Marsh Lake Storage Project – Fact Sheet

History of Existing Infrastructures

Whitehorse Rapids Generating Station (WRGS)

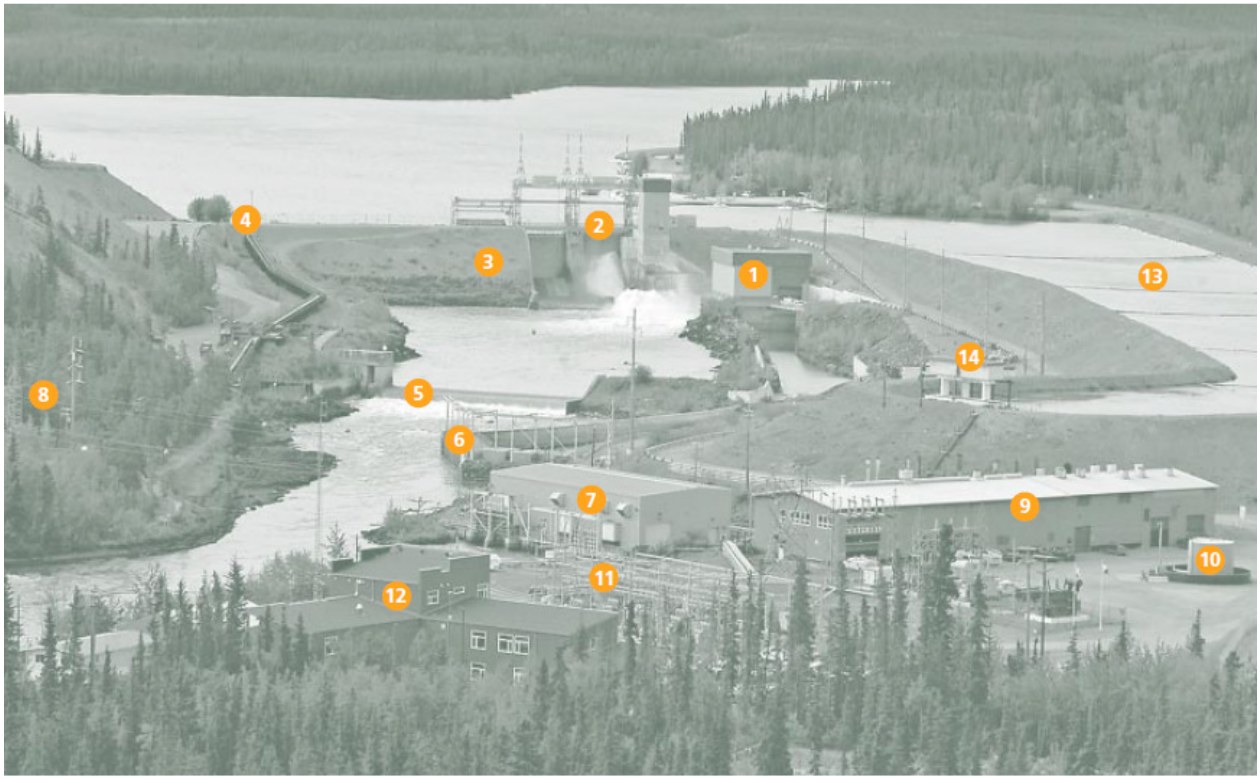
- Built by National Canada Power Commission in 1958 with 2 turbines; 3rd turbine added in 1969; 4th turbine in 1984
- Purpose of Whitehorse Hydro Plant is to generate electricity year-round using renewable energy. It is the largest hydro facility in the Yukon
- Total capacity: 40 MW; reduced in winter to ~24 MW as flow in Yukon River drops.
- Annual Generation averages 246 GWh/yr – approximately 60% of the total hydro generation in the Yukon .
- Summer Generation represents ~ 92% of the total generation in the Yukon; in winter this drops to approximately 50% of the total generation
- Fish Ladder: Built in June 1959 following the original construction of the Whitehorse Rapids dam. Usually open by mid-June (when spill occurs) through to September after Chinook salmon have completed upstream migration
- Fish Hatchery: Built in 1984 to offset the potential loss of fish due to turbine mortality. In 1976, the water license for the 4th turbine was approved, conditional upon the provision of *incubation boxes* to protect salmon in the Yukon River from adverse conditions created by the power plant. Ultimately, the fish hatchery was built and became operational in 1984.

