0.78 m during the 1:1,000 IDF condition.

2.2 Allowable Reservoir Levels and Flows

Table 3: Allowable Reservoir Levels (Miramar/NTPC Datum)

Plant Name	**Minimum** (m/ft)	**Normal Maximum** (m/ft)	**High Flow Maximum** (m/ft)
Bluefish	182.88 m / 600.03 ft	185.0 m / 607.00 ft	187.10.m / 613.90 ft
Duncan Lake	209.45 m / 687.20 ft	212.04 m / 695.70 ft	213.67 m / 701.05 ft

Table 4: Allowable Water Flows

Plant Name	Maximum (m^3/s / cfs)	Minimum (m^3/s / cfs)
Bluefish	387.0 / 13666	6.0 / 212
Duncan Lake	105.2 / 3716	N/A

2.3 Spillway Design Capacities

2.3.1 Operating Parameters

Stoplogs are adjusted at Duncan Lake according to the anticipated flow of the Upper Yellowknife River. The goal is to supplement the flow in order to maximize both Bluefish Hydro units, generally in the winter months. If additional flow is not necessary stoplogs are placed in order to build up the Duncan Reservoir, generally in the spring, summer and fall.

2.3.2 Rating Curves

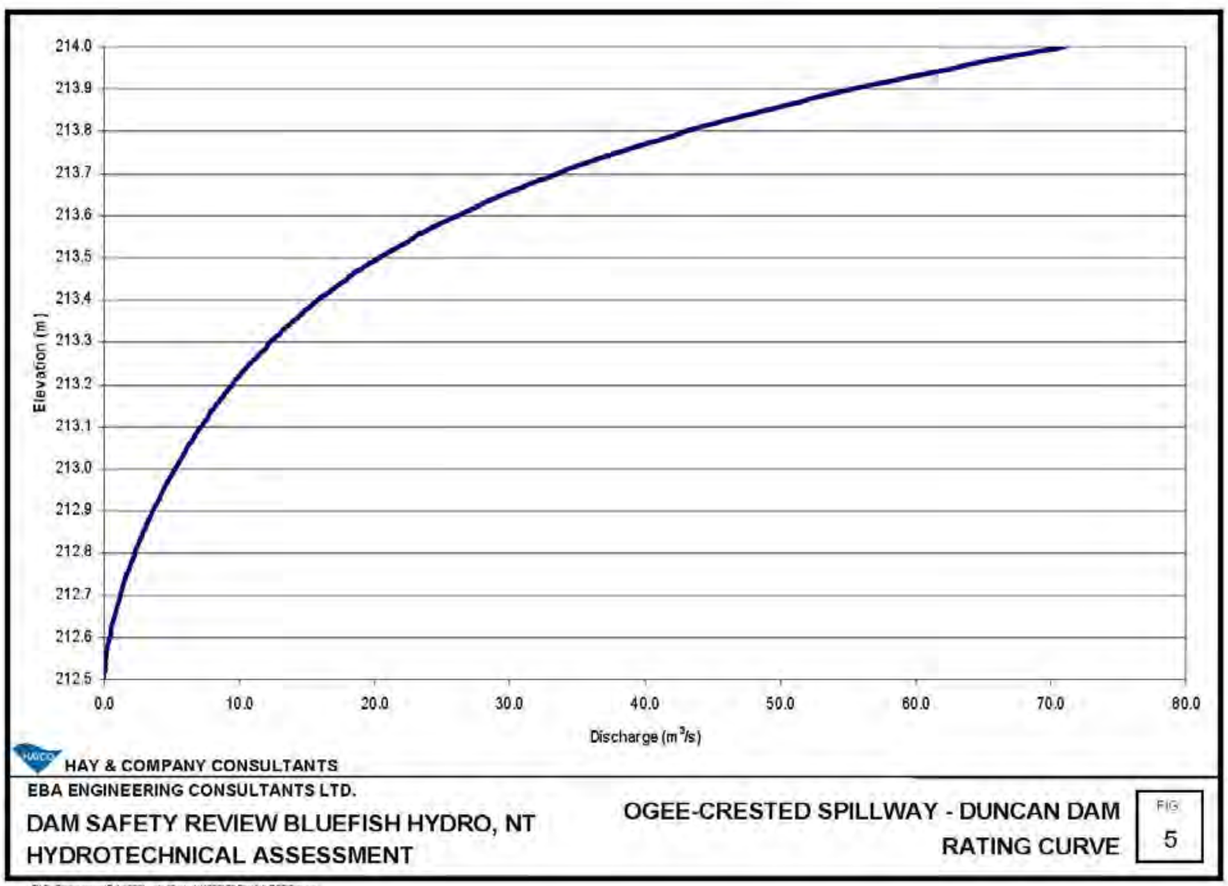

Figure 13: Rating Curve - Duncan Main Spillway

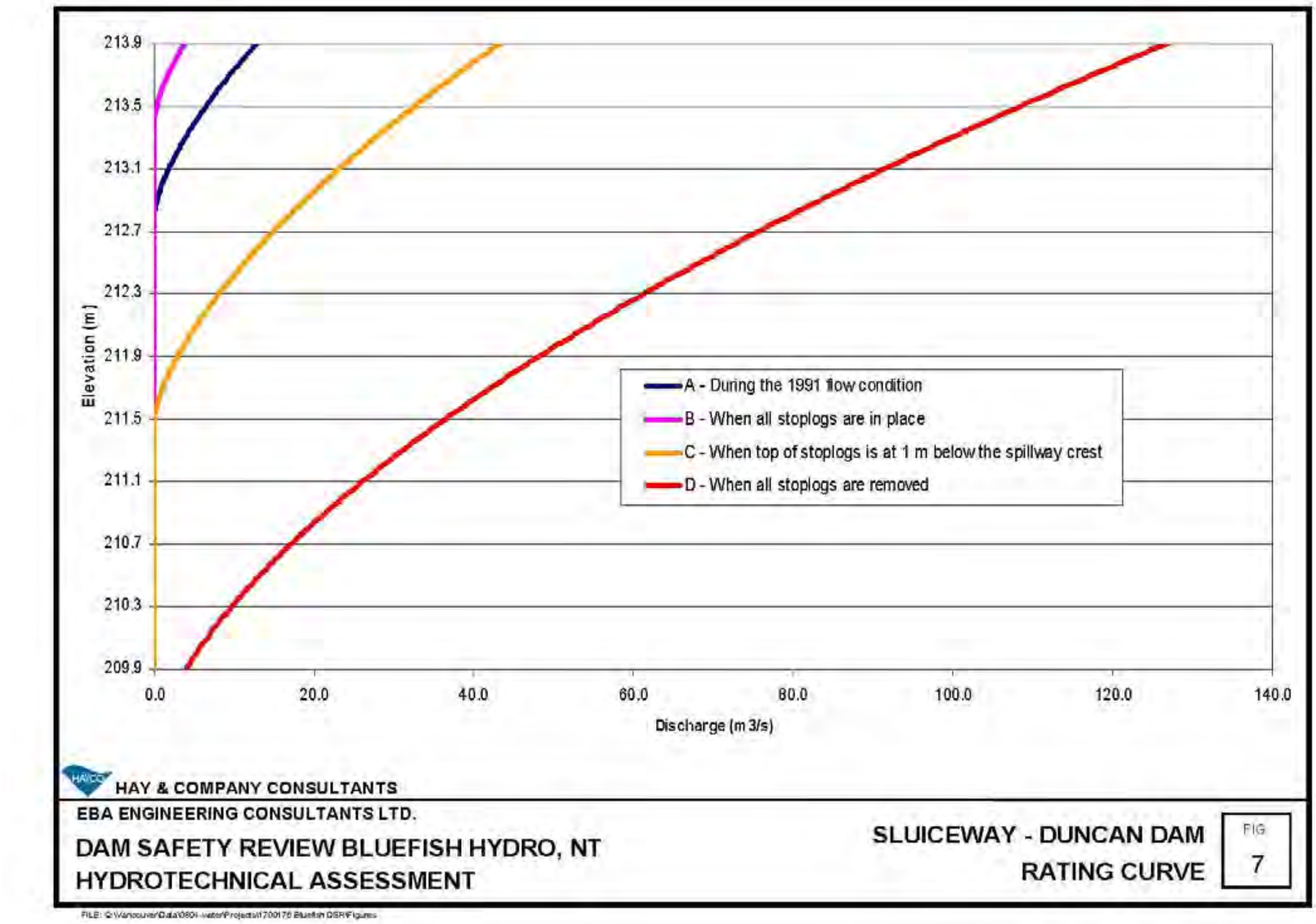

Figure 14: Rating Curve - Duncan Auxillary Spillway

2.3.3 Duncan Main Spillway

There are two fixed spillways that are both 6.09 m in length at an elevation of 212.49 m once Duncan Lake reaches an elevation of 212.49 it will start to spill over the spillway.

2.3.4 Duncan Auxiliary Spillway

The auxiliary spillway is 4.26 m wide with a bottom elevation of 209.44 m. There are twelve logs 25.4 cm X 25.4 cm. Logs are put in place during the Spring run off the build up Duncan Lake and logs are removed in the winter to keep both Bluefish units at as close to full load as possible. If the Spring runoff appears to be too high and the Duncan Lake level could reach 213.14 m logs will be pulled during the Spring as well.

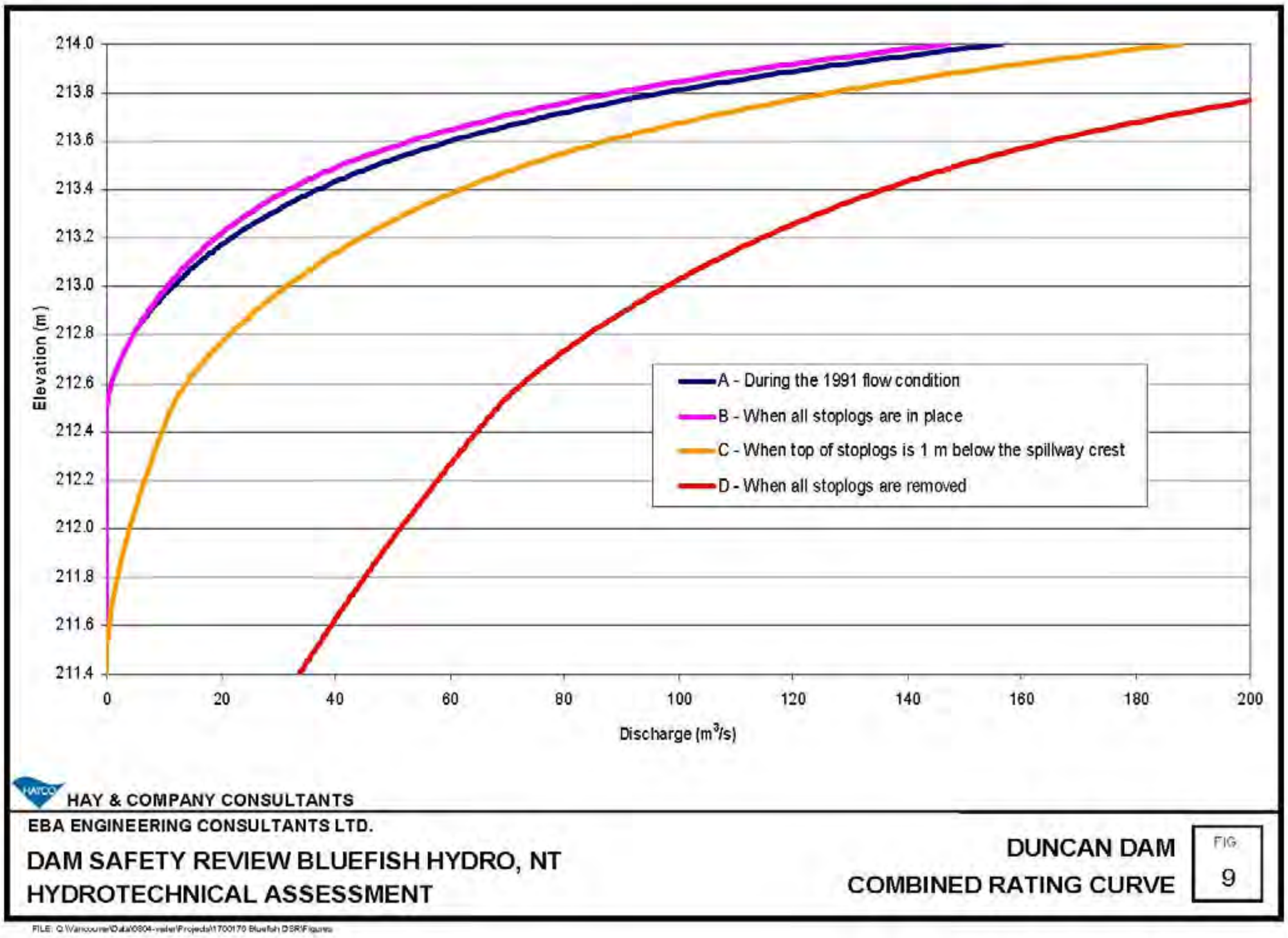

Figure 15: Rating Curve - Duncan Main and Auxillary Spillways Combined

2.4 Turbine Design Capacities

2.4.1 Operating Parameters

Bluefish G1: With a designed head of 32 m Unit 1 can be operated from 0.0 to 3.8 MW, with a flow of 0.0 to 13.7 m^3/s

Bluefish G2: With a designed head of 32 m Unit 2 can be operated from 0.0 to 3.5 MW, with a flow of 0.0 to 14.7 m^3/s

2.4.2 Rating Curves

Rating curves for both generating units (G1 & G2) are illustrated in Figure 16.

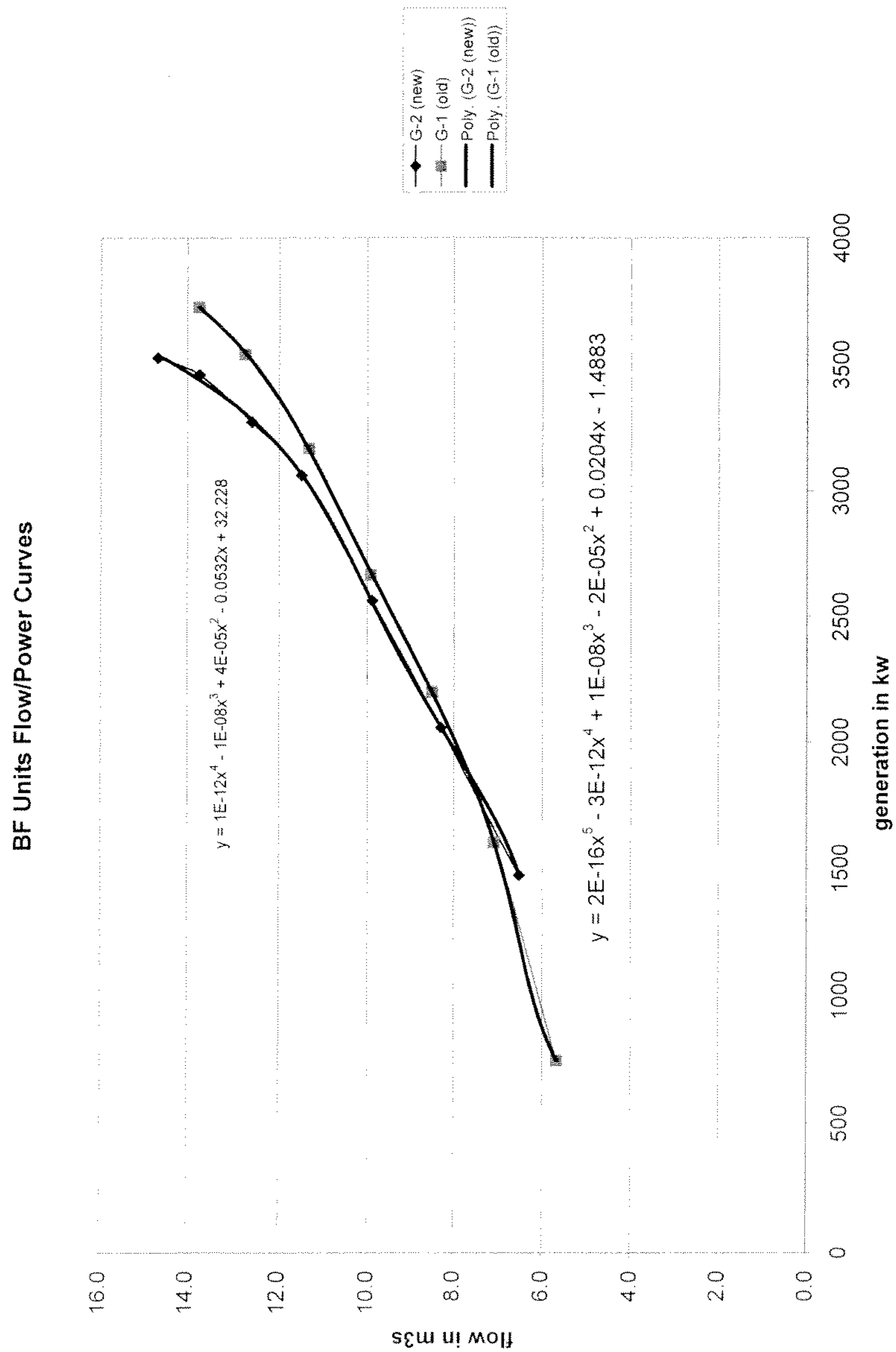

Figure 16: Bluefish Generating Units Flow/Power

2.5 Forecasting

The Yellowknife Power System is stand alone and not integrated into any other electrical grid. Generation therefore cannot be initiated without a demand for it. In order to forecast power generation; hydro, diesel or both, one must first forecast both the amount of power required by the load and when it is required. The annual forecasting process is summarized by the flow diagram in Figure 18.

The first step is to look at the previous year recorded load; from revenue customers, internal use (station service) and losses (transmission and transformer heat). After discussions with the major customers a load forecast for the following year is developed, generally on a monthly basis. This process is later reiterated with the hydro and diesel forecast as the amount of losses is dependent on the amount of hydro generation, higher hydro generation creates higher losses, particularly on the transmission line. The same with the invert of diesel generation and station service. Low diesel generation causes higher station service due to unit heating requirements. Initially the load forecast assumes an average power production from hydro and any load requirements beyond that to be diesel.

Looking at annual or monthly load requirements is not suitable for forecasting hydro generation, especially in the winter, as there is a finite amount of hydro available at any one time. The demand of the load might exceed the capacity of all the available hydro units at any specific time and yet there may be surplus capacity for other times. It is therefore required to have a forecast of what the load demand could be on an hourly basis. For that, the hourly data of the previous year from the Yellowknife System Control Center is adjusted by the load change estimate determined previously. An average day for each month is then calculated on an hourly basis. This “day” includes week days and weekends, warm days and cold, and therefore does not actually exist but it still can represent that month as far as the general hourly use of power by the customer.

