Sand Blanket Material

Shields curves related to sand particle size and depth-averaged velocities in the post-Project reservoir environment obtained from MIKE21 modeling were used to model the erosion potential of sand particles placed at the placement sites. Results suggest that sand particles sized greater than 1.0 mm and less than 2.0 mm in diameter can be used.

Sand Blanket Thickness

In order to cover any boulders or cobbles present on the bed of the Nelson River, a sand blanket thickness of approximately 0.20 m would be used.

4.5.2 Lake Sturgeon Stocking

It is predicted that YOY rearing habitat may be limiting within the reservoir during the initial operation of the Keeyask GS (Section 4.5.1). As monitoring will need to occur before it can be determined whether YOY lake sturgeon can effectively use available reservoir habitat for rearing purposes, there is the potential for temporary disruptions to early life history stages.

Stocking effectively improves natural recruitment by ensuring survival through the very young life history stages, thereby bypassing a significant portion of mortality that occurs in wild fish populations. In the case of the Project, this will be particularly important as suitable habitat for the rearing of YOY lake sturgeon may not exist initially in the reservoir. See Section 4.4.2 and AE SV Appendix 1A-Part 2 for a more detailed description of stocking strategies.

4.6 LAKE STURGEON SPAWNING HABITAT DOWNSTREAM OF POWERHOUSE

The creation of artificial spawning habitat downstream of the powerhouse would increase the certainty that lake sturgeon spawning habitat is available downstream of the GS following development of the Project. Currently, the creation of spawning habitat in proximity to where it exists today appears to have the greatest probability of success. This spawning habitat would be designed specifically to attract lake sturgeon, but it could also be used by other species that spawn under similar conditions.

In addition, the spawning structure would provide habitat suitable for colonization by benthic invertebrates that inhabit high-velocity rocky habitats, and will thereby partially compensate for the loss of foraging habitat in Gull Rapids.

Design Criteria

Biological design criteria for the construction of lake sturgeon spawning habitat (Table 3) are based on successful lake sturgeon spawning structures that have been constructed in Québec and Russia (Verdon and Gendron 1991; DuMont et al. 2009; LeHaye et al. 1992 in Kerr et al. 2011). HSI modelling indicates that existing suitable spawning habitat within and below Gull Rapids tends to be found along the edges of the main channel (AE SV Section 6.3.2.3). The spawning structure is proposed to be built on the north shore of the river below the powerhouse in order to increase the certainty of adequate and reliable flow and to be situated where lake sturgeon moving upstream in low velocity habitat along the river's edge would locate it.

Table 3. Biological design criteria for lake sturgeon spawning habitat creation below the Keeyask tailrace.

Parameter	Design Criteria	Additional Considerations
Velocity	Min = 0.5 m/s Max = 1.5 m/s Velocities referenced to 0.6 of depth from surface.	A range of velocities should be available over the constructed habitat.
Flow	Flow should remain relatively constant during the spawning and incubation period.	Flow should be laminar downstream of the site, transitioning to more turbulent at the site.
Depth	Min = 1 m Max = 10 m Pre-construction depth of 2m–11m required for materials placement.	A range of depths should be available over the constructed habitat.
Substrate	Minimum 10 cm diameter. Maximum 60 cm diameter. Size distribution (diameter): 100% <0.6 m, 75% <0.4m, 50% <0.2 m and 25% <0.15m.	Important that there be ample interstitial space for egg incubation and larval development. Minimum thickness of 0.6 m.
Micro-habitats	65 boulder clusters (3 boulders >0.9 m diameter) will be interspersed over the spawning habitat.	Provide refuge and create turbulence.
Size of Spawning Area	A total area of 3.0 ha is recommended.	Could be made up of several areas of no less than 0.5 ha that meet hydraulic criteria.
Location	As close as possible to the north shore of the river while satisfying hydraulic criteria.	
Critical Annual Period	Mid-May to mid-July.	Discharge would be managed during this period to satisfy velocity and depth criteria.

Final Design Plans/Considerations

A phased approach will be taken to constructing lake sturgeon spawning habitat below the powerhouse. The proposed locations of the constructed spawning habitat are shown in maps 8 and 9 (phases 1–3). Key features to this spawning habitat are a minimum substrate thickness of 0.6 m (with 0.1–0.6 m diameter rock) and water depths of 1–10 m. Under this initiative, micro spawning sites will be created by placing three (1 m to 2 m diameter) boulders in V-shape (upstream chevron) clusters as shown in Figure 1.