Lewes Dam

- Originally built in 1899 to flush out ice for river navigation; the structure was rebuilt several times, most recently in 1976
- Purpose of Lewes Dam is to regulate the flows out of Marsh Lake to increase the water available for winter generation at the Whitehorse Rapids Generating Station
- Current structure has 30 gates used to regulate flow from Marsh Lake, 4 are automated
- Structure includes a boat lock and a fishway which have to be operational

Schematic drawings and pictures showing the components of the two facilities are presented in the next pages.

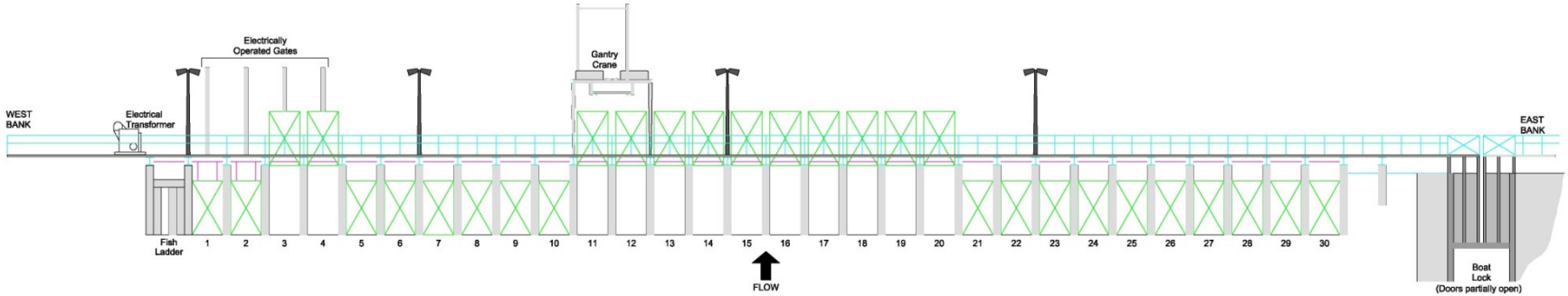
Whitehorse Rapids Generating Station



Components

1. Hydro turbine no. 4 (known as Fourth Wheel)
2. Spillway – water not needed to produce energy is spilled in the Yukon River, composed of 2 passages equiped with vertical sluice gates
3. Main dam (earthfill dam)
4. Fish ladder – allows migration of salmon and other species of fish upstream
5. Concrete weir – directs fish towards the fish ladder
6. Metal screens – also helps direct fish towards fish ladder
7. Hydro turbines no. 1, 2 and 3
8. Switching station – sends electricity to various communities
9. Seven back-up diesel generators
10. Diesel storage tank
11. Substation – gives electricity a voltage boost to help it travel along power lines
12. Yukon Energy's corporate office
13. Power canal – moves water from Schwatka Lake towards the intake to turbines no. 1, 2 and 3
14. Water intake – controls the flow of water entering the penstock (water conveyance conduits to turbines)

Lewes Dam – Marsh Lake Control Structure



Current Water Licence HY99-010

- Issued in January 2000; expires May 31st, 2025
- Marsh Lake operating levels (as measured by the Water Survey of Canada gauge 9AB004, available real-time online at http://www.ec.gc.ca/rhc-wsc) are:
- Full Supply Level (FSL) is 656.23 m asl and Low Supply Level (LSL) is 653.80 m asl
- All gates have to remain fully open between May 15 and August 15
- Gate operations are allowed between August 15 and May 15, except if the water level of Marsh Lake is above the FSL (656.23 m) when all gates have to be fully open
- In a very low water year up to 20 gates may be closed if the level of Marsh Lake does not reach the following elevations by certain dates:
    - July 7 654.82 meters elevation
    - July 21 655.15 meters elevation
    - Aug 10 655.65 meters elevation

  (Early gate closure only occurred once in 1996)
- A minimum flow of 85 m^3/s has to be maintained in the Yukon River downstream from Lewes Dam

Current Operations

- 240 m^3/s flow allows the total available 40 MW capacity to be achieved at WRGS. When flows are less than this volume, hydro generation is reduced
- Almost all of the water available for power generation at WRGS comes from Marsh Lake; the inflow between Marsh Lake and Whitehorse are negligible for most of the year
- In a typical year, Lewes Dam is operated as follows:
    - All gates are open from May 15th to August 15th thus no control is done between those dates
    - After August 15th, gates can start to be closed with 2 scenarios possible:
        - If the lake level is below the Full Supply Level (FSL) of 656.23 m, some gates are closed to raised the lake level towards the FSL
        - If the lake level is above the FSL of 656.23 m, no control is done until the lake level drops at this level, after which some gates are closed to maintain that level
    - In the winter, flows are adjusted to achieve a relatively constant flow throughout the winter
    - Prior to May 15th, the river flows and lake level are managed to stay above the minimum licensed levels