The typical hourly load profile for 2015 is illustrated in Figure 19. Higher overall demand can be observed in the winter months as well as a more prominent peak in the dark evenings. That year there was also a low flow situation on both the Snare and Yellowknife Rivers. This diminished both overall hydro energy production and also peaking capacity. As an example, the entire hydro system could produce 26 MW but only had enough water to do that for 4 hours. The water management objective for this scenario is to store water in the summer in order to increase the duration of peaking ability in the winter. This would ease the requirements of diesel in the winter and allow for some flexibility to deal with temporary shortfalls.

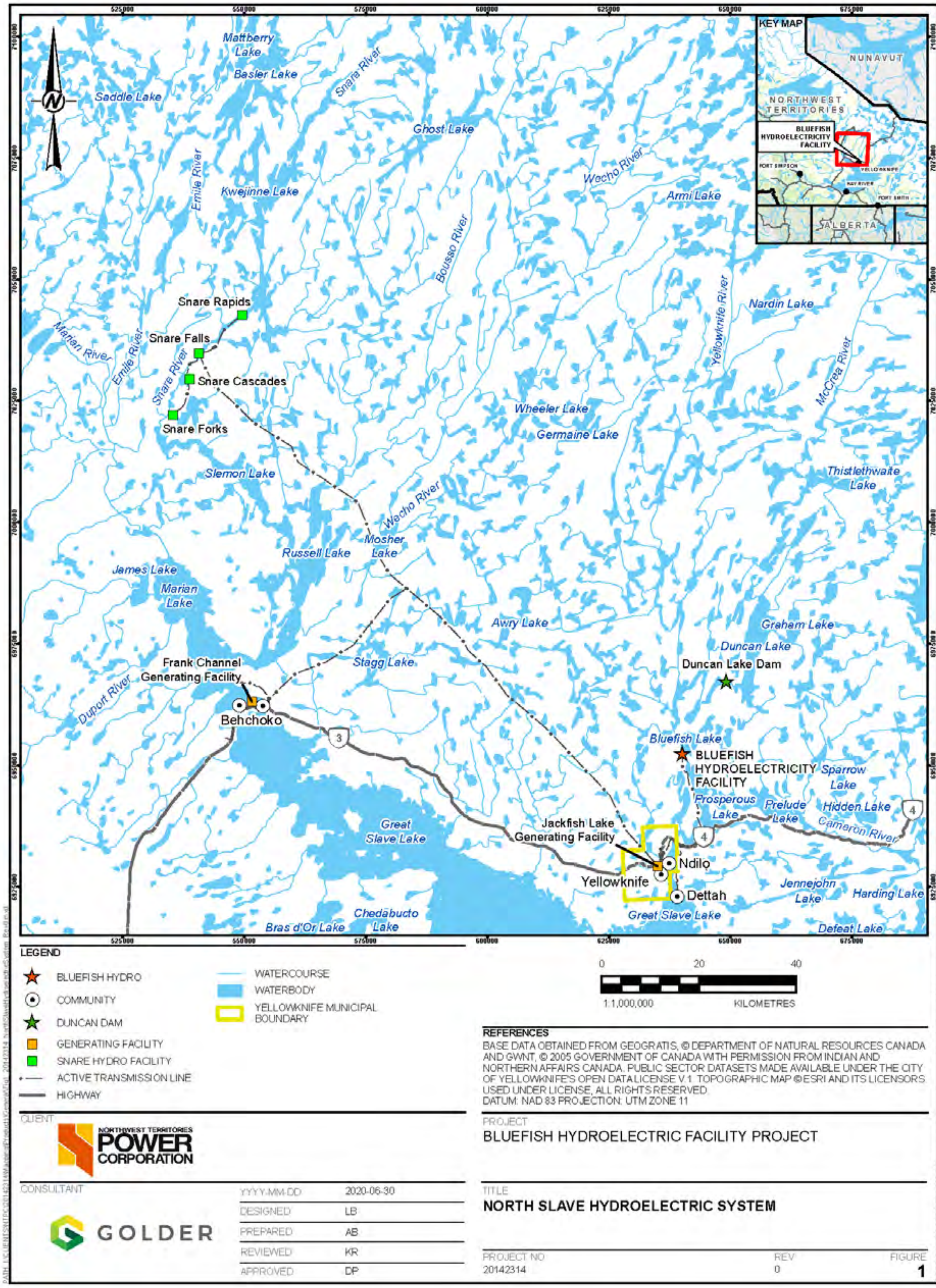

Figure 17: North Slave Hydroelectric System Locations

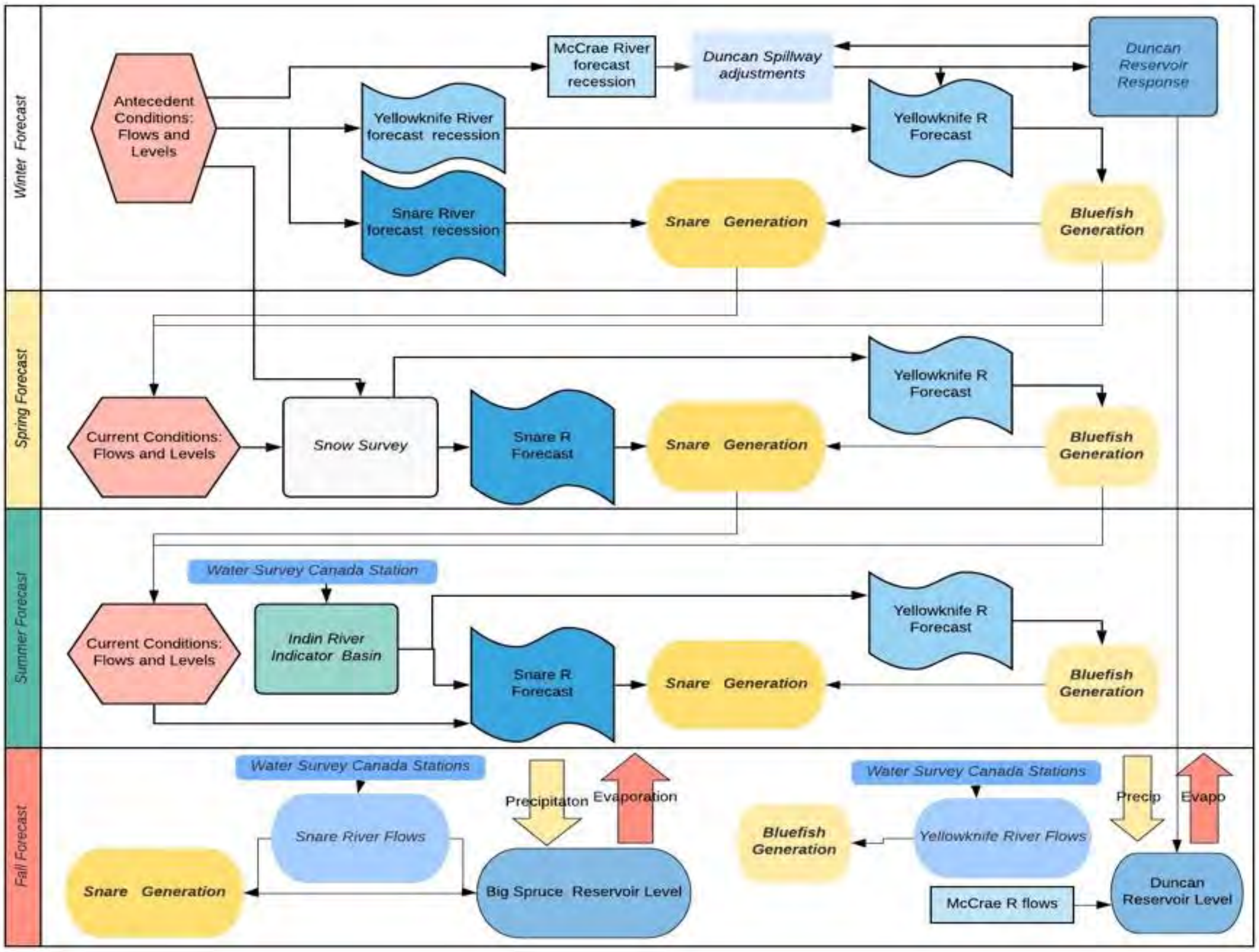

Figure 18: North Slave Hydro Forecasting Process

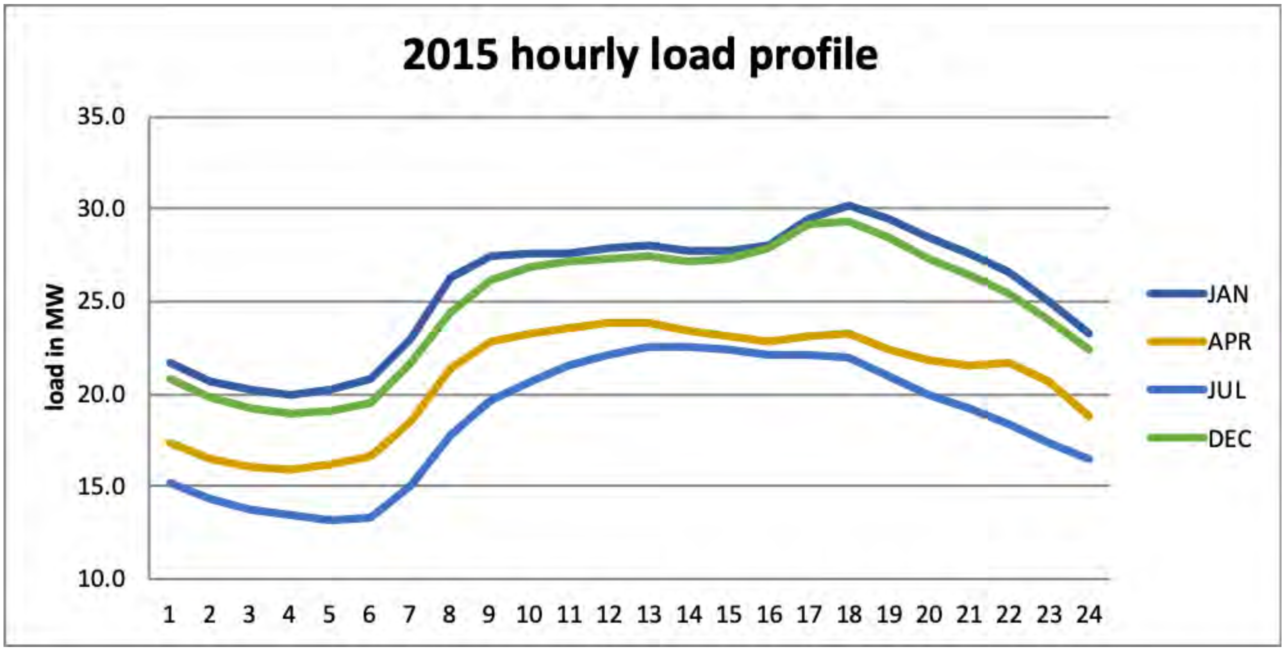

Figure 19: Hourly Load Profile (2015)

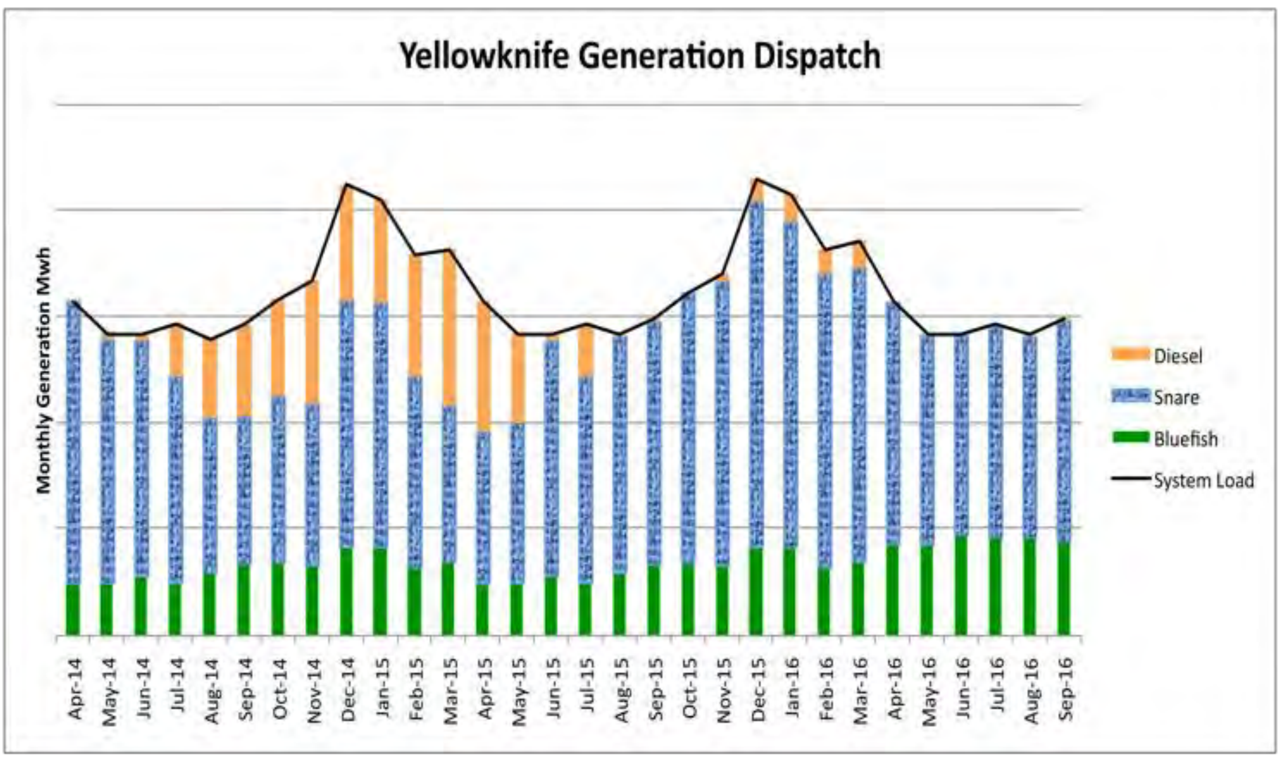

Figure 20: Monthly Generation, 2014-2016

2.5.1 Forecasting Methodology

1.0 INTRODUCTION

1.1 Authorization

This study was authorized on June 6, 2003 by fax message from D. Grabke, Hydro Officer, Northwest Territories Power Corporation, in response to AMEC's proposal of May 6, 2003.

1.2 Approach

The Yellowknife River watershed supplying Bluefish G.S. can be considered to consist of two sub-basins:

- the main stem of Yellowknife River at Bluefish draining 7,414 km^2, and
- McCrea River at Duncan Lake draining 3,886 km^2.

Runoff from Yellowknife River is uncontrolled since the capacity of Bluefish Reservoir is too small to provide medium or long-term storage. However, Duncan Lake Reservoir on McCrea River is large enough to provide seasonal flow regulation of McCrea River flows.

To facilitate plant operations, two runoff forecasts are required, one for Yellowknife River at Bluefish and another for McCrea River at Duncan Lake Reservoir. As for the Snare River System, an annual forecasting cycle having four steps in generally followed.

Forecasting Cycle:

Step 1: May Forecasts, based on snow pack measurements from the April snow survey and covers the period May to mid-June.

Step 2: June Forecasts, based on the spring peak observed at Indin River and covers the period mid-June to mid-July.

Step 3: Summer Forecasts, based on observed peak flows on Yellowknife and Cameron Rivers and covers the period mid-July to mid-October, with periodic updates.

Step 4: Winter Forecasts, based on the Recession Curves of the annual hydrograph at Yellowknife and Cameron River and covers the period mid-October through April with periodic updates.

These procedures are further explained by a sample applications in Sections 2 and 3 of this manual and illustrated by Exhibits 1 to 5 at the end of the text.

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2.0 FORECASTING RUNOFF ON YELLOWKNIFE RIVER AT BLUEFISH

Yellowknife River runoff forecasting procedures are explained by a sample application for the annual forecast cycle from May 1st, 1999 to mid February, 2000. The resulting forecasts and updates are illustrated in Exhibit 3 and backup arithmetic is provided in the working files on the enclosed computer disk.

2.1 May Forecast

Results of the April 1999 snow survey, were:

Snow Survey Stations		SWE (mm)
07SB-SC02	Tibbett Lake	86
07SB-SC04	Allan Lake	101
07SB-SC05	Denis Lake	132
07SB-SC6	Little Lathem Lake	109
07SB-SC07	Nardin Lake	115
07SB-SC08	Sharples Lake East	118
Mean S.W.E.		110.2

- Estimate Yellowknife River peak of spring flood (Q_{max}) using equation 2.1 or 2.2 below or from graph in Exhibit 1.

$$Q_{max} = 0.0137\ SWE^2 - 0.789\ SWE + 2.2 \qquad \text{for } SWE \geq 80 \qquad (2.1)$$

or

$$Q_{max} = 0.336 - SWE \qquad \text{for } SWE < 80 \qquad (2.2)$$

Where: Q_{max} = Yellowknife River peak spring flood (m^3/s)
SWE = snow water equivalent (mm)

Since SWE = 110.2 > 80.0 mm, use equation 2.1

$$\therefore \quad Q_{max} = 0.0137 \times 110.2^2 - 0.789 \times 110.2 - 2.2 = 77.2\ m^3/s$$

- Estimate date of spring flood peak, as mean date – Julian 195 (July 14)
- Select template from Exhibit 2

Use 1992 with factor = $\frac{Q_{forecast}}{Q_{template}} = \frac{77.2}{64.2} \rightarrow \times 1.20$

-2-

Applying the adjusted template with peak flow centred on Julian 195 provides the initial (spring) forecast, as shown in Exhibit 3.

2.2 June Forecast

Use Indin River flows as an index to update forecast.

