



MAYO RIVER FLOOD CONTROL PROJECT

PREPARED FOR
**2017 YUKON ENGINEERING
EXCELLENCE AWARD**

CLIENT: YUKON GOVERNMENT COMMUNITY SERVICES
YEARS COMPLETED 2014-2017

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CONTRACTORS: Ewing Transports Ltd. | Wilf's Contracting

SITE SUPERVISION: Tony Gaw and Mark Alford

PROJECT SUMMARY AND OBJECTIVES

The lower reach of the Mayo River in the vicinity of the Village of Mayo has been subject to significant winter flooding related to the development of ice jams, especially between 2010 and 2014. This has caused significant harm to the community and various stakeholders:

- Private and public properties affected by flooding (private residences, Village of Mayo infrastructures, YEC diesel plant, etc.)
- Significant capital costs to Yukon Government to perform emergency flood relief efforts including extensive ice removal
- Reduction in winter generation at Yukon Energy's Mayo Generating Station over at least 4 winters
- Constant community concerns over winter months and lack of trust amongst stakeholders creating stress within the community

In February 2014, Yukon Government Community Services – Infrastructure Development Branch (CS-IDB) retained Morrison Hershfield (MH) to complete a preliminary design of long-term flood mitigation options.

Yukon Energy Corporation (YEC) operates the Mayo Generating Station approximately 13 km upstream of the village which controls the flows on the lower Mayo River. An increase in winter flows (as a response to increasing electrical production from the power plant), changing geomorphological conditions and meteorological conditions have all contributed to the freeze-up related flooding.

The project goal is to reduce or eliminate flooding in the



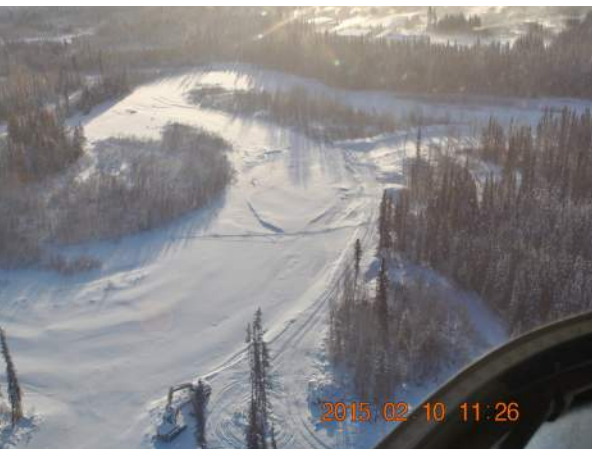
Village of Mayo, while minimizing human intervention and at the same time providing the opportunity to maximize hydroelectric generation during the winter. Given the complexity of the issue and high degree of uncertainty, it was recognized that a single solution would be unlikely to resolve the problem while achieving the multiple goals. Therefore a series of measures that could be implemented incrementally were identified in the preliminary design phase, including:

1. Develop and implement a winter operation protocol;
2. Increase hydraulic capacity of Mayo River;
3. Provide bank stabilization;
4. Permanently establish diversion channels.

..... **FLOW MANAGEMENT**

In late 2014, CS-IDB and YEC formed a flow management committee to collect and analyze data from a monitoring and instrumentation program, as well as to develop flow management procedures to minimize ice-related flooding issues. To a certain degree, a flow management program is developed through operational experience and will be refined over multiple years' operation.

The goal of the flow management program is to promote the formation of an ice cover on the river to reduce frazil ice-generation.



Frazil ice is believed to be a major contributor to ice accumulation in the channel, causing ice jamming on the lower reach of the Mayo River. This is accomplished by implementing flow cut back during freeze up. Furthermore, daily and hourly flow rate fluctuations are minimized to reduce frazil ice transport and to minimize the potential of collapsing or breakage of the ice cover as a result of flow changes.

The flow management procedure has shown good results over the last three winter seasons. During this period, only minor localized flooding has occurred and there has not been any significant risk to infrastructures within the Village of Mayo. An almost complete ice cover has been established by early January during the last three winters, mostly by shore ice formation. During this period Yukon Energy Corporation was also able to increase hydroelectrical generation relative to the previous winters (2010 through 2014) when the river experienced significant flooding.

DESIGN AND CONSTRUCTION OF FLOOD MITIGATION WORKS

Morrison Hershfield completed detail design of the long-term flood mitigation works in 2016. Construction of the majority of the works was completed during the summer 2016. Construction work was completed entirely by local contractors from the Village of Mayo. The works consisted of the following:

1. Construction of access roads along the river to provide permanent year-round access for construction and future maintenance.
2. Placement of six culverts to provide permanent crossings over two side channels that are used as fish rearing habitats. Significant erosion and channel realignment was occurring previously at these channels which created risk of rapid river migration. Establishing the permanent crossing stabilized these channel inlets.
3. Sediment removal in six zones along the lower Mayo River. These are areas where the channel had become very shallow and lacked well-defined deep channel. These zones were previously identified as the most problematic areas for ice jamming. A total of approximately 1,500 truck-loads of sediments (estimated volume of 6,850 m³) of gravel was removed from the river channel. All work was completed during an in-stream work window under a letter of advice from the Department of Fisheries and Oceans.
4. Bank protection with riprap was installed along approximately 320 m of river bank. This protects banks that were stripped of vegetation during previous emergency flood mitigation efforts. Protecting the banks reduces the amount of sediment being eroded and deposited in the river.
5. The emergency diversion channels constructed in 2011 are to be stabilized and established as permanent overflow channels (work to be conducted in 2017). These channels will provide additional hydraulic capacity in case of high water levels associated with flooding. Those two diversion channels will be protected against erosion and overflow weirs will be constructed as their inlet such that they act as overflow by-pass channels only.

CHALLENGES, INNOVATION AND SUSTAINABILITY

- The Mayo River is a small wandering gravel bed river that is very shallow which makes winter hydro operations challenging. Hydropower production on such small northern rivers is uncommon.
- Flow in the Mayo River has been regulated since the early 1950's. Operations have varied as a result of power demand but generally the dam has led to a reduction in peak flows thus reducing sediment transport downstream to the Stewart River. Significant aggradation of the river has occurred through the years reducing the hydraulic capacity.
- There is very limited existing literature on flood mitigation related flow management on small rivers; most literature that exists related to ice related issues downstream of power plants are on much larger and deeper rivers.
- It was discovered that the Mayo River ice cover forms primarily through shore ice growth. This is unique compared to many rivers that will form an ice cover by frazil ice accumulation. Such a finding allowed helped focus the flow management protocol to promote the formation of a stable ice cover.
- The project has allowed Yukon Energy to increase their renewable energy generation from the Mayo hydroelectric facility during winter months. This reduces the Yukon's reliance on thermal electrical generation (LNG or diesel).
- Construction was completed over a 6 week period with a very tight schedule to accommodate the fish timing window for instream works. Numerous environmental constraints had to be adhered to and the project was completed successfully on time with good protection of the environment.
- The project has significantly contributed to protecting the Village of Mayo against adverse effects related to winter flooding on the Mayo River.
- Construction of the permanent works was completed entirely by contractors from the Mayo area. A Project Management approach by Yukon Government facilitated leveraging local resources from the Village. The expertise gained from this project has stayed within the community and it will facilitate future maintenance and monitoring of the river.
- The project has provided future recreational opportunities in the vicinity of the lower Mayo River, providing access to this natural areas to residents. Access trails will allow residents to enjoy the natural setting along the river, especially in the McIntyre Park area.