- Lowest flows occur in late April/early May – same time as lowest lake levels
- During summer, excess water that cannot be utilized for generation is spilled – this usually occurs from late June to mid-October, with average peak flows reaching 450 m^3/s
- Winter generation is achieved by releasing water from Marsh Lake, starting in November through to early May when the available water from Marsh Lake has been fully utilized and levels are reaching the licensed minimum
- Flows in the Yukon River are limited to a maximum of 170 m^3/s during the beginning of the winter when ice forms on the river, to prevent flooding of the Marwell sector in Whitehorse
- Since 1984, the level of Marsh Lake has reached or exceeded the current FSL (656.23 m) in 21 of 26 years. Only in 1985, 1995, 1996, 2002 and 2003 did lake elevations fall short of, or barely reach the current regulated FSL
- Since 1984, Marsh Lake level has **exceeded the new proposed FSL in 10 years**

Proposed Change to Water Licence

The following potential changes will be assessed as part of the project:

- Raise FSL 0.3 m (1 ft) to 656.53 m asl
- Lower LSL by ~ 0.1 m to 653.70 m asl
- No change to minimum flow of 85 m^3/s
- Gate openings – assess benefits of changing the mode of operation to :
    - fill Marsh Lake as late as possible in the fall
    - smooth flows on the Yukon River for environmental aspects
    - avoid increase in risk of flooding
- Improve flow forecasting techniques
- Effects monitoring after project implementation

Southern Lakes Hydrology

- The main lakes of the Southern Lakes are presented in the table below with their mean elevation. The region of the Southern Lakes represents the headwaters of the Yukon River. A map of the lakes with the direction of flow is presented on the following page.

Lake	Mean Elevation (mASL)	Connecting Reach to Downstream Lake
Marsh	655	Yukon River
Tagish	656	Tagish River
Bennett	656	Nares River
Fantail	690	Fantail River
Tutshi	707	Tutshi River
Atlin	668	Atlin River

- The Marsh Lake water level can have influence on both Tagish and Bennett Lakes due to the small difference in elevation between those lakes
- Marsh, Tagish and Bennett Lakes effectively behave as one lake when lake levels in Marsh Lake are above ~654.2 m when flows are receding in the winter; and above 655.5 m when inflows are increasing (summer). The effect does not extend to Bennett Lake over this entire range, but Bennett Lake levels are influenced by Tagish Lake levels at elevations above 655 m.
- The timing of this noticeable backwater effect that Marsh exerts on Tagish is from ~ mid to late September to early April, and on Bennett Lake from ~ mid to late September to end of February. This period coincides with the active regulation of the gates at Lewes Dam.
- Atlin Lake, along with other higher elevation lakes in the Southern Lake region are not, and will not be affected by higher levels on Marsh Lake
- Mean elevation of Atlin Lake is 668 m which is ~ 13 m higher than Marsh Lake. Tutshi Lake is located at 707 m, Fantail at 690 m, so neither of these lakes are now, nor would be affected by a 0.3 m change in Marsh lake elevation at FSL.
- Connecting rivers (Tutshi, Atlin, Fantail rivers) have steep gradients (slope) and effects of Marsh Lake on these rivers are negligible
- Peak lake levels on Marsh Lake typically occur between mid August and early September
- Lowest levels reached in late April to early May
- Water Survey of Canada hydrometric stations exist at Marsh Lake, Bennett Lake and Tagish lake, as well as on the Yukon River in several locations. However, data is only available real-time for the Marsh Lake gauging station in the Southern Lakes region; the data from all other stations is added to the Water Survey of Canada website which approximately a 1 year delay.
- The lake level records for Marsh Lake date back as early as 1950, with continuous water levels since 1956