Particulars of the 1999 Spring Peak at Indin are:

Q_{max} at Indin = $73.7\ m^3/s$
Date of Q_{max} = June 10 (Julian 161)

- Estimate Q_{max} Yellowknife River from equation (2.3):

$$Q_{max,YK} = 1.501\ Q_{max,in} - 0.6 \quad (2.3)$$
$$= 1.501 \times \cancel{73.6} - 0.6 \longrightarrow \cancel{109.9}\ m^3/s$$

73.7 110.0

- Estimate Date of Peak from equation (2.4):

$$\text{Lag (days)} = 0.0016\,(Q_{max,in})^2 - 0.536\ Q_{max,in} + 61.3 \quad (2.4)$$
$$= 0.0016 \times 73.7^2 - 0.536 \times 73.7 + 61.3$$
$$= 30.5 \text{ days (say 31 days)}$$

$\therefore$ date of peak = 161 + 31 $\longrightarrow$ 192 (July 11)

- Select template from Exhibit 2

Use 1992 with updated factor = $\dfrac{Q_{forecast}}{Q_{template}} = \dfrac{109.9}{109.0} \longrightarrow \times 1.01$

- ***Exhibit 3 illustrates this process.***

2.3 Summer Forecast and Updates

The spring peak flow was observed on Julian 180 (June 29). It is suggested that the initial extrapolation of the falling limb of the hydrograph be estimated by use of a template from Exhibit 2.

Use 1992 with updated factor = $\dfrac{Q_{forecast}}{Q_{template}} = \dfrac{117.0}{109.0} \longrightarrow \times 1.07$

The extrapolation is started from Julian 185, since a few days of observation must pass before the peak event can be confirmed (see Exhibit 3).

- ***Update Julian 213 (August 1st)***

Select the appropriate extrapolation formula from the following set of equations:

$$Q = Q_o \cdot 10^{-0.0081(t-t_o)} \quad \text{for } Q > 50\ m^3/s \quad (2.5a)$$
$$Q = Q_o \cdot 10^{-0.0047\,(t-t_o)} \quad \text{for } 50 \geq Q > 30\ m^3/s \quad (2.5b)$$

-3-

$$Q = Q_o . 10^{-0.0015\,(t-t_o)} \quad \text{for } Q < 30\ m^3/s \qquad (2.5c)$$

Where:

Q_o	=	initial flow at t_o	(m^3/s)
Q	=	flow at time t	(m^3/s)
t_o	=	initial time	(day)
t	=	subsequent time	(day)

Now, the observed flow at the end of July (Julian 212) was observed to be 65.4 m^3/s ($= Q_o$)

Since $Q_o = 65.4 > 50.0\ m^3/s$, equation (2.5 a) applies, whence:

$$Q = 65.4 \times 10^{-0.0081(t-212)}$$

The above relationship applies until Julian (225) when Q is reduced to ~50 m^3/s. After this date equation (2.5 b) is applied, as follows:

$$Q = 50.6 \times 10^{-0.0047(t-225)}$$

Similar updates are applied for the remainder of the summer / fall period, see Exhibit 3.

However, if an unusually large summer or fall flood were to occur the runoff would be reforecast, essentially as above, starting from a secondary peak observed on the Yellowknife River hydrograph.

2.4 Winter Forecasts

Consistently sub zero (Centigrade) weather sets in in mid October (usually!!). From this date until mid April in the following year precipitation into the system is in the form of snow, which does not contribute to winter runoff. During this period the runoff process can be treated as an exponential recession process, represented by equations 2.5 (a) to 2.5 (c), as in Section 2.3

3.0 FORECASTING RUNOFF FOR MCCREA RIVER AT DUNCAN LAKE

McCrea River runoff forecasting procedures are explained by a sample application for the annual forecast cycle from May 1st, 1999 to mid February 2000. The resulting forecasts and updates are illustrated in Exhibit 5 and backup arithmetic is provided in the working files on the enclosed computer disk. At present direct estimates of McCrea River inflows into Duncan are problematic due to difficulties in measuring outflow through Duncan Dam Sluiceway; therefore McCrea River (inflows) are estimated as 1.07 x Cameron River flows.

3.1 May Forecast

The May forecast is based on the same April 1999 snow survey, as for Yellowknife River, (see Section 2.1) whence:

Mean SWE = 110.2 mm

- Estimate the McCrea River spring flood peak (Q_{max}) using equations 3.1 or 3.2.

For SWE > 90 mm:

$$Q_{max} = 0.0096 \times SWE^2 - 1.399 \times SWE + 57.4 \quad (3.1)$$

or

For SWE < 90 mm

$$Q_{max} = 0.095 \times SWE \quad (3.2)$$

Where:

Q_{max}	=	peak spring flood, McCrea River	(m^3/s)
SWE	=	snow water equivalent	(mm)

Since SWE = 110.2 > 90.0, use equation 3.1

$$\therefore \quad Q_{max} = 0.0096 \times 110.2^2 - 1.399 \times 110.2 + 57.4 = 19.8\ m^3/s$$

- Estimate date of spring flood peak as mean date = Julian 171 (June 20).
- Select template from Exhibit 4

Use 1980 with factor = $\frac{Q_{forecast}}{Q_{template}} = \frac{19.8}{16.2} \longrightarrow \times 1.22$

Applying the adjusted template flows with peak flow centred on Julian 171 provides the initial (spring) forecast.

When the spring flood is centred on Julian 171 a significant displacement in time is observed, see "Initial Try" in Exhibit 5. Accordingly, a better estimate would be obtained by extending the curve from the last known point, Julian 120 (April 30), 9.4 m^3/s.

3.2 June Forecast

Use Indin River gauge as an index to update the forecast. As before, particulars of the 1999 spring flood peak at Indin were:

Q_{max} at Indin = 73.7 m^3/s
Date of Max = June 10 (Julian 161)

- Estimate Q_{max}, McCrea from equation (3.3)

$Q_{max,mcc}$ = $0.469\ Q_{max,in} - 3.4$

$\therefore$ = $0.469 \times 73.7 - 3.4 \longrightarrow$ 31.2 m^3/s

- Estimate Date of Peak, assuming a constant value for lag = 24 days

$\therefore$ Date of Peak = 161 + 24 $\longrightarrow$ 185 (Julian date)

- Select template from Exhibit 4

Use 1992 with updated factor = $\dfrac{Q_{forecast}}{Q_{template}} = \dfrac{31.2}{33.1} \longrightarrow \times 0.94$

Exhibit 5 illustrates this process.

3.3 Summer Forecast and Updates

The spring peak flow of 24.4 m^3/s was observed on Julian 175 (June 24, 1999).

It is suggested that the initial extrapolation of the falling limb of the hydrograph be estimated by use of a template from Exhibit 4.

Use 1992 with updated factor = $\dfrac{Q_{forecast}}{Q_{template}} = \dfrac{24.4}{33.1} \longrightarrow \times 0.737$

The extrapolation is started from Julian 180, (June 29) since a few days of observation must pass before the peak event can be confirmed.

- ***Update Julian 213 (August 1st).***

Select the appropriate extrapolation formula from the following set of equations:

$$Q = Q_o \cdot 10^{-0.0074(t-t_o)} \quad \text{for } Q > 10\ m^3/s \qquad 3.4(a)$$
$$Q = Q_o \cdot 10^{-0.0045(t-t_o)} \quad \text{for } 10 \geq Q > 5\ m^3/s \qquad 3.4(b)$$
$$Q = Q_o \cdot 10^{-0.0024(t-t_o)} \quad \text{for } Q < 5\ m^3/s \qquad 3.4(c)$$

Where:

Q_o = initial flow at time t_o (m^3/s)
Q = flow at time t (m^3/s)
t_o = initial time (days)
t = subsequent time (days)

Now the observed flow at the end of July (Julian 212) was 14.4 m^3/s (=Q_o).
Since $Q_o = 14.4 > 10\ m^3/s$, equation 3.4 (a) applies.

$$\therefore\ Q = 14.4 \times 10^{-0.0074(t-212)}$$

The above relationship applies until Julian 233 after which equation 3.4(b) is used, as below:

$$Q = 10.1 \times 10^{-0.0045(t-t_o)}$$

Similar updates are applied for the remainder of the summer/fall period, see EXHIBIT 5.

However, if an unusual summer or fall flood were to occur the runoff would be reforecast, starting from a secondary peak observed on the McCrea hydrograph.

3.4 Winter Forecasts

Consistently sub zero (Centigrade) weather sets in in mid-October (usually!!). From this date until mid April in the following year precipitation into the system is in the form of snow, which does not contribute to winter runoff. During this period the runoff process can be treated as an exponential recession process, represented by equations 3.4(a) to 3.4(c), as in Section 3.3.

2.5.2 Data Sources

Four Environment Canada WaterWeb sites are available on the internet for real time elevations and/or flows. They are located at; Yellowknife River at inlet to Prosperous Lake (07SB003), Duncan Lake near Yellowknife (07SB012), Bluefish Lake near Yellowknife (07SB015) and Yellowknife River above Quyta Lake (07SB020) as illustrated in Figure 21.

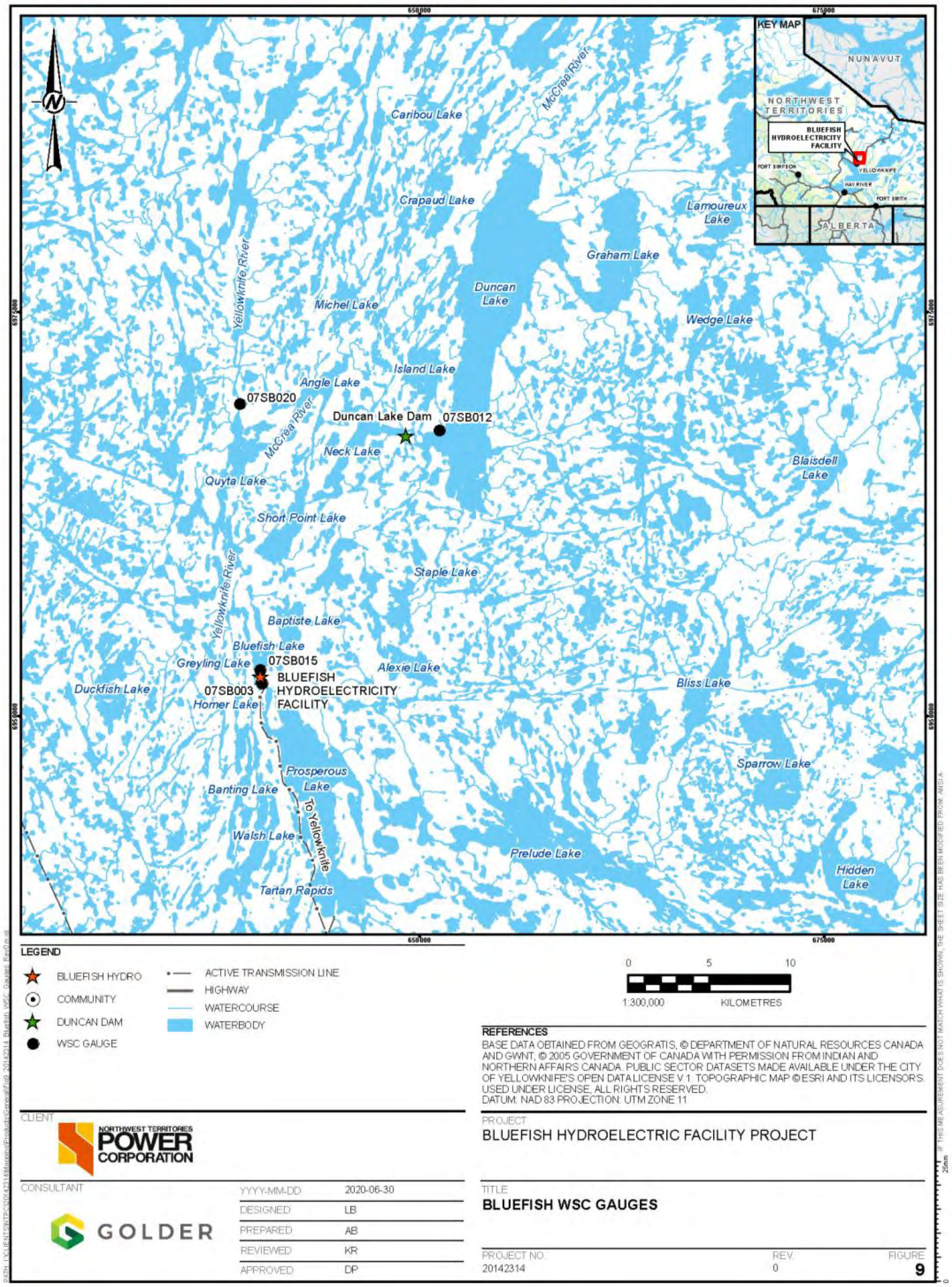


Figure 21: Water Survey Monitoring Station Locations

With assistance from the Meteorological Service of Canada, Climate Processes and Earth Observation Division, from January to May satellite shots are sent to NTPC indicating the water equivalency in the snow pack.

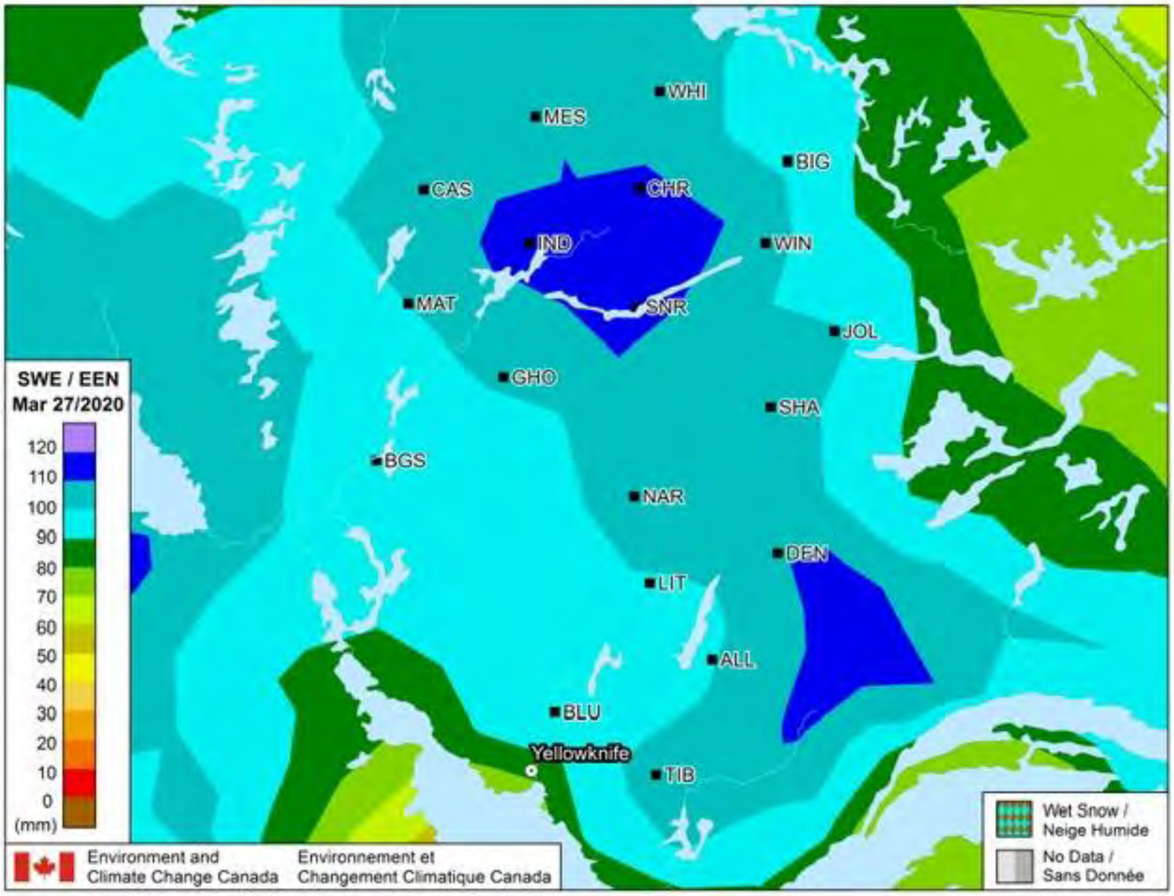


Figure 22: Snow Water Equivalent (SWE) Mapping Derived from Satellite Data

The Yellowknife River Snow Survey is performed with Environment and Natural Resources GNWT every year. Manual readings are taken at seven different locations in April to verify the satellite readings.

Table 5: Yellowknife Basin Snow Survey Data (2020)

Yellowknife Basin Survey Sites	Current End-of-Winter SWE (mm)	Average End-of-Winter SWE (mm)	Current Percent of Average (%)
Allan Lake	79.0	86.14	92
Bluefish Hydro	80.5	80.81	100
Denis Lake	109.5	108.64	101
Jolly Lake	115.0	135.5	85
Little Latham Lake	108.0	97.89	110
Nardin Lake	117.5	105.61	111
Sharples Lake East	124.5	107.85	115
Tibbitt Lake	85.0	84.21	101

Table 6: Snow Survey Station Locations and Historical Data Availability

Stations	Positions	Periods
Allan Lake	62.95° North, 113.05° West	1988 - 2020
Bluefish Hydro	62.68° North, 114.25° West	1995 - 2020
Denis Lake	63.37° North, 112.62° West	1987 - 2020
Jolly Lake	64.12° North, 112.21° West	1995 - 2020
Little Latham Lake	63.20° North, 113.63° West	1987 - 2020
Nardin Lake	63.51° North, 113.85° West	1987 - 2020
Sharples Lake East	63.90° North, 112.82° West	1987 - 2020
Tibbitt Lake	62.50° North, 113.38° West	1982 - 2020

2.6 Water Balance and Flood Handling

2.6.1 Flood Operating Procedures

During flood periods both units will be run at the maximum they can produce, and the spillways will be adjusted to maintain forebays. The maximum a unit can produce will be determined by the flow through the spillways and for how long the spill ways are open. The unit's maximum load will be reduced as the head is reduced. The maximum forebay at Bluefish is 187.37 at which time there would be 387 m^3/s spilling.

Flood handling decisions at Duncan and Bluefish Spillways are made by the Manager, System Control in consultation with engineering and maintenance, based on water level observations and the forecast of future inflows. Flood handling involves two situations:

pre spilling, water level at Duncan and Bluefish < F.S.L.

flood routing, water level at Duncan and Bluefish = F.S.L.

2.6.2 Pre-Spilling

Pre spilling would be initiated where situations, using the latest available forecast, predict that the Duncan and Bluefish Reservoirs are likely to fill and spill some volume of water. Pre spilling would be initiated in anticipation of this event to release the forecast spill volume over an extended period thereby minimizing the peak volume spilled.

2.6.3 Flood Routing

Flood routing would become the primary concern as the water level at Duncan Lake approaches an elevation of 212.5 m and the Bluefish elevation approaches 185.9 m . At this time the Manager, System Control estimates on the rate of spill through the spillway and orders stop logs to be removed to appropriate settings. This decision is based on the following considerations:

- Inflows and outflows should be equalized to maintain the H.W.L at the F.S.L. (ideally)
- Mean outflow for next week (or longer) is determined from forecast (net) inflow minus plant flow at Bluefish.
- The selected flow would be somewhat conservative and to minimize the need for frequency (unscheduled) spillway stop log Adjustments.
- Bluefish, Duncan, plant and spillway flows would be monitored daily and the spillway adjusted when needed to correct for deviations between forecast and observed conditions.
- In the case of flood flows approaching the design flow all stop logs would be removed and handling of the flood would rely upon the flood routing effect.
- If it appeared likely that the design maximum flood level would be exceeded then the provisions of the General Contingency Plan would be implemented.

2.7 Normal Operating Procedures

During normal operating the Bluefish forebay is kept between 185.8 m and 183.8 m, this is done mainly by adjusting the loads of the two Bluefish units. On occasion it is necessary to pull a few logs at the auxiliary spillway to keep with in normal operating levels.

During normal operating the Duncan Lake elevation is kept between 212.4 m and 211.0 m. Logs are pulled or inserted to maintain the normal operating level.

2.7.1 Average Inflows

The Yellowknife River's average peak inflow is 92.6 m3/s and the peak generally occur in mid-July.

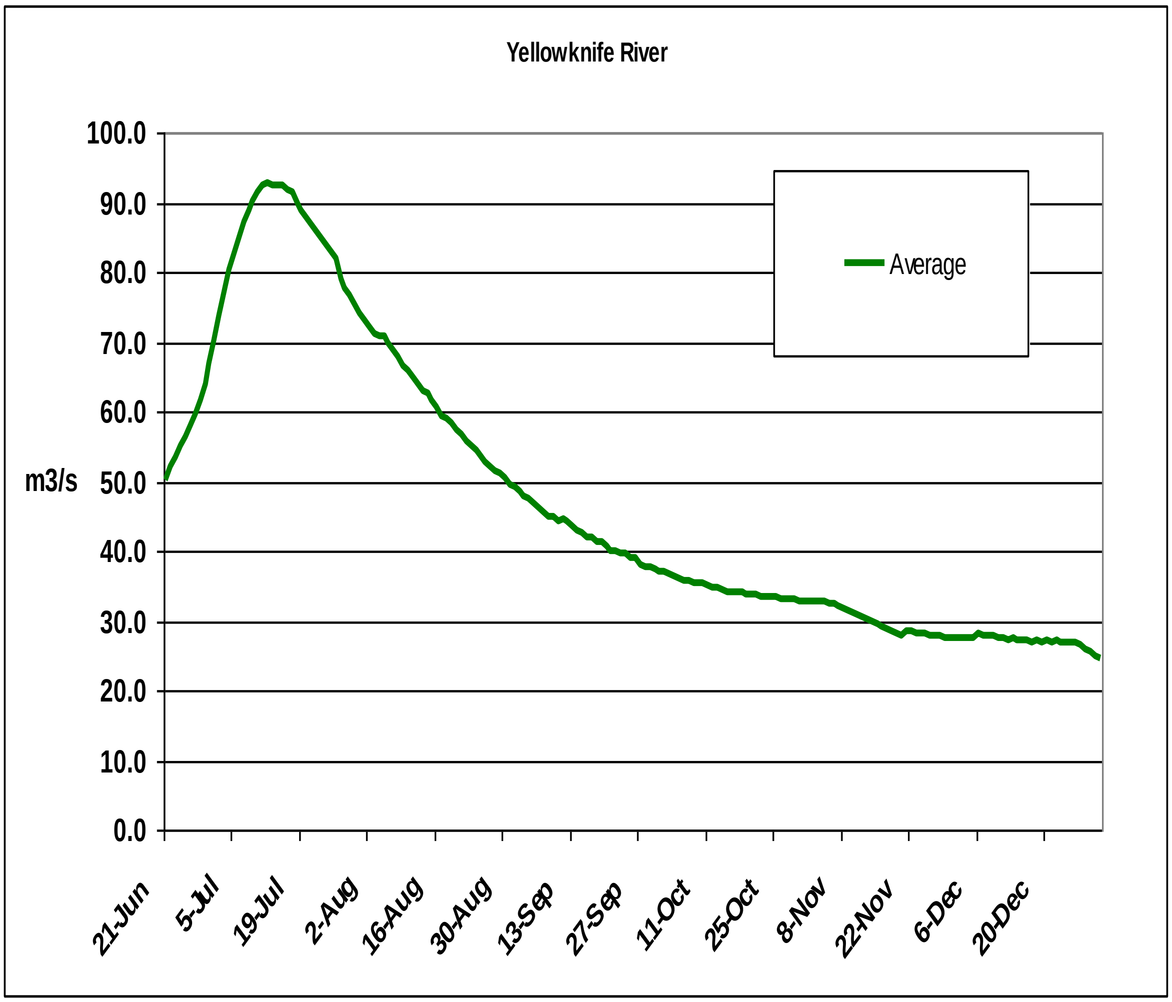


Figure 23: Yellowknife River Average Inflows

The McCrea River, the main tributary to Duncan Lake, generally peaks in mid-June.

Although there is not a Water Survey of Canada Hydrometric Station on the McCrea River a calculation of inflow based on Duncan Lake elevation changes demonstrates that it's flows are similar to the Cameron River where Station 07SB010 records the flow. This station can be used as an indicator basin as it is also similar in size; 3900km^2 vs 3630km^2.

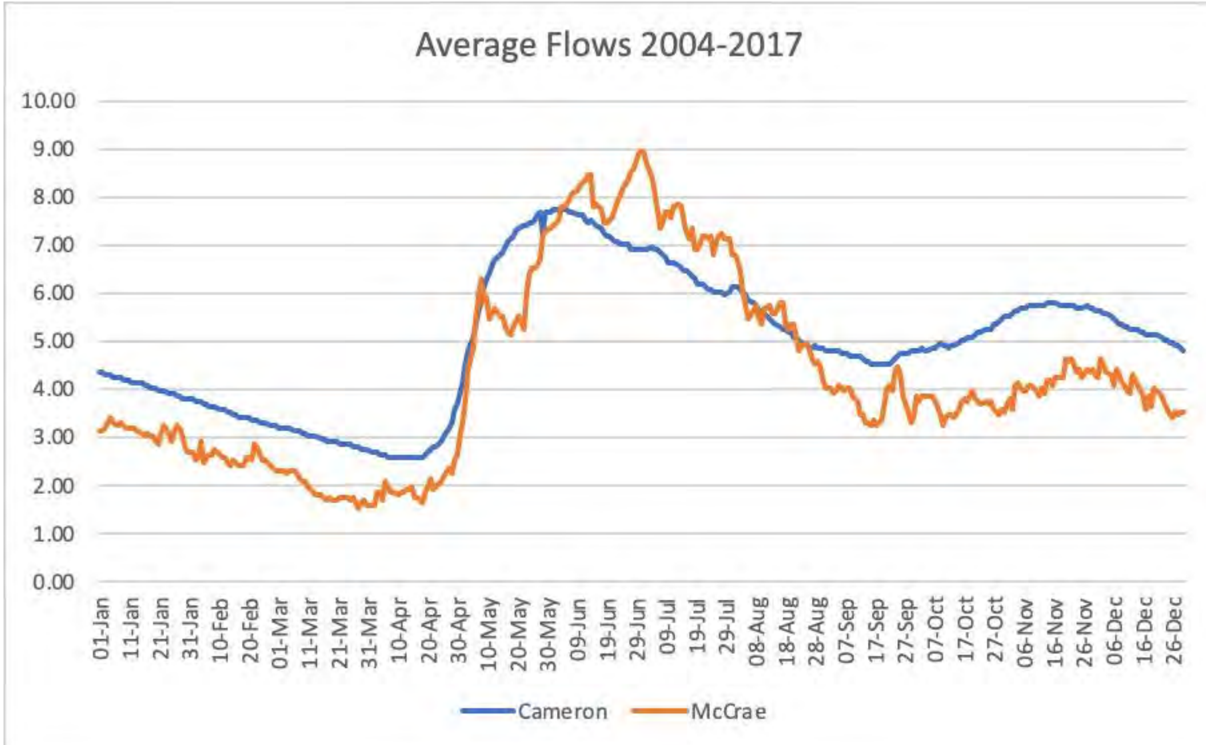


Figure 24: Cameron and McCrae River Inflows

With normal inflow both units would be on line 24 hours a day at close to full load.

SAMPLE WEEKLY REPORT (Normal Inflows)

	PRECIP.		LEVEL		WEEK ENDING
	1.5mm		724.52		4/8/2000
	MWH	HRS. ON LINE	AVG. FLOW	AVG. SPILL	AVG. CFS
SR G1	1144.70	168	1487.03	0.00	1605.90
SR G2	74.70	168	118.87		
TOTAL SR	1219.40				
			663.4		
SF G1	1119.50	166	1480.09	100.22	1580.31
TOTAL SF	1119.50				
SC G1	606.90	168	1601.11	212.42	1813.53
TOTAL SC	606.90				
			569.7		
SK G1	418.00	134	784.68	0.00	1644.88
SK G2	438.40	168	860.19		
TOTAL SK	856.40				
			609.6		
BF G1	540.00	168	185.5 m	0.00	
BF G2	540.00	168	185.0 m		
TOTAL BF	1080				
			hour	date	
MAX. MW LOAD		35.3	09:00	7-Apr-00	
MAX. MW PEAK		35.6	09:00	7-Apr-00	

2.7.2 High Inflow

With high inflows both units would be at full load 24 hours a day and there would be a total of about 3000 cfs spilling through or over the spillways.

SAMPLE WEEKLY REPORT (High Inflows)

	PRECIP.		LEVEL		WEEK ENDING
	3.3m.m.		726.32		7/17/1999
	MWH	HRS. ON LINE	AVG. FLOW	AVG. SPILL	AVG. CFS
SR G1	883.30	168	1173.32	9972.01	11262.67
SR G2	76.40	168	117.34		
TOTAL SR	959.70				
			662.4		
SF G1	863.80	168	1271.05	9319.73	10590.79
TOTAL SF	863.80				
SC G1	518.10	168			
TOTAL SC	518.10				
			573.7		
SK G1	633.80	168	1157.30	9232.38	11295.24
SK G2	463.10	168	905.56		
TOTAL SK	1096.90				
			612.2		
BF G1	554.0	168	186.3	3000.00	
BF G2	554.0	168	186.3		
TOTAL BF	1108.0				
			hour	date	
MAX. MWH LOAD		33.7	12:00	12-Jul-99	
MAX. MW PEAK		34.7	12:00	12-Jul-99	

2.7.3 Low Inflows

With low inflows one unit would be offline 24 hours a day and the second unit operated at loads to keep the Bluefish level around 183.5 m

SAMPLE WEEKLY REPORT (Low Inflows)

	PRECIP.		LEVEL		WEEK ENDING
	0.8 mm		723.24		8/15/1998
	MWH	HRS. ON LINE	AVG. FLOW	AVG. SPILL	AVG. CFS
SR G1	317.00	126	829.17	0.00	829.17
SR G2	0.00	0	0.00		
TOTAL SR	317.00				
			663.4		
SF G1	536.10	168	745.27	0.00	745.27
TOTAL SF	536.10				
SC G1	280.00	168			
TOTAL SC	280.00				
			569.5		
SK G1	281.80	168	618.57	0.00	678.37
SK G2	26.50	16	59.80		
TOTAL SK	308.30				
			606.3		
BF G1	508.10	168	183.5 m		
BF G2	0.00	0	183.5 m		
TOTAL BF	508.10				
			hour	date	
MAX. MWH LOAD		29.6	14	17-Jul-98	
MAX. MW PEAK		30.8	11	13-Jul-98	

2.8 Emergency Operating Procedures

If both units at Bluefish shut down the IFR gate is opened to provide minimum downstream flow.

If a plant should have a runaway (uncontrolled discharge of water) the operator at Bluefish will drop the head gate from the plant, the head gate house or have the operator in Yellowknife drop the head gate remotely. The three gate closure devices are checked during the annual shutdowns.

2.9 Ice and Debris Handling

To prevent icing in winter no unit will be off line for more than 24 hours at a time. If the load does not require a unit to be online, it will be started and changed over with a unit online, for 8 hours every 24 hours. If maintenance is to be done on a unit and it will be down for more than 24 hours the unit will be dewatered.

Debris is picked up by use of a gaff located at the head gate deck. The trash racks are cleaned by divers annually.

2.10 Review Procedures

Procedures will be reviewed once a year by the Manager, System Control and Manager, Plant Operations in consultation with the Mechanical and Electrical Managers. If any changes are to be made, they will be done at this time.

3 Maintenance

3.1 Maintenance Responsibilities

The Mechanical and Electrical Managers are responsible for the Dam, Spillway, Turbine and other Structures and Equipment maintenance. These Managers report to the Director, Hydro Division. The Maintenance on these facilities is done by the Plant Operator, Electricians, Mechanics, Millwright and contractors depending on the work to be done.

3.2 Maintenance Programs

Operations Check Sheets are provided in Appendix C. These sheets are used for regular weekly and monthly inspections and maintenance of the Bluefish facilities and may change during the year to reflect new products, processes and procedures. Each update of the OMS manual will reflect the forms in use at the date of OMS release.

Electrical and Mechanical Maintenance on the turbines and generators are performed according to a check sheet and schedule that is produced by the Computerized Maintenance Management System (CMMS). This maintenance is normally completed quarterly.

3.2.1 Dams

The Dam Faces, Crest, Toe and Abutments are cleared of excessive vegetation when required. After the Annual Inspection any concerns, such as cracking, settlement erosion, sinkholes or wet spots, will be addressed as soon as possible. Debris is cleared from the Dam and intake area once a year. A survey of the Dam is done every 5 years to determine if there is settlement, erosion or instability anywhere on the Dam.

3.2.2 Other Structures and Equipment

Once a year all head gates are raised to their maintenance positions and pullies, wheels, cables and seals checked. All areas that require it are oiled or greased. Limit switch, heaters, controls and emergency drop are checked. All head gate drop times are recorded. All equipment is cleaned. Any adjustments to limit switch, breaks, etc are undertaken at this time. In the fall all heaters are checked and the hoist rooms winterized. In winter all deck and walkways are kept clear of snow.

3.2.3 Turbines

Bluefish G1 & G2

Once a year clearance measurement are taken of the turbine and the gates. The turbine and gates are also inspected for cracks or pitting. The walls of the scroll case are also inspected for erosion.

3.3 Reference Manuals

The manuals for the operation and maintenance of any piece of equipment are kept in the respective plant, with a copy at the Jackfish Diesel Plant and on the computerized company Imanage filing system.

4 Surveillance

Many data points are continually monitored by the System Control and Data Acquisition (SCADA) system in Yellowknife. The control center is continuously staffed and has various setpoints for alarms and shutdowns. Examples of monitoring points include; Turbine Guide Bearing Temperature, Turbine Thrust Bearing Temperature, Generator Stator Temperature, Turbine Scrollcase Pressure, Forebay and Tailrace Levels.

4.1 Routine Inspections

The Bluefish Operator does a visual inspection of each facility a minimum of every week. The results are evaluated by the Plant Manager and the System Control Manager, then passed on to the Hydro Facilities Engineer.

4.2 Intermediate Inspections

The System Control Manager or Plant Manager and representative from Engineering do inspection of all facilities once a year. Results of inspections are evaluated by the Manager, System Control, Engineering and the Hydro Region Director. All maintenance concerns are passed on to the Hydro Maintenance Manager.

4.3 Comprehensive Inspections

A comprehensive inspection will be done every 4 years, or anytime the 24-hour precipitation exceeds 80 mm, or anytime the weekly precipitation exceeds 300 mm.

In the case of an earthquake in the Bluefish Hydro area the Manager, System Control shall immediately arrange for a general overall inspection of the dam and surrounding slopes.
Results of the inspection are evaluated by the Manager, System Control and by Corporate Engineering.

4.4 Required Instrumentation

There are six Ground Temperature Cables (Thermistors) with a varied number of nodes and depths installed in the Bluefish Dam. There is no required instrumentation at the Duncan Dam and Spillway

4.4.1 Reading Frequency

The Thermistors are read on a monthly basis.

4.5 Testing of Facilities

4.5.1 Responsibility

The testing of any Facility would take the coordinated efforts of the Manager, Plant Operations and Manager, System Control and if required an engineer depending on the type of testing to be done.

4.5.2 Procedure

Procedures for testing the equipment, (motors, pumps, headgates, stoplogs, controls and the like) are kept in each plant, in a binder entitled Operating Procedures. A copy of this binder is kept in the Manager, Plant Operations and the Maintenance Managers offices.

4.5.3 Frequency

All major components to the facilities such as headgates, stoplogs, governors and controls are tested annually. The motors and heaters are tested monthly. The pumps are tested bi-weekly.

4.5.4 Checklist

Each plant has a Plant Maintenance and Operation Inspection & Maintenance
Check List. That incorporates the dam and tailrace, power house, penstocks, turbines and governors, generators and motors, switchgear, breakers, disconnects and fuses, transformers, transmission lines and communication.

5 Reporting

5.1 Responsibility

On Site Personnel / Control Center Operator shall report to:

Position	Name	Office #	Cell #	E-mail
President & CEO	Noel Voykin	(867) 874-5276	(867) 875-7451	nvoykin@ntpc.com
Chief Operating Officer	Dean Mozden		(867) 875-8268	dmozden@ntpc.com
Director, Hydro Division	Colin Steed	(867) 669-3326	(867) 446-4712	csteed@ntpc.com
Director, Health Safety & Environment	Eddie Smith	(867) 874-5327	(867) 875-7737	esmith@ntpc.com
Manager, Plant Operations	Anthony Upton		(867) 445-1841	aupton@ntpc.com
Manager, System Control	Eileen Hendry	(867) 669-3301	(867) 444-1170	ehendry@ntpc.com
Manager, Mechanical Services	Sergio Catlyn	(867) 669-6881	(867) 445-3389	scatlyn@ntpc.com
Manager, Electrical Services & Substations	Todd Thompson	(867) 669-3308	(867) 444-8424	tthompson@ntpc.com
Manager, T&D Great Slave Region	Grant Penney	(867) 669-3355	(867) 446-3335	gpenney@ntpc.com

Local Agencies (Yellowknife):

Fire or Emergency	867-873-2222
Ambulance	867-873-2222
Hospital	867-669-4111
RCMP	867-669-1111
City of Yellowknife	867-920-5600

Other important phone numbers:

GNWT Emergency Measure Organization	867-873-7554

5.1 Inspection Results

All inspections results are passed to the Manger, Plant Operations, Hydro Maintenance Manager, System Control. If required the results are also passed to the Director of Engineering and the Hydro Operations Director.

5.2 Regular Reporting

The Operator on site reports all maintenance items to the Manager, Plant Operations and Manager, System Control. The maintenance items are then passed on to the respective Maintenance Manager and if the maintenance items are large in scope or costs, the Hydro Operations Director and the Director of Engineering.