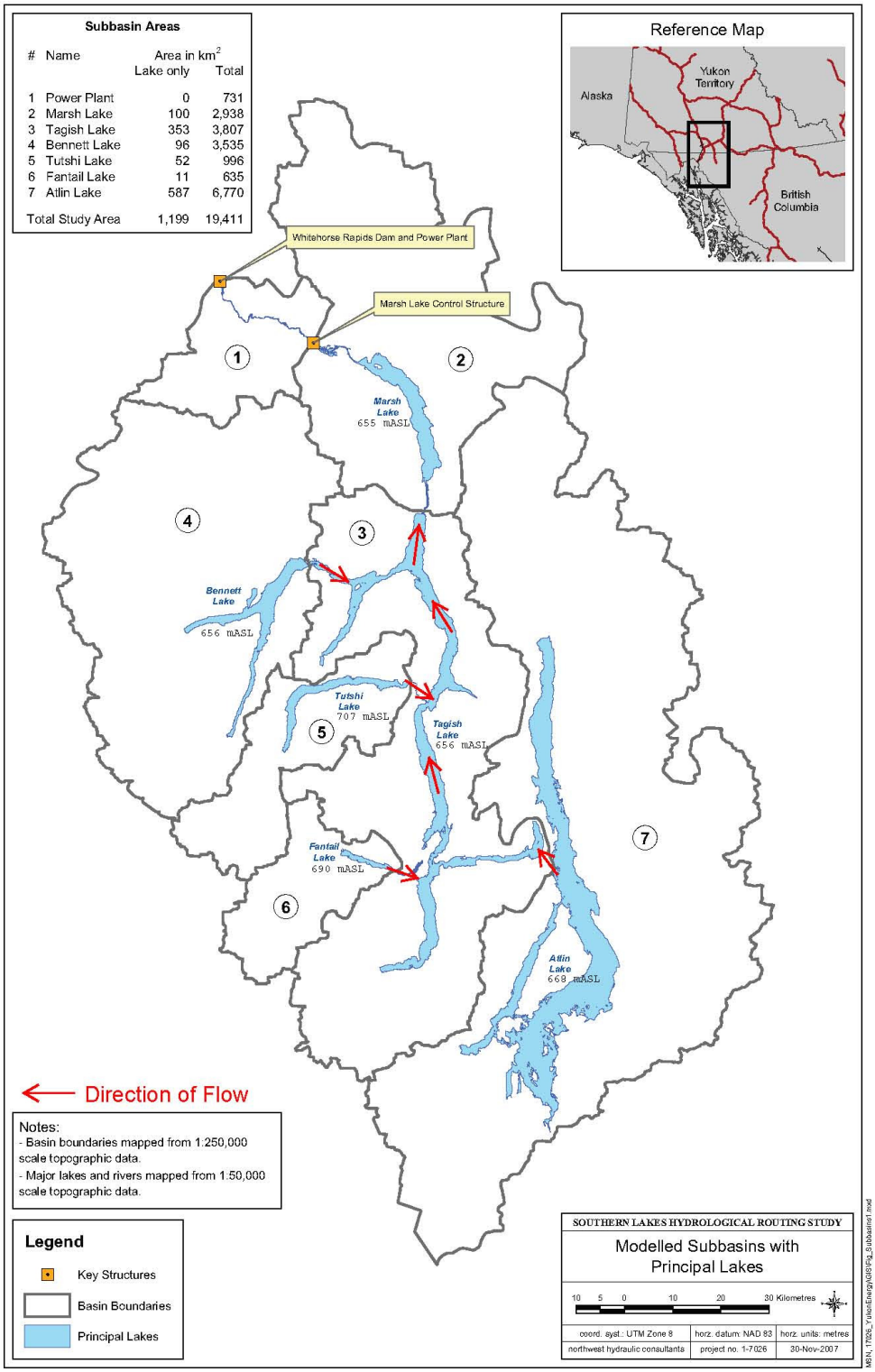

Subbasin Areas
Name Area in km² Lake only Total
1 Power Plant 0 731
2 Marsh Lake 100 2,938
3 Tagish Lake 353 3,807
4 Bennett Lake 96 3,535
5 Tutshi Lake 52 996
6 Fantail Lake 11 635
7 Atlin Lake 587 6,770
Total Study Area 1,199 19,411
Reference Map
Yukon Territory
Alaska
British Columbia
Whitehorse Rapids Dam and Power Plant
Marsh Lake Control Structure
Marsh Lake 655 mASL
Bennett Lake 656 mASL
Tutshi Lake 707 mASL
Tagish Lake 656 mASL
Fantail Lake 690 mASL
Atlin Lake 668 mASL
1
2
3
4
5
6
7
Direction of Flow
Notes:
- Basin boundaries mapped from 1:250,000 scale topographic data.
- Major lakes and rivers mapped from 1:50,000 scale topographic data.
Legend
Key Structures
Basin Boundaries
Principal Lakes
SOUTHERN LAKES HYDROLOGICAL ROUTING STUDY
Modelled Subbasins with Principal Lakes
10 5 0 10 20 30 Kilometres
coord. syst.: UTM Zone 8
horz. datum: NAD 83
horz. units: metres
northwest hydraulic consultants
project no. 1-7026
30-Nov-2007
MXD_1702b_YukonEnergy\GIS\Fig_Subbasins1.mxd

Figure 1

Longitudinal Water Profile from Atlin Lake to WRGS