Appendices

NORTHWEST TERRITORIES POWER CORPORATION *Empowering Communities* August , 2019	**Bluefish IFR Gate Minimum Flow Standard Operating Procedure**

As per a Fisheries and Oceans Canada (DFO) directive the IFR gate at the Bluefish Hydro Facility will maintain a minimum flow of 0.75 m^3/s year round. It is acceptable if the fish gate exceeds the minimum height and more water is passed through the gate but there **must always be a minimum of 0.75 m^3/s passing through the gate**.To maintain this flow the minimum fish gate height must correspond to the water elevations in Bluefish Lake provided in Table 1 below.

Table 1: Minimum IFR Gate Height vs Water Elevation to Maintain a Flow of 0.75 m^3/s (20% Error Margin)

Minimum Fish Gate Height (cm)	Bluefish Lake Water Elevation* (m)
11	>185.59
12	185.02 - 185.59
13	184.58 - 185.02
14	184.23 – 184.58
15	183.95 - 184.23
16	183.72- 183.95
17	183.53- 183.72
18	183.37- 183.53

**Bluefish Lake Elevation is provided by the Water Survey of Canada's Water Level*

IFR Gate Flow Verification Procedure

Step 1: Plant Operator verifies the IFR gate height by reading the small gauge at the top of the gate structure. **The IFR gate height is entered daily into the IFR Gate Spreadsheet. Any changes to the IFR Gate must also be entered into this spreadsheet.** For Weekly checks for blockages refer to Bluefish IFR Gate Staff Gauge Readings Procedure.	
Step 2: Plant Operator verifies the current Bluefish Lake elevation by checking Water Survey of Canada's water level gauge. The Water Survey of Canada's water level gauge is located in the small grey building near the head gate.	
Step 3: Verify that the Bluefish Lake Elevation falls within the range provided for the gate height; if it does not then adjust the gate height based on the information provided in Table 1. If the fish gate height does not match the minimum height provided for various water level elevations in Table 1 **NTPC is in non-compliance and could be subject to fines from DFO.****	

IFR Gate Adjustment Procedure

Step 1: Plant Operator identifies that the fish gate height needs to be adjusted based on changing water levels in Bluefish Lake.
Step 2: Notify the System Control Manager immediately and take steps to either: 1) Adjust the water level; or 2) Adjust the fish gate height based on the new water level.
Step 3: Document changes in the IFR Gate Spreadsheet and notify Environmental Dept. (mmiller@ntpc.com).

NORTHWEST TERRITORIES POWER CORPORATION *Empowering Communities* August , 2019	# Bluefish IFR Gate Staff Gauge Readings Procedure

To ensure there are no blockages in the IFR gate at the Bluefish Hydro Facility the gate is checked as part of the **weekly operator** checks using the procedure outlined below.

If the gate becomes blocked from underwater debris flows will be reduced and NTPC will be in violation of its minimum flow requirements with DFO. To verify flows downstream of the IFR gate a staff gauge is installed in the spillway which provides a reference point to visually record the water level and verify minimum flow requirements.

Step 1: IFR staff gauge is located on the west side of the spillway. The gauge can be safely checked from the east side of the spillway using binoculars to read the water level.	
Step 2: The water level in the spillway can be visually recorded using the staff gauge and binoculars.	

Step 3: If the water level is below 25.5cm and the orange tape is **above the water** the minimum flow requirements are not being met and **NTPC is in non- compliance and could be subject to fines from DFO.****	
Step 4: If the water level is below 25.5cm the IFR gate height and Bluefish Lake water elevation should be checked to ensure they match the required values in Table 1 of the **Bluefish IFR Gate Minimum Flow Standard Operating Procedure**. • If gate height and BF lake water level values do not match Table 1 requirements adjust IFR gate accordingly, • If gate height and BF lake water level values do match Table 1 requirements but water level is below 25.5cm a blockage is present and the Manager, Plant Operations, Hydro Operations and Environmental Department must be must be notified.	

Appendix B Bluefish Planned Shutdown Standard Procedure

NORTHWEST TERRITORIES POWER CORPORATION *Empowering Communities* September, 2016	**Bluefish Planned Shutdown Standard Operating Procedure**

<u>Background</u>

Each year between September 1st and October 31st Whitefish, Lake Trout and Cisco spawn in high densities in the tailrace of the G1 and G2 plants at the Bluefish Hydroelectric facility (see Figure 1 below).

Figure 1- Bluefish Hydroelectric Plants G2 and G1 and Whitefish gathering before spawning in the G2 tailrace.

Standard Operating Procedure for Shutdowns

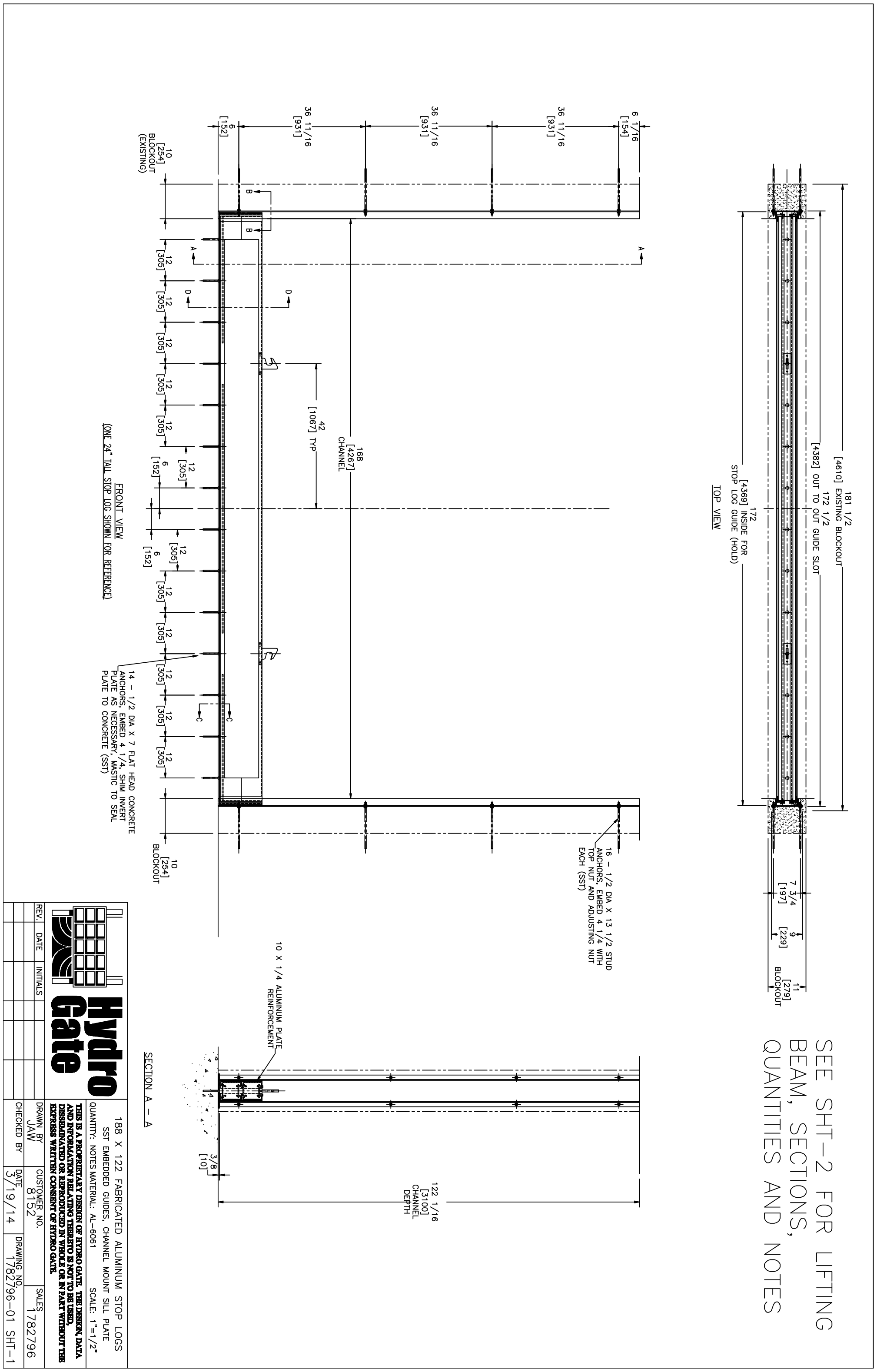
Planned Shutdowns

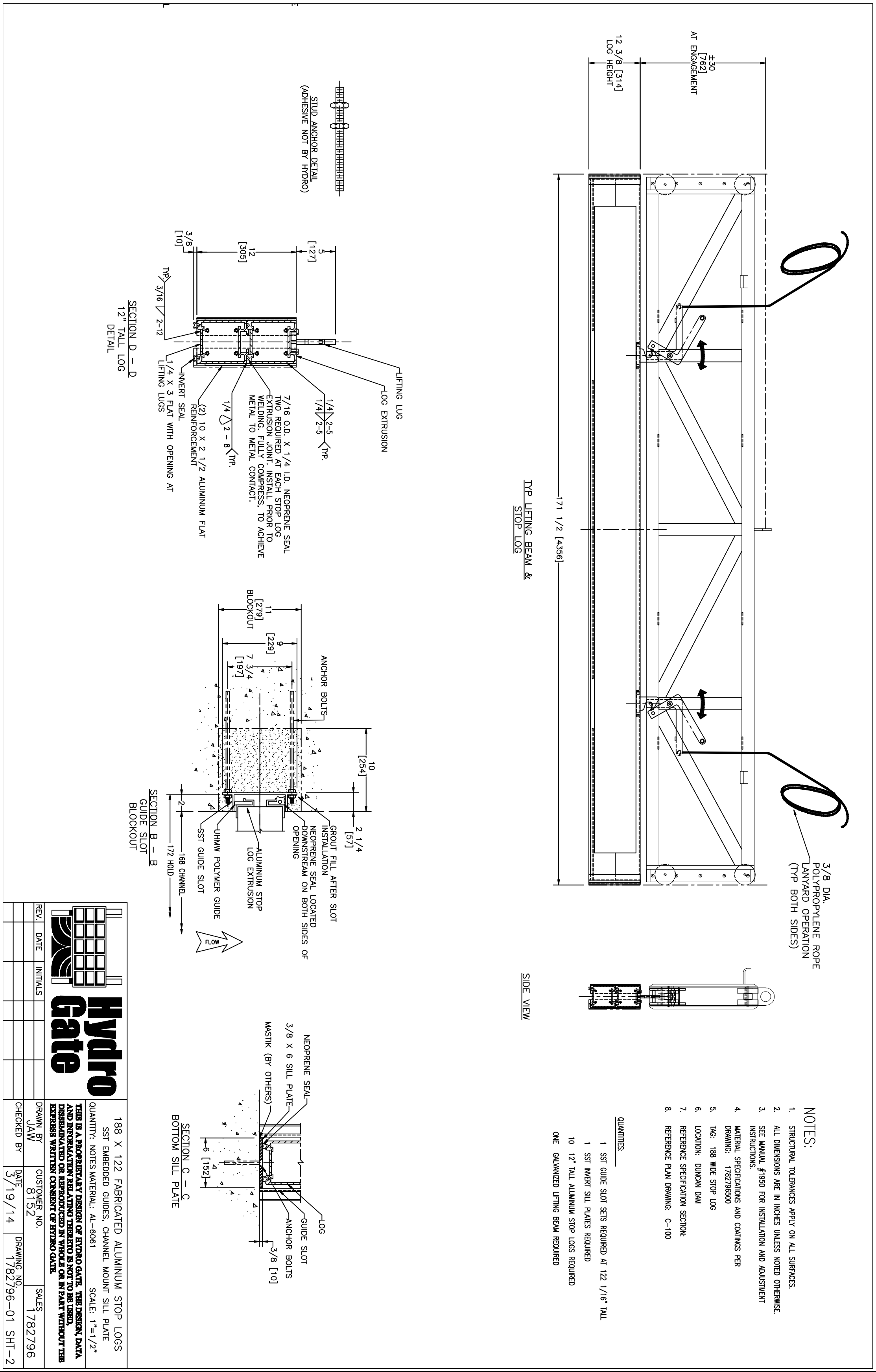
Moving forward, planned shutdowns of the Bluefish Hydroelectric G1 and G2 plants **shall not be completed between September 1st and October 31st of each year**. Avoiding shutdowns during this time will prevent harm to fish and ensure NTPC is not charged under the *Fisheries Act*.

Emergency and Unplanned Shutdowns

Declared emergencies requiring shutdown and unplanned events (e.g., outages, etc.) which cause involuntary plant shutdown shall be reported to the NTPC Environmental Licensing Specialist, Matthew Miller (mmiller@ntpc.com, 867-874-5314) as soon as reasonably practical.

Appendix C Duncan Spillway and Stoplog Operation




3/8 DIA.
POLYPROPYLENE ROPE
LANYARD OPERATION
(TYP BOTH SIDES)
±30
[762]
AT ENGAGEMENT
12 3/8 [314]
LOG HEIGHT
171 1/2 [4356]
TYP LIFTING BEAM &
STOP LOG
SIDE VIEW
NOTES:
1. STRUCTURAL TOLERANCES APPLY ON ALL SURFACES.
2. ALL DIMENSIONS ARE IN INCHES UNLESS NOTED OTHERWISE.
3. SEE MANUAL #1950 FOR INSTALLATION AND ADJUSTMENT INSTRUCTIONS.
4. MATERIAL SPECIFICATIONS AND COATINGS PER DRAWING: 1782796500
5. TAG: 188 WIDE STOP LOG
6. LOCATION: DUNCAN DAM
7. REFERENCE SPECIFICATION SECTION:
8. REFERENCE PLAN DRAWING: C-100
QUANTITIES:
1 SST GUIDE SLOT SETS REQUIRED AT 122 1/16" TALL
1 SST INVERT SILL PLATES REQUIRED
10 12" TALL ALUMINUM STOP LOGS REQUIRED
ONE GALVANIZED LIFTING BEAM REQUIRED
STUD ANCHOR DETAIL
(ADHESIVE NOT BY HYDRO)
LIFTING LUG
LOG EXTRUSION
5
[127]
12
[305]
3/8
[10]
1/4 2-5
1/4 2-5
TYP.
7/16 O.D. X 1/4 I.D. NEOPRENE SEAL
TWO REQUIRED AT EACH STOP LOG
EXTRUSION JOINT. INSTALL PRIOR TO
WELDING. FULLY COMPRESS, TO ACHIEVE
METAL TO METAL CONTACT.
1/4 2 - 8
(2) 10 X 2 1/2 ALUMINUM FLAT
REINFORCEMENT
INVERT SEAL
1/4 X 3 FLAT WITH OPENING AT
LIFTING LUGS
3/16 2-12
SECTION D — D
12" TALL LOG
DETAIL
10
[254]
2 1/4
[57]
ANCHOR BOLTS
GROUT FILL AFTER SLOT
INSTALLATION
NEOPRENE SEAL LOCATED
DOWNSTREAM ON BOTH SIDES OF
OPENING
11
[279]
BLOCKOUT
9
[229]
7 3/4
[197]
ALUMINUM STOP
LOG EXTRUSION
UHMW POLYMER GUIDE
SST GUIDE SLOT
FLOW
2
168 CHANNEL
172 HOLD
SECTION B — B
GUIDE SLOT
BLOCKOUT
NEOPRENE SEAL
3/8 X 6 SILL PLATE
MASTIK (BY OTHERS)
LOG
GUIDE SLOT
ANCHOR BOLTS
3/8 [10]
6 [152]
SECTION C — C
BOTTOM SILL PLATE
Hydro
Gate
188 X 122 FABRICATED ALUMINUM STOP LOGS
SST EMBEDDED GUIDES, CHANNEL MOUNT SILL PLATE
QUANTITY: NOTES MATERIAL: AL-6061
SCALE: 1"=1/2"
THIS IS A PROPRIETARY DESIGN OF HYDRO GATE. THE DESIGN, DATA AND INFORMATION RELATING THERETO IS NOT TO BE USED, DISSEMINATED OR REPRODUCED IN WHOLE OR IN PART WITHOUT THE EXPRESS WRITTEN CONSENT OF HYDRO GATE.
REV.
DATE
INITIALS
DRAWN BY
JAW
CUSTOMER NO.
8152
SALES
1782796
CHECKED BY
DATE
3/19/14
DRAWING NO.
1782796-01 SHT-2

MATERIAL SPECIFICATIONS

GATE PART OR ITEM OF ASSEMBLY	MATERIAL DESCRIPTION	MATERIAL CODE	MATERIALS SHOWN IN ASTM SPECIFICATION UNLESS NOTED OTHERWISE
EMBEDMENTS			
ANCHOR BOLTS	STAINLESS STEEL	(L)	A276, TYPE 304
ANCHOR BOLT NUTS	STAINLESS STEEL	(L)	F594, ALLOY GROUP 1
GUIDE EXTRUSIONS	ALUMINUM	(R)	B308, ALLOY 6061–T6
GATE ASSEMBLY			
LOGS AND LOG END CAPS	ALUMINUM	(R)	B308, ALLOY 6061–T6
SEALS	NEOPRENE	(BB)	D2000, GRADE 1BE625
UHMW GUIDES	POLYETHYLENE	(T)	D4020
HOOKS	STAINLESS STEEL	(L)	A276, TYPE 304 OR 304L
SET SCREWS	STAINLESS STEEL	(L)	A276, TYPE 304
LIFT ASSEMBLY			
LIFTING BEAM	GALVANIZED STEEL	(N)	A36, A123 (ZINC COATING)
FASTENERS	STAINLESS STEEL	(L)	A276, (BOLTS) TYPE 304
		(L)	F594, (NUTS) ALLOY GROUP 1

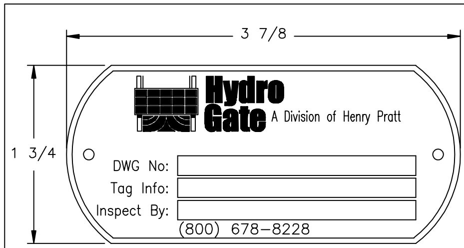
NOTE :

1. ALUMINUM SURFACES IN CONTACT WITH CONCRETE TO RECEIVE ONE COAT OF TNEMEC SERIES 1 – 1216 GREENISH GRAY (SOLVENT CLEAN BEFORE PAINTING).

Hydro Gate

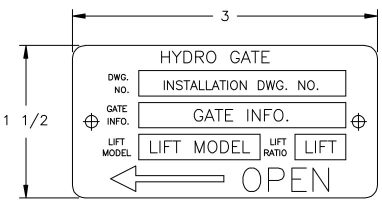
MATERIAL SPECIFICATIONS FOR ALUMINUM STOP LOGS

REV.	DATE	INITIALS				DRAWN BY	CUSTOMER NO.	SALES
						JAW	8152	1782796
						CHECKED BY	DATE 3/20/14	DRAWING NO. 1782796500



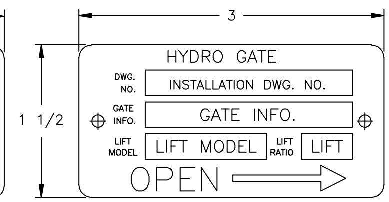
DATA PLATE 34179T

DETAIL A
ID TAG FOR GATES WITH ELECTRIC ACTUATORS OR HYDRAULIC CYLINDERS



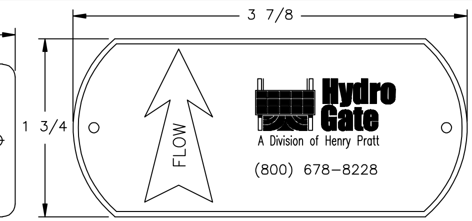
DATA PLATE 35494T

DETAIL B
ID TAG FOR GATES WITH MANUAL HANDCRANK



DATA PLATE 39664T

DETAIL C
ID TAG FOR GATES WITH MANUAL HANDWHEEL



DATA PLATE 34179––FLOW, REV 1

DETAIL D
ID TAG FOR BULKHEAD GATES AND STOP LOGS PER NOTE #6

NOTES:
1. 24 GAUGE STAINLESS STEEL WITH BLUE BAKED ON ENAMEL.
2. ATTACH DATA PLATE AS REQ'D WITH 2 – NO. 4 x 1/4 U–DRIVE SCREWS (PART NO. 20700––L) PER DWGS. 35494––T, 39664––T, 34179––T, AND PART NO. 3.34179FLOW
3. ALL OPERATED GATES TO RECEIVE ONE TAG FOR THE LIFT MODEL.
4. ALL NON–OPERATED GATES (I.E., FLAP GATES, BULKHEAD GATES, ETC.) TO RECEIVE ONE TAG (PART NO. 34179––T).
5. ALL STOP LOG ASSEMBLIES TO RECEIVE ONE TAG PER LOG AND ONE TAG PER LIFTING BEAM ASSEMBLY. STOP LOG TAGS TO BE POSITIONED ON CENTERLINE IN TOP HOOK SLOT. (PART NO. 34179––T)
6. SINGLE DIRECTION LOGS AND GATES THAT CAN BE MANUALLY ENTERED INTO GUIDE SLOTS (BULKHEADS) TO RECEIVE A FLOW DIRECTION TAG (PART NO. 34179––FLOW).

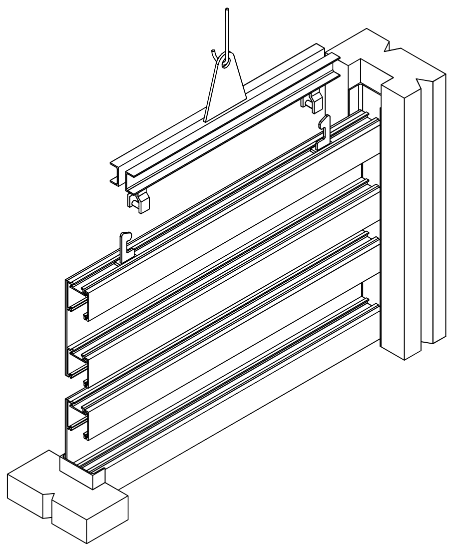
ITEM	ID TAG DETAIL	REFERENCE INSTALLATION DRAWING	GATE INFORMATION	LIFT MODEL	LIFT RATIO	QUANTITY
#1	DETAIL A	1782796–01	188x12 ST LOG	–	–	10
#1	DETAIL D	–	–	–	–	10

Hydro Gate

ID TAGS

REV.	DATE	INITIALS	DRAWN BY	CUSTOMER NO.	SALES
			JAW	8152	1782796
			CHECKED BY	DATE 3/20/14	DRAWING NO. 1782796600

Installation, Operation, & Maintenance Manual



Stop Log Gates

G1950-OG

DO NOT DISASSEMBLE GATE FOR INSTALLATION

3888 E. 45th Avenue #120 • Denver • Colorado • 80216 • 1-800-678-8228 • FAX (303) 287-8531
www.hydrogate.com

Installation, Operation, &

Maintenance Manual

Stop Log Gates

G1950-OG

DO NOT DISASSEMBLE GATE FOR INSTALLATION

CONTENTS

CAUTIONARY STATEMENT FOR INSTALLATION, OPERATION, &

MAINTENANCE MANUAL

This manual describes the recommended procedures for installation, adjustment, operation and maintenance of Hydro Gate gates. When it is used in conjunction with installation drawings that have been supplied by

Hydro Gate, this manual will be sufficient for most installations. Proper care and precautions must be taken in handling and storing the gates at the delivery site. For further details on the handling, storing, and installation of a specific project, contact Hydro Gate's headquarters.

PRECISE AND ACCURATE INSTALLATION IS CRITICAL TO SATISFACTORY OPERATION. HYDRO GATE ASSUMES NO LIABILITY, EXPRESSED OR IMPLIED, FOR INTERPRETATION OF THE CONTENTS OF THIS MANUAL. IF YOU HAVE ANY QUESTIONS CONCERNING THE INTERPRETATION OF THE CONTENTS OF THIS MANUAL OR INSTALLATION PROCEDURES IN GENERAL, YOU SHOULD CONTACT HYDRO GATE'S COLORADO FACILITY. HYDRO GATE EXPRESSLY DISCLAIMS ALL LIABILITY, EXPRESSED OR IMPLIED, FOR FAULTY INSTALLATION OF ANY GATE OR ASSOCIATED EQUIPMENT AND FOR ANY DIRECT, CONSEQUENTIAL, OR INCIDENTAL DAMAGES THAT MAY RESULT.

FOREWORD

The purpose of this Installation, Operation, and Maintenance Manual is to provide information on the correct procedures for installation, adjustment, operation and maintenance of Hydro Gate Stop Log Gates and their component parts.

The stop logs, lifting beam, and accessories were accurately fabricated, assembled, adjusted, and inspected before leaving the Hydro Gate Corporation factory. For best results, read and follow the applicable parts of this Manual carefully, including thorough cleaning and lubrication of parts and final adjustment. If the stop logs will not be installed immediately, consult the long-term storage instructions following.

Caution

Do not disassemble the stop logs or lifting beam.

Notes

Spare Parts – Hydro Gate does not recommend the stocking of spare parts. Replacement parts are readily available for worn or broken parts. Contact Hydro Gate or our representative in your area.

Special Tools – Special tools are not required to operate and/or maintain the equipment supplied by Hydro Gate on this project.

Price List – Prices for individual parts and/or assemblies may be obtained from Hydro Gate at the time that they are needed.

Disassembly – Hydro Gate does not recommend the disassembly/reassembly of any of the equipment on this project.

Emergencies – Emergency/shutdown procedures do not differ from normal operating procedures for this project. If you should need assistance, please contact Hydro Gate's Field Service Department at (303) 288-7873.

INSTALLATION

Safety Precautions

To help ensure your workers' safety, Hydro Gate recommends the personnel responsible for installation, operation, and maintenance of the gates for this project read and study the instructions and precautions in the Installation, Operation, and Maintenance Manual, and follow all directions carefully. The following are major items associated with safe installation, operation, and maintenance of this stop log gate.

- Do not operate equipment before carefully reviewing the Installation, Operation, and Maintenance Manual.
- Always use proper equipment when lifting or unloading heavy items.
- Do not stack equipment too high for storage. Always use heavy wood blocking between equipment.
- Refer to the storage instructions contained herein for details.
- Adequately support and brace heavy items during placement of equipment.
- Wear proper personal protective equipment (PPE) and clothing when working on or around gates, (e.g., hard hats, heavy boots, safety glasses, and breathing apparatus, if necessary).
- Never place bodily obstructions in the path of moving parts. When operating gates and accessories, stand clear of all moving parts. Serious injury can result from contact with moving parts.
- Use caution when performing operations and maintenance. Watch for loose or damaged parts. Stop all functions until any damage has been corrected.
- Do not use any mechanical devices other than the factory-supplied equipment to operate the gates for this project.
- Do not attempt operational procedures other than set forth in the Operation and Maintenance Manual.
- Contact your Hydro Gate representative with any questions you may have regarding safety in installing, operating, and handling Hydro Gate products.

Things To Do and Not To Do during Installation of This Gate

To properly install this gate, Hydro Gate recommends that personnel study these instructions and installation drawings and follow the installation directions carefully. These stop logs are precision fabricated, quality checked, and designed for low leakage. Attention must be given to proper storage, careful handling, and accurate location of embedded items for this gate to operate as designed.

Some DO'S and DON'TS to ensure proper gate installation.

X DO – Read and follow the Installation instructions and drawings in this Manual.

X DO – Carefully inspect the gates and accessories when received, before unloading trucks or cars. Report ALL shortages or suspected damage by marking the Bill of Lading and Receiving Reports at this time. Latent shortages must be reported in writing within 30 days of shipment.

X DO – Store stop logs evenly on planks or timbers. Even the heaviest stop logs are subject to permanent warpage if unevenly blocked during storage.

X DO – Support full length of stop logs and protect seals during storage and handling.

X DO – Accurately locate and brace embedded items during placement of concrete.

X DO – Contact your Hydro Gate representative with questions regarding this gate. Hydro Gate and its related companies have 100 years combined experience in the water control industry.

X DON'T – Stack stop logs without heavy wood blocking between logs.

X DON'T – Disassemble the stop logs (seals) for installation.

X DON'T – Allow excess concrete to overlap stop log guides.

X DON'T – Tighten nuts for studs or anchors unevenly, or try to pull a guide tightly against an uneven wall surface. This, in most cases, will cause excessive leakage.

X DON'T – Operate gates with concrete and debris on them.

Installing Guides on Concrete Wall

1. Secure all anchor bolts in proper position in the forms. For proper size, length, projection, and spacing, see the installation drawings.

2. Two nuts are provided per bolt. Leave sufficient grout space for adjustment of the back nut on the anchor bolt.

3. Pour concrete and strip forms.

4. Apply anti-seize compound on anchor bolt threads. Place a nut on each anchor bolt and establish a flat vertical plane as close as possible to the wall using taut lines, plumb lines, or straight edges. Starting with upper corner anchor bolt back nuts, drop a plumb line down past the face of the nut. Bring the other back nuts up to the plumb line. Using a straight edge or taut line, bring back nuts on anchor bolts across top and bottom in line with nuts on corner anchors.

5. Place assembled stop log guide in position on the anchor bolts. Install front nuts and tighten being careful not to move the back nut out of the plane established in No. 4 above.

6. Carefully grout in the guides with a cement-based "non shrink" grout such as U.S. Grout Corporation's "5 Star Grout."

7. After the grout has set, ensure no voids exist between the guide and the concrete.

Installation Note
Because of possible shrinkage of certain types of grout, it may be necessary to loosen the guide and apply a sealing compound between the gate seat and the wall.

8. Tighten all nuts or anchor bolts uniformly.

Installation Note
Do not warp the guide to conform to an uneven surface, excessive leakage can result.

Installing Guides in Concrete Channel after Original Pour of Concrete

1. A recess (block-out) must be made in the original pour of concrete to receive the guide. For the minimum width and depth of this recess, see the installation drawings. Use plumb lines and spirit levels to ensure the frame is straight and plumb before pouring.

2. Pour the concrete. Strip the forms including removal of material used to form the block-out.

3. Set the assembled guide in the recess along the sides and across the bottom of the structure. Guide anchor bolts are not required because the irregular shape of the section holds the gate frame in position after grouting.

4. By blocking and shimming, align the guide in the vertical position. Use care to maintain the side guides in a plane without warping or distorting the guides.

Installing Invert Sill Plate

1. Gates that have a sill plate embedded in concrete should have the sill plate installed at the invert of the opening

2. A recess should be formed in the invert for the sill plate. The dimensions of the recess are shown on the installation drawing.

3. For guides with adjustable sill plates, set anchor bolts in the concrete recess as shown on the installation drawings.

Installation Note
Do not cast the bottom sill plate into an original concrete pour.

4. Pour concrete and strip forms.

5. Place one nut on each anchor bolt. Position the nuts so that the sill plate will be flat and flush with the invert and form a 90-degree angle with the vertical guide.

6. Place the sill plate on the anchors and install top nuts on the anchor bolts.

7. Level the sill plate and grout it in place.

OPERATION

General Operation Information

Stop log gates are used to control flow of or retain a volume of water, effluent, or other fluids. Typical applications include dams, flood control, and many other applications that require accurate control of liquid flow.

Depending on size, most stop log gates can operate without error in diverse conditions. Some extenuating circumstances may include large amounts of ice or other solids that will obstruct the travel path of the stop logs. In most cases, when the obstruction is removed, normal operation can be resumed.

Stop Log Gate Operation Procedures

The following sections cover the general operating procedures associated with Hydro Gate Stop Log Gates. Read and follow the operating procedures. If you have any questions concerning safe operation of this gate, contact Hydro Gate immediately.

Hydro Gate Lifting Beams

Two styles of lifting beams are shown on the following page (Figure 4). Either type may or may not have adjustable spans to cover different widths of stop log openings. To adjust the widths, remove the clevis pin clips, pull the heavy pins, slide the telescoping wheel assemblies in or out, and reinstall the pins and clips.

Using the Hydro Gate Lifting Beam

Inserting Stop Logs into Guides

Stop logs are integrated units and require no field assembly. The following procedures should be followed when using the Hydro Gate Lifting Beam to insert stop logs into guides:

1. Inspect the lifting beam lanyard line for damage.

Safety Note
Do not use the lifting beam if the lanyard line is defective, personal injury or damage to the beam or stop logs can occur.

2. Secure the lifting beam to a crane or other substantial lifting device by the center lifting eye.

3. Position the beam directly over the stop log to be moved.

4. Lower over the lifting lugs on top of the stop log. The beam will automatically latch over the lugs.

Operation Note
Stop logs are designed for insertion into the guide rails at balanced head or zero-flow conditions. Allow the stop log to fill with water before lowering to the desired elevation.

5. Raise the stop log for transport to the point of use.

Safety Note
The Hydro Gate Stop Log Lifting Beam is a self-contained device designed exclusively for handling Hydro Gate Stop Logs. Use of this device for purposes other than installing and removing Hydro Gate Stop Logs could cause personal injury or damage to the Stop Log Lifting Beam.

6. Position the stop log directly over the stop log guides.

7. Lower the lifting beam until the stop log rests firmly on the sill plate or previously installed stop log.

8. Pull lanyard line to release latches from the stop log lugs.

9. Raise the lifting beam while holding the lanyard.

10. After the lifting beam clears the lugs, release the lanyard and raise the lifting beam from the guide rail slot.

Removing Stop Logs from Guides

The following procedures should be used when using the Hydro Gate Lifting Beam to remove stop logs

from guides:

1. Inspect the lanyard line for damage.

Safety Note
Do not use the lifting beam if the lanyard line is defective, personal injury or damage to the beam or stop logs can occur.

2. Secure the lifting beam to a crane or other substantial lifting device by the center lifting eye.

3. Position the beam directly over the stop log to be moved.

4. Lower over the lifting lugs on the top of the stop log. The beam will automatically latch over the lugs.

5. Raise the stop log above the surface of the water and drain before removal from guide slots.

6. Position the stop log directly over the designated release point.

7. Lower the stop log until it rests firmly on an appropriate storage area as described later in this Manual.

Storage Note
Clean the stop logs and lifting beam as needed before storage. Do not use solvents. Damage to the seals and slide material can result.

8. Pull the lanyard line to release the latches from the lugs.

9. Raise the lifting beam while holding the lanyard.

10. After the lifting beam clears the lugs, the lanyard can be released and the lifting beam moved.

MAINTENANCE

Maintenance of Stop Logs

Hydro Gate Stop Logs are a single integrated unit fitted with a permanent neoprene seal. The only maintenance required is inspection of the seal for damage and cleaning of the stop log after each use to remove dirt and other debris that could cause difficult installation upon re-use.

Maintenance Note

Do not use solvents for cleaning. Damage to the seals and slide material can result.

Storage of Stop Logs

1. Store stop logs neatly in either the horizontal or vertical position on flat hard surface or on timbers. Do not store directly on the ground or on uneven surfaces that will flatten or damage seals.

2. Store stop logs in a shaded or covered area to avoid degradation of neoprene seals caused by UV rays of sunlight.

3. Store stop logs in storage racks, if specified by contract.

Maintenance of Lifting Beams

Before each use, check all moving parts to ensure proper working condition. Lubrication of moving parts is not normally required. Clean as required.

Storage of Lifting Beams

1. Store lifting beams on hard flat surface or on timbers. Do not store directly on the ground.

2. Coil and protect the lanyard cable to prevent tangling and kinking.

Maintenance and Lubrication Summary

General Cleaning and Inspection After each use, as often as conditions require or permit, or every 6 months.

Inspect Rubber Stop Log Seals Before each installation.

Inspect Lifting Beam Before each use.

Troubleshooting Tips for Hydro Gate Stop Logs

Stop logs depend on water pressure to seal. The purpose of the stop logs is to control the flow or divert the flow. Tight shutoff of water is not possible. Stop logs are not a substitute for valves or gates; therefore, some fluid leakage around the stop logs should be expected. Proper seal inspection and maintenance will help limit the leakage.

Excessive Leakage around Seals

Excess leakage around seals can be caused by the bottom or side seals being damaged through improper storage or handling. Check for foreign material, cuts, or other damage on the seal surfaces. Scrape off any extraneous material or replace the seals if the damage is not repairable.

Excessive Leakage between Stop Logs

If the stop logs are not seated properly, excessive leakage between the stop logs will result. Check for debris on top of the bottom log or debris in the channel guide frame. Remove all debris and reinstall the stop logs.

Binding of Stop Logs during Removal

If the stop logs bind during removal, check for debris on top of or beside the stop logs. Remove all debris. Ensure the lifting beam has engaged BOTH lift lugs on the log. If a stop log is not properly engaged, reseat the lifting beam and ensure the lanyard line is not in tension and the linkage on the beam is operating properly.

Appendix D Bluefish Operations & Maintenance Checklists

TASK: Bluefish OPs Checklist - Weekly

Description Operations Checklist for Bluefish to be Performed Weekly

Company NTPC

Activities detail

1 BLUEFISH SITE
2 Any trades people on site?
3 Any visitors on site?
4 Site left clean after trades/visitors departed?
5 All PPE on site and available?
6 Test SAT Phone call control.
7 POWERHOUSE (G-1)
8 Check intake louvers.
9 Check all exhaust fans.
10 Check plant heating.
11 Check plant lighting.
12 Check all sump levels.
13 Check sump for contaminants and remove if necessary.
14 Check battery charger. Volts_______ Amps_______
15 Check Invertor, Note Status
16 Check plant crane. Unit 1_________ Unit 2________
17 COMPRESSOR (G-1 PLANT)
18 Check oil level.
19 Check belts.
20 Check air filter.
21 Bleed any water.
22 Check air pressure. PSI________
23 GOVERNOR SYSTEM (G-1)
24 Check sump oil level.
25 Check accumulator tank level.
26 Check accumulator tank pressure. PSI__________
27 Check dash pot oil level.
28 Dash pot oil added?
29 GENERATOR (G-1)
30 Check Generator bearing oil level
31 Check generator bearing oil temps, record __________
32 Oil added?
33 Check brushes for wear.
(Report any arcing immediately)
34 EXCITER (G-1)
35 Check brushes for wear.
(Report any arcing immediately)

Hendry, Eileen GuideTI
2020-07-02 12:58:21 PM Page: 1 / 5

BLUEFISH

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

POWER DAM, TAILRACE		NOTES
CONCRETE & MASONRY	( )	
EMBANKMENTS	( )	
RIPRAP	( )	
ROADS WAYS & WALKS	( )	
RAILINGS & MISC. METAL WORKS	( )	
STAIRWAYS & LADDERS	( )	
TRASH RACKS	( )	
INTAKE STRUCTURE	( )	
INTAKE HOUSE	( )	
LIGHTING & POWER	( )	
INTAKE LIFTING EQUIPMENT (GENERAL)	( )	
FOREBAY	( )	
HOISTS	( )	
ROCK TUNNEL	( )	
ROCK BOX	( )	
PENSTOCK	( )	

INSPECTED BY

DATE

BLUEFISH UNIT 1

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

PENSTOCKS, GATES		NOTES
PENSTOCKS		
TUNNEL	( )	
TUNNEL / LINER CONNECTION	( )	
	( )	
GATE	( )	
SEALS & GUIDES	( )	
WHEELS, PINS & ROLLERS	( )	
STEEL STRUCTURE	( )	
PAINT PROTECTION	( )	
CLEANLINESS	( )	
GATE HOIST (SEE D)	( )	
ELECTRIC MOTOR (SEE G)	( )	
ELECTRIC CONTROL (SEE M)	( )	
GATE HOUSE	( )	
FIRE PROTECTION	( )	

INSPECTED BY

DATE

BLUEFISH UNIT 2

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

PENSTOCKS, GATES		**NOTES**
PENSTOCKS		
TUNNEL	( )	
TUNNEL / LINER CONNECTION	( )	
	( )	
GATE	( )	
SEALS & GUIDES	( )	
WHEELS, PINS & ROLLERS	( )	
STEEL STRUCTURE	( )	
PAINT PROTECTION	( )	
CLEANLINESS	( )	
GATE HOIST (SEE D)	( )	
ELECTRIC MOTOR (SEE G)	( )	
ELECTRIC CONTROL (SEE M)	( )	
GATE HOUSE	( )	
FIRE PROTECTION	( )	
INSPECTED BY		
DATE		

Duncan Dam and Spillway

NWTPC
SPILLWAY AND CONTROL STRUCTURE INSPECTION SHEET

CHECKLIST

Operating Rules (2)
Slope Stability (2)
Erosion (2 or 3)
Debris Accumulation (3)
Concrete Condition (3)
Drains and Joints (3)

Obstruction of Discharge Channel (3)
Leakage Around Gates (3)
Debris in the Structure (2)
Erosion of Structure Backfill
Mechanical & Electrical Equipment (2)
Accessibility (2)

Site Specific Concerns

____
____

Dam: ____________________ Reservoir Elev.____________

Date of Inspection: ________________

Inspector(s): _____________________ Spillway Operating: _________________
_____________________ _________________

Weather Conditions: ____

OBSERVATIONS

Location & Item	Observation	Comments

ITEMS REQUIRING ACTION:

____

Inspector's Signature: _______________________ Date: ________________

NOTE: Bracketed numbers in checklist represent action codes.

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

HYDRAULIC TURBINES & GOVERNORS	Page 1	NOTES
TURBINES		
RUNNER	( )	
STEAL RINGS	( )	
SCROLL CASE	( )	
WICKET GATES	( )	
WEARING RING	( )	
GATE LINKAGE	( )	
DRAFT TUBE	( )	
SHAFT & COUPLING	( )	
BEARINGS , OIL SAMPLE	( )	
SERVOMOTOR CYLINDER, PISTON & ROD	( )	
MAIN SEAL	( )	
LUBRICATION (SEE E)	( )	
THERMOMETERS, GAUGES	( )	
OPERATION	( )	

INSPECTED BY

DATE

BLUEFISH UNIT 1

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

HYDRAULIC TURBINES & GOVERNORS	Page 2	NOTES
GOVERNORS		
ELECTRIC CONTROL DEVICES	( )	
BALL HEAD, BEARINGS & MOTORS	( )	
SPEEDER ROD & VIBRATOR	( )	
PILOT, RELAY VALVES	( )	
STRAINERS	( )	
COMPENSATING DASHPOT ASSEMBLY	( )	
OIL PIPING & PRESSURE TANK	( )	
PMG ASSEMBLY	( )	
CONTROLS & INDICATORS	( )	
LINKAGE & PINS	( )	
OIL PUMPS	( )	
OIL SAMPLE	( )	
SAFTY VALVES	( )	
REGULATING VALVES	( )	

INSPECTED BY

DATE

BLUEFISH UNIT 2

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

HYDRAULIC TURBINES & GOVERNORS	Page1	**NOTES**
TURBINES		
RUNNER	**( )**	
STEAL RINGS	**( )**	
SCROLL CASE	**( )**	
WICKET GATES	**( )**	
WEARING RING	**( )**	
GATE LINKAGE	**( )**	
DRAFT TUBE	**( )**	
SHAFT & COUPLING	**( )**	
BEARINGS , OIL SAMPLE	**( )**	
SERVOMOTOR CYLINDER, PISTON & ROD	**( )**	
MAIN SEAL	**( )**	
LUBRICATION (SEE E)	**( )**	
THERMOMETERS, GAUGES	**( )**	
OPERATION	**( )**	
INSPECTED BY		
DATE		

BLUEFISH UNIT 2

PLANT MAINTENANCE AND OPERATION

INSPECTION & MAINTENANCE CHECK LIST

HYDRAULIC TURBINES & GOVERNORS	Page 2	**NOTES**
GOVERNORS		
ELECTRIC CONTROL DEVICES	( )	
BALL HEAD, BEARINGS & MOTORS	( )	
SPEEDER ROD & VIBRATOR	( )	
PILOT, RELAY VALVES	( )	
STRAINERS	( )	
COMPENSATING DASHPOT ASSEMBLY	( )	
OIL PIPING & PRESSURE TANK	( )	
PMG ASSEMBLY	( )	
CONTROLS & INDICATORS	( )	
LINKAGE & PINS	( )	
OIL PUMPS	( )	
OIL SAMPLE	( )	
SAFETY VALVES	( )	
REGULATING VALVES	( )	

INSPECTED BY

DATE

WICKET GATE CLEARANCES

DATE ____

		HEEL	TOE	REMARKS			HEEL	TOE	REMARKS
1	TOP				2	TOP			
	BOTTOM					BOTTOM			
3	TOP				4	TOP			
	BOTTOM					BOTTOM			
5	TOP				6	TOP			
	BOTTOM					BOTTOM			
7	TOP				8	TOP			
	BOTTOM					BOTTOM			
9	TOP				10	TOP			
	BOTTOM					BOTTOM			
11	TOP				12	TOP			
	BOTTOM					BOTTOM			
13	TOP				14	TOP			
	BOTTOM					BOTTOM			
15	TOP				16	TOP			
	BOTTOM					BOTTOM			
17	TOP				18	TOP			
	BOTTOM					BOTTOM			
19	TOP				20	TOP			
	BOTTOM					BOTTOM			

BLUEFISH UNIT 1

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

POWER HOUSE		**NOTES**
DOORS & WINDOWS	( )	
STAIRWAYS & LADDERS	( )	
RAILINGS & MISC. METAL WORKS	( )	
CRANE & HOISTS	( )	
HEATERS	( )	
VENTILATING FANS	( )	
WATER SUPPLY & DRAIN PIPE	( )	
WATER HEATER	( )	
SINK, TOILET	( )	
CONDUIT & FITTINGS	( )	
LIGHTING	( )	
FIRE PROTECTION	( )	

INSPECTED BY

DATE

BLUEFISH UNIT 2

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

POWER HOUSE		NOTES
DOORS & WINDOWS	( )	
STAIRWAYS & LADDERS	( )	
RAILINGS & MISC. METAL WORKS	( )	
CRANE & HOISTS	( )	
HEATERS	( )	
VENTILATING FANS	( )	
WATER SUPPLY & DRAIN PIPE	( )	
WATER HEATER	( )	
SINK, TOILET	( )	
CONDUIT & FITTINGS	( )	
LIGHTING	( )	
FIRE PROTECTION	( )	

INSPECTED BY

DATE

BLUEFISH UNIT 1

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

CRANES, HOISTS		NOTES
CRANE, RAIL, SUPPORTS & STOPS	( )	
CRANE BRIDGE & STOPS	( )	
HOIST FRAMEWORK	( )	
TRUCK	( )	
BUMPERS	( )	
TROLLEY RAILS OR WIRE & SUPPORTS	( )	
TROLLEY SHOES & SUPPORTS	( )	
RUNWAYS & CATWALKS	( )	
LADDERS & HAND RAILS	( )	
CAB	( )	
DRIVING GEARS, SHAFTS	( )	
BEARINGS & WHEELS	( )	
BRAKES	( )	
CABLE DRUMS & SHEAVES	( )	
BLOCKS & HOOKS	( )	
ELECTRICAL MOTORS	( )	
ELECTRICAL CONTROLS	( )	
ELECTRIC WIRING	( )	
SAFETY DEVICES	( )	
OPERATION	( )	
NWT INSPECTION	( )	

INSPECTED BY

DATE

BLUEFISH UNIT 2

PLANT MAINTENANCE AND OPERATION
INSPECTION & MAINTENANCE CHECK LIST

CRANES, HOISTS		NOTES
CRANE, RAIL, SUPPORTS & STOPS	( )	
CRANE BRIDGE & STOPS	( )	
HOIST FRAMEWORK	( )	
TRUCK	( )	
BUMPERS	( )	
TROLLEY RAILS OR WIRE & SUPPORTS	( )	
TROLLEY SHOES & SUPPORTS	( )	
RUNWAYS & CATWALKS	( )	
LADDERS & HAND RAILS	( )	
CAB	( )	
DRIVING GEARS, SHAFTS	( )	
BEARINGS & WHEELS	( )	
BRAKES	( )	
CABLE DRUMS & SHEAVES	( )	
BLOCKS & HOOKS	( )	
ELECTRICAL MOTORS	( )	
ELECTRICAL CONTROLS	( )	
ELECTRIC WIRING	( )	
SAFETY DEVICES	( )	
OPERATION	( )	
NWT INSPECTION	( )	

INSPECTED BY

DATE

DAM INSPECTION

Check List	Comments	Complete

Crest

Cracking:		
Settlement:		
Sinkholes:		
Vegetation:		

Up Steam Face

Cracking:		
Erosion:		
Sinkholes:		
Rip rap:		
Instability:		
Vegetation:		

Downstream Face

Cracking:		
Erosion:		
Sinkholes:		
Rip rap:		
Wet spots		
Vegetation:		

Toe

Wet spots		
Seepage		
Ponding		
Vegetation		

Abutments

Instability		
Wet spots		
Seepage		
Erosion		
Vegetation		

NWTPC

SPILLWAY AND CONTROL STRUCTURE INSPECTION SHEET

CHECKLIST

Operating Rules (2)	Obstruction of Discharge Channel (3)
Slope Stability (2)	Leakage Around Gates (3)
Erosion (2 or 3)	Debris in the Structure (2)
Debris Accumulation (3)	Erosion of Structure Backfill
Concrete Condition (3)	Mechanical & Electrical Equipment (2)
Drains and Joints (3)	Accessibility (2)

Site Specific Concerns

____

____

Dam: ___________ Reservoir Elev.___________ Date of Inspection:___________

Inspector(s): ______________________ Spillway Operating: __________________

______________________ __________________

Weather Conditions: ____

OBSERVATIONS

<u>Location & Item</u>	<u>Observation</u>	<u>Comments</u>

ITEMS REQUIRING ACTION: ____

Inspector's Signature: _________________________ Date: __________________

NOTE: Bracketed numbers in checklist represent action codes.

NWTPC

EMBANKMENT DAM AND DYKE INSPECTION SHEET

CHECKLIST

Crest U/S Face D/S Face Toe Abutments

Cracking (2) Whirlpool (1) Boils (1) Boils (2) Instability (1)

Sinkholes (1) Cracking (2) Wet Spots (2) Wet Spots (2) Seepage (2)\

Settlement (2) Instability (2) Cracking (2) Seepage (2) Boils (1)

Slope Alignment (1) Sinkholes (1) Slope Instability (2) Vegetation (3) Wet Spots (2)

Vegetation (3) Erosion (3) Sinkholes (1) Ponding (3) Erosion (3)

Settlement above Riprap (3) Erosion (3) Vegetation (3) Vegetation (3)

Conduit (1) Piping Along Conduit (1)

Lateral Movement (3

Site Specific Concerns

____

____

Dam: ___________ Reservoir Elev.: ___________ Date of Inspection: _____________

Inspector(s): _________________ Spillway Operating: _______________________

Weather Conditions:

OBSERVATIONS

<u>Location & Item</u> <u>Observation</u> <u>Comments</u>

____

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____

____

____

____

____

ITEMS REQUIRING ACTION: ____

Inspector's Signature: ______________________ Date: _______________________

NOTE: Bracketed numbers in checklist represent action codes.

Thermistor Reading- Bluefish Dam

Fore bay level--------------------- Temperature -------------(C^0)

Date ------------------------- Name of Operator -----------------------

GTC 1	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		

GTC 2	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

GTC 3	Temp Reading (C^0)	
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

GTC 4	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

GTC 5	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

GTC 6	Temp Reading (C^0)	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Note: If no reading please mark "X"

Revised 18/09/ 2017

NORTHWEST TERRITORIES POWER CORPORATION
Empowering Communities

Water Management and Reservoir Operating Plan- Bluefish

Water Licence Number:

MV2005L4-0008

December 19, 2018

Prepared by:

Colin Steed
Assistant Director, Hydro Division
Northwest Territories Power Corporation

Contents

TABLES AND FIGURES

MAP

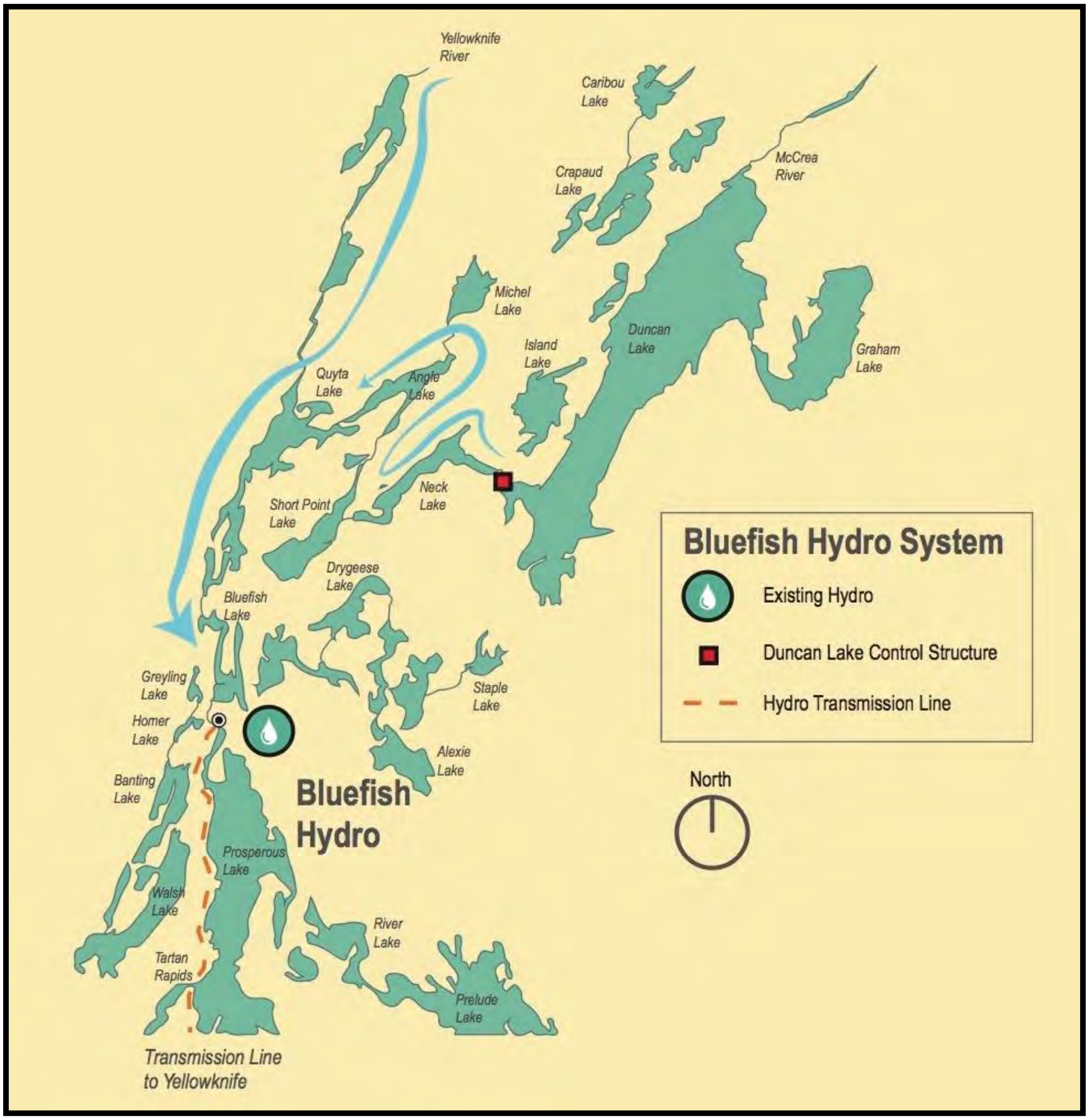


Figure 1: Map of Bluefish Hydro System Area

Summary

Snow survey results of the Yellowknife basin in early April were 68 % of average. The model using this data suggests peak flows of only 23.2 m^3/s, very low and similar to 1962. Record rainfall in June, however, had a significant positive impact on inflows. NTPC expects Bluefish operations to be above average during winter months.

The spillway at Duncan Lake was closed off on April 30 and will remained closed until late November. Duncan Reservoir rose to 211.62 m in November and will provide flow to Bluefish hydro for the winter months.

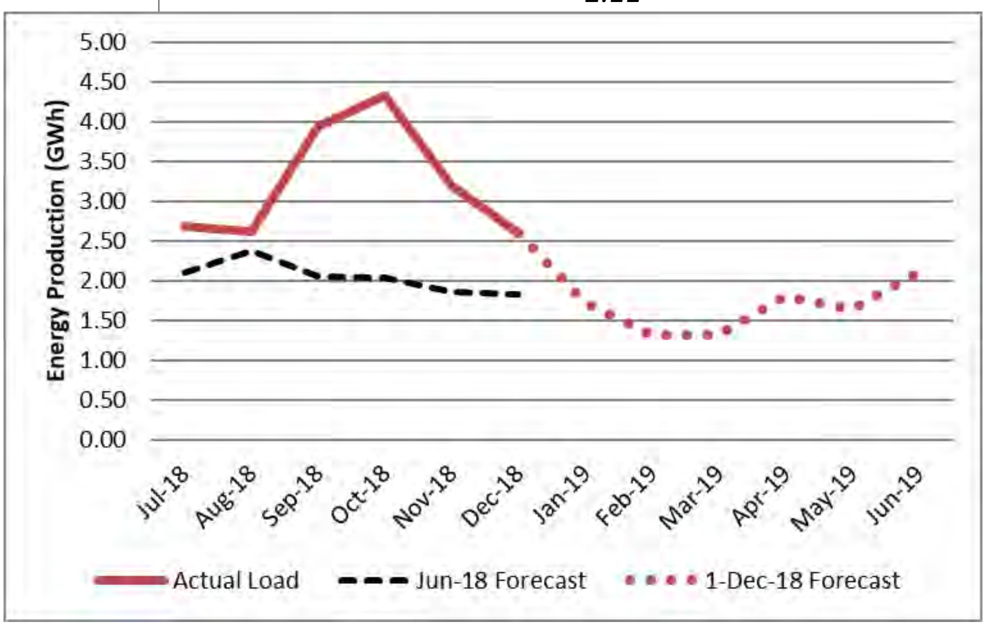
The Bluefish fore bay level is presently in the top range of the operating level and will be operated to remain near there to have reserve capacity in the event of temporary issues arising at Snare Hydro.

Energy Forecast

Forecast and actual energy production (GWh) for the months of July 2018 through June 2019 2018 are shown in *Table* and Figure 26.

Table 1: Bluefish Hydro Production (GWh)

	JUN-18 FORECAST	ACTUAL LOAD	DEC-18 FORECAST
JUL-18	*2.11*	2.68	
AUG-18	*2.38*	2.63	
SEP-18	*2.06*	3.94	
OCT-18	*2.03*	4.34	
NOV-18	*1.87*	3.20	
DEC-18	*1.83*	2.60	*2.60*
JAN-19			*1.72*
FEB-19			*1.33*
MAR-19			*1.33*
APR-19			*1.8*
MAY-19			*1.64*
JUN-19			*2.11*



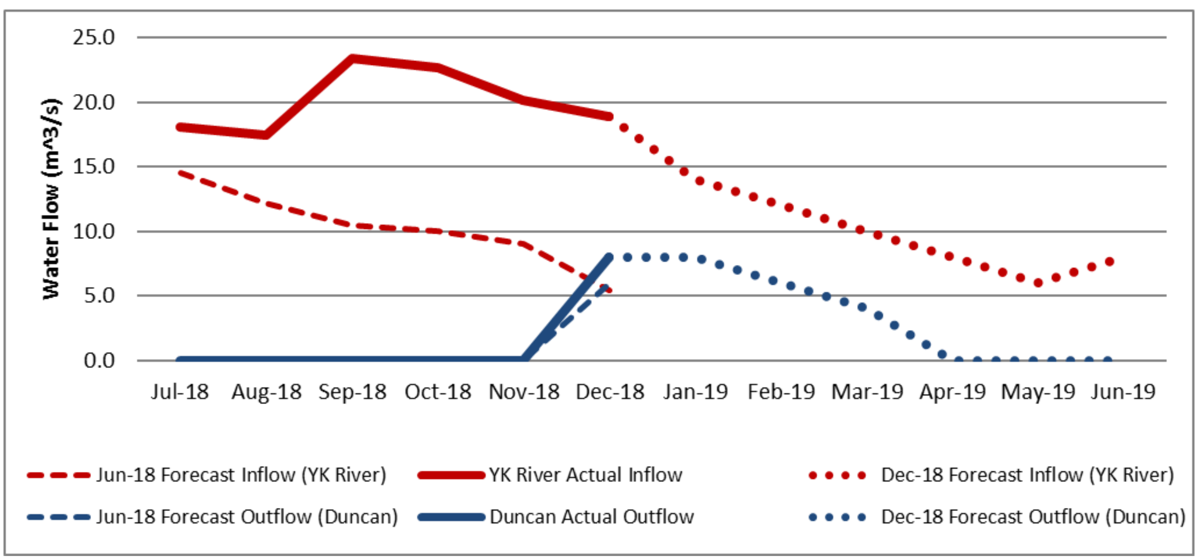
Review of Previous Operating Plan

Forecast and actual inflow and outflow in cubic meters per second for the months of July 2018 through June 2019 are shown.

Figure 25: Bluefish Hydro Actual and Forecast Output (GWh)

Table 2: Bluefish Hydro Actual and Forecast Water Flow (m^3/s)

	YELLOWKNIFE RIVER			DUNCAN LAKE		
	Jun-18 Forecast Inflow	**Actual Inflow**	**Dec-18 Forecast Outflow**	**Jun-18 Forecast Outflow**	**Actual Outflow**	**Dec-18 Forecast Outflow**
JUL-18	*14.5*	18.1		*0.0*	0.0	
AUG-18	*12.2*	17.4		*0.0*	0.0	
SEP-18	*10.5*	23.4		*0.0*	0.0	
OCT-18	*10.0*	22.6		*0.0*	0.0	
NOV-18	*9.0*	20.2		*0.0*	0.0	
DEC-18	*5.4*	18.9	*18.9*	*6.0*	8.0	*8.0*
JAN-19			*14.0*			*8.0*
FEB-19			*12.0*			*6.0*
MAR-19			*10.0*			*4.0*
APR-19			*8.0*			*0.0*
MAY-19			*6.0*			*0.0*
JUN-19			*8.0*			*0.0*

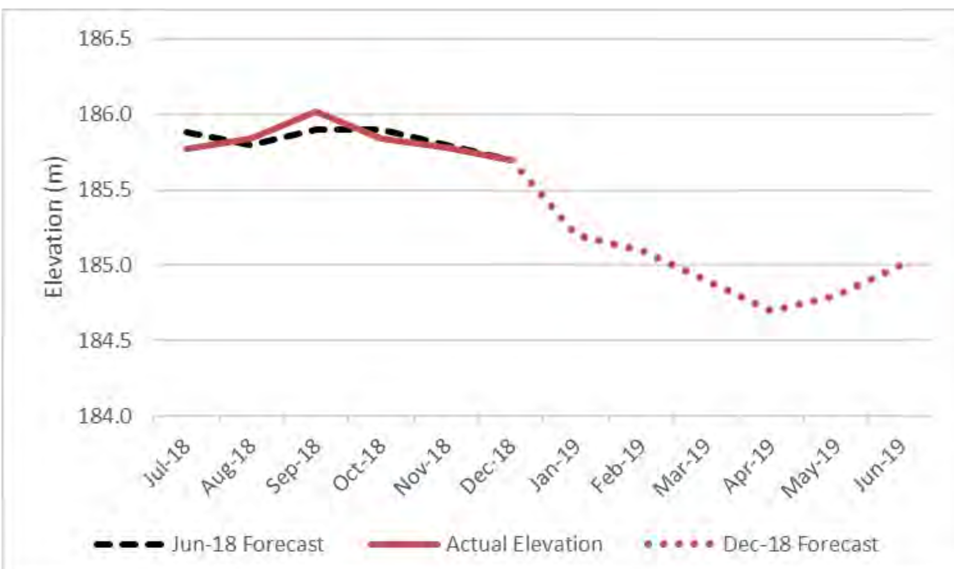


Bluefish Hydro Forecast and Actual Water Flow (m^3/s)

Forecast and actual reservoir levels in meters of elevation above sea level for the months of July 2018 through June 2019 are shown in **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 3: Bluefish Lake Reservoir - Forebay Levels (m)

	JUN-18 FORECAST	ACTUAL ELEVATION	DEC-18 FORECAST
JUL-18	185.88	185.77	
AUG-18	185.80	185.84	
SEP-18	185.90	186.02	
OCT-18	185.90	185.84	
NOV-18	185.80	185.78	
DEC-18	185.70	185.70	185.7
JAN-19			185.20
FEB-19			185.10
MAR-19			184.90
APR-19			184.70
MAY-19			184.80
JUN-19			185.00

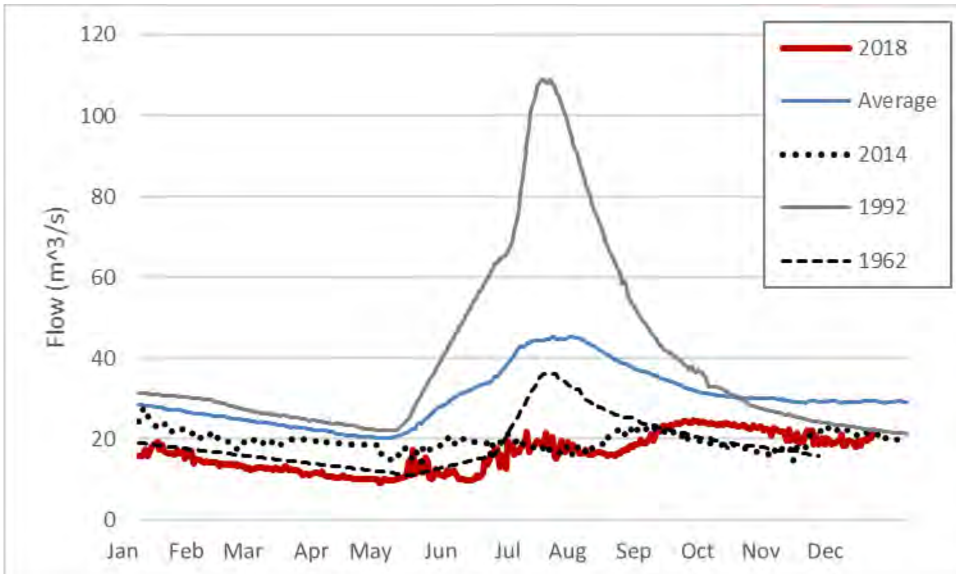


Bluefish Lake Reservoir - Forebay Levels (m)

Indicators

Flows and Trends

Error! Reference source not found. illustrates annual flows and trends for the Yellowknife River at Bluefish and the Cameron River at Reid Lake. 1962 provided a suitable forecast template for the first six months of 2018, with the second half of the year following more closely with 2014. The historical peak year (1992) and 30-year average trend lines are provided for reference purposes.



Annual Flow Trends - Yellowknife River at Bluefish

Precipitation

4 shows the 2018 and historical normal monthly precipitation at Yellowknife. June and July recorded significantly more precipitation than normal. This higher level of precipitation has helped to sustain inflows at Bluefish through the second half of the year.

Table 4 : Yellowknife Precipitation[1]

MONTH	NORMAL PRECIPITATION (MM)	2018 PRECIPITATION (MM)
JAN	14.3	13.2
FEB	14.1	14.4
MAR	13.9	3.8
APR	11.3	5.8
MAY	18.4	11.4
JUN	28.9	114.1
JUL	40.8	86.2
AUG	39.3	38.7
SEP	36.3	8.8
OCT	30.3	10.1
NOV	24.8	22.9
DEC	16.2	2
TOTAL	**288.6**	**331.4**

Snow Survey

Results of the April 03, 2018 Snow Survey are summarized in Table 5.

[1] Precipitation data from Environment Canada *https://weather.gc.ca/ retrieved 2018-12-19*

Table 5: Snow Survey Results (Snow Water Equivalent mm)

	2018 SWE (MM)	AVERAGE SWE (MM)	YEARS OF RECORD	PERCENT OF AVERAGE
ALAN LAKE	60.5	87.3	30	69%
DENIS LAKE	81.5	109.5	31	74%
LITTLE LATHAM LAKE	71.0	98.6	31	72%
723NARDIN LAKE	66.0	106.2	31	62%
SHARPLES LAKE EAST	82.0	108.4	31	76%
TIBBITT LAKE	53.0	85.5	36	62%
AVERAGE	69.0	99.2		70%

Expected Inflows

The Runoff Forecasting Model results for 2018 using the snow water equivalent in the Yellowknife River basin suggested a low water year similar to 1962.

May Yellowknife River Forecast

Snow Survey Basin ***SWE***		**69.0**	
SWE > 80	***Qmax = 0.0137*SWE²-0.789*SWE+2.2***		**13.0**
SWE < 80	*Qmax = 0.336*SWE*		23.2
Forecast Peak Flow =		23.2 m^3/s	mean date Julian 195 (July 14)

Template Year

1962	Peak Flow =	38.0	m^3/s

The McCrea River peak inflow, based on the 2018 Indin River Peak of 30.3 m^3/s, is estimated to be 10.8 m^3/s.

JUNE McCREA RIVER FORECAST

*Qmax = 0.469*Qindin-3.4*

Indin Peak	30.3	m^3/s		
McCrea	10.8	m^3/s	24.0	lag past Indin = July 22

Note: McCrea River Inflows can also be crudely estimated as 1.07 Cameron River Flows

Cameron River (07SB010)	2.85	m^3/s	18-06-27
McCrea River estimation	3.05	m^3/s	

Forecast Water Flows and Levels

Reservoirs

The following table summarizes the expected flows for the Yellowknife River, McCrea River and Duncan Lake outflow and Duncan Lake reservoir level for the next six months.

Table 6: Forecast Flows and Levels

MONTH	MCCREA RIVER (M^3/S)	DUNCAN OUTFLOW (M^3/S)	RESERVOIR WATER LEVEL (M)	YELLOWKNIFE RIVER (M^3/S)
JULY	10.8	0.0	210.82	14.5
AUG	9.3	0.0	210.94	12.2
SEPT	7.7	0.0	211.00	10.5
OCT	6.0	0.0	211.03	10.0
NOV	5.1	0.0	211.19	9.0
DEC	3.4	8.0	210.99	11.4

Water Use Efficiencies

The following table summarizes the expected GWh to m^3/s flow from the Yellowknife River and the Duncan Lake reservoir.

Table 7: Generation & Forecast Efficiencies

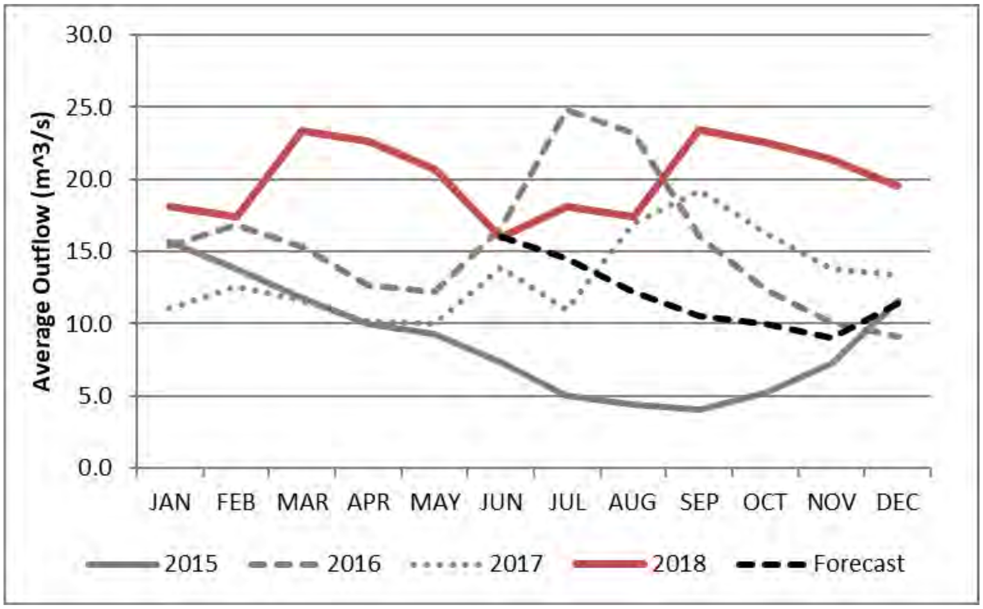
MONTH	YELLOWKNIFE RIVER (M^3/S)	DUNCAN OUTFLOW (M^3/S)	PLANT FLOW (M^3/S)	SPILL (M^3/S)	ENERGY (GWH)
JULY	14.5	0.0	14.5	0.0	2.11
AUG	12.2	0.0	12.2	0.0	2.38
SEPT	10.5	0.0	10.5	0.0	2.06
OCT	10.0	0.2	10.0	0.0	2.03
NOV	9.0	3.6	9.0	0.0	1.87
DEC	5.4	7.8	11.4	0.0	1.61

Notes:

Plant Flow Capacity =	26.5 m^3/s
Gross Head =	33.0 m
Hydraulic Efficiency =	98%
Turbine Efficiency =	86%
Generator Efficiency =	97%
Overall Efficiency =	82%

Actuals example

A comparison of actual to forecast outflows at Bluefish in 2018, and other recent years is shown in **Error! Reference source not found.**. The high amount of rain during the summer months caused a significant increase in outflow compared to forecast over the second half of 2018.



Actual and Forecast Flows

Commentary on Operations and Compliance

The Bluefish Hydro facilities were operated within compliance of the water license throughout the previous six months.

Surveillance network data for the period Oct-Dec, 2017 was submitted on January 9/18.

Surveillance network data for the period Jan-Mar, 2018 was submitted on April 30/18.

The Annual Report for Bluefish Hydro 2017 was submitted April 30th, 2018

Commentary on Reports and Inspections

GNWT, Department of Lands completed inspections for the Land Use Permit MV2017X0005 on October 3, 2017, February 6th, & 19th, 2018.

Final upon closure was completed on April 12th, 2018.