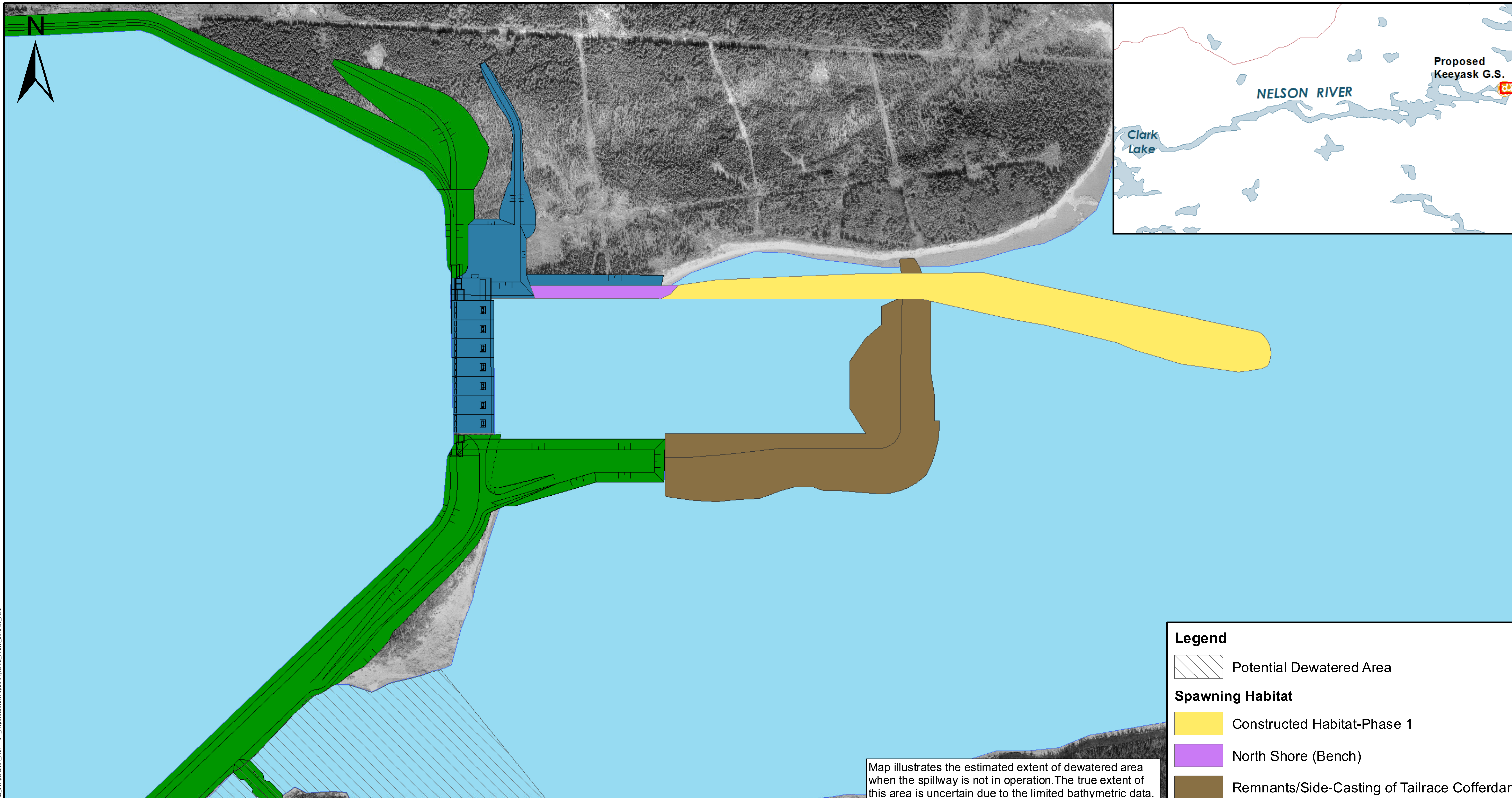
Studies conducted at the Pointe du Bois GS (NSC 2011) have found that that, under some flow conditions, sturgeon move into the tailrace channel and that quiet waters next to turbulent fast flow create preferred microhabitats. As a result, a slope will be incorporated into the north wall of the tailrace channel (Section B-B in Figure 2) and a bench covered in spawning substrate will be constructed along the north shore of the tailrace (Section A-A in Figure 2) The modifications to the vertical wall of the tailrace channel are meant to guide sturgeon that move upstream past the constructed spawning structure to an additional area of suitable spawning substrate (the bench).

The potential to create additional suitable substrate for spawning by leaving behind remnants of the cofferdam, or side-casting, was also evaluated (Map 8). Due to the hydraulic effects of the cofferdam remnants, leaving a substantial amount of material is not feasible. However, where practical, coarse materials from the remnants of the tailrace summer level cofferdam may be spread to create conditions attractive to spawning fish in areas where interference with the outflow from the GS will not be a concern.

During the initial years of Project operation, spawning habitat available to sturgeon downstream of the GS will consist of the Phase 1 constructed spawning habitat (up to 5.3 ha), the modified north bank of the tailrace channel, and areas of remnant coarse material from cofferdam removal/side-casting (see Map 8). Use of these areas by spawning sturgeon will be monitored for three years (see Section 6.2.3 of the AEMP for monitoring details); if a requirement for other spawning habitat is identified (e.g., if conditions in the initially created habitat are not suitable), then additional habitat (i.e., phases 2 and 3) will be constructed. Potential areas downstream of the GS adjacent to the initially created habitat have been identified based on hydraulic modelling (creating up to 15.9 ha of spawning habitat; Map 9); however, actual locations would be adjusted depending on site-specific conditions and responses of sturgeon to the flows downstream of the GS.

The area of spawning habitat that meets the design criteria is dependent on the discharge through the powerhouse and the water elevation of Stephens Lake. For example, Phase 1 provides 0.4–4.7 ha for discharges of 1,100 m^3/s (two units, 1 and 2) to 4,000 m^3/s (seven units) respectively, while Phase 3 provides approximately 3.0–7.9 ha for these same discharges.

During the spawning period, the operation of the Keeyask GS will be modified such that flow from the two northernmost units is continuous to maintain appropriate hydraulic conditions over the spawning structure. In addition, monitoring will be required to determine if the cycling mode of operation adversely affects the behaviour of spawning fish. As long as drawdowns on Stephens Lake do not cause spawning habitat velocity and depth criteria to be violated, it is unlikely that operation of the Kettle GS would have to be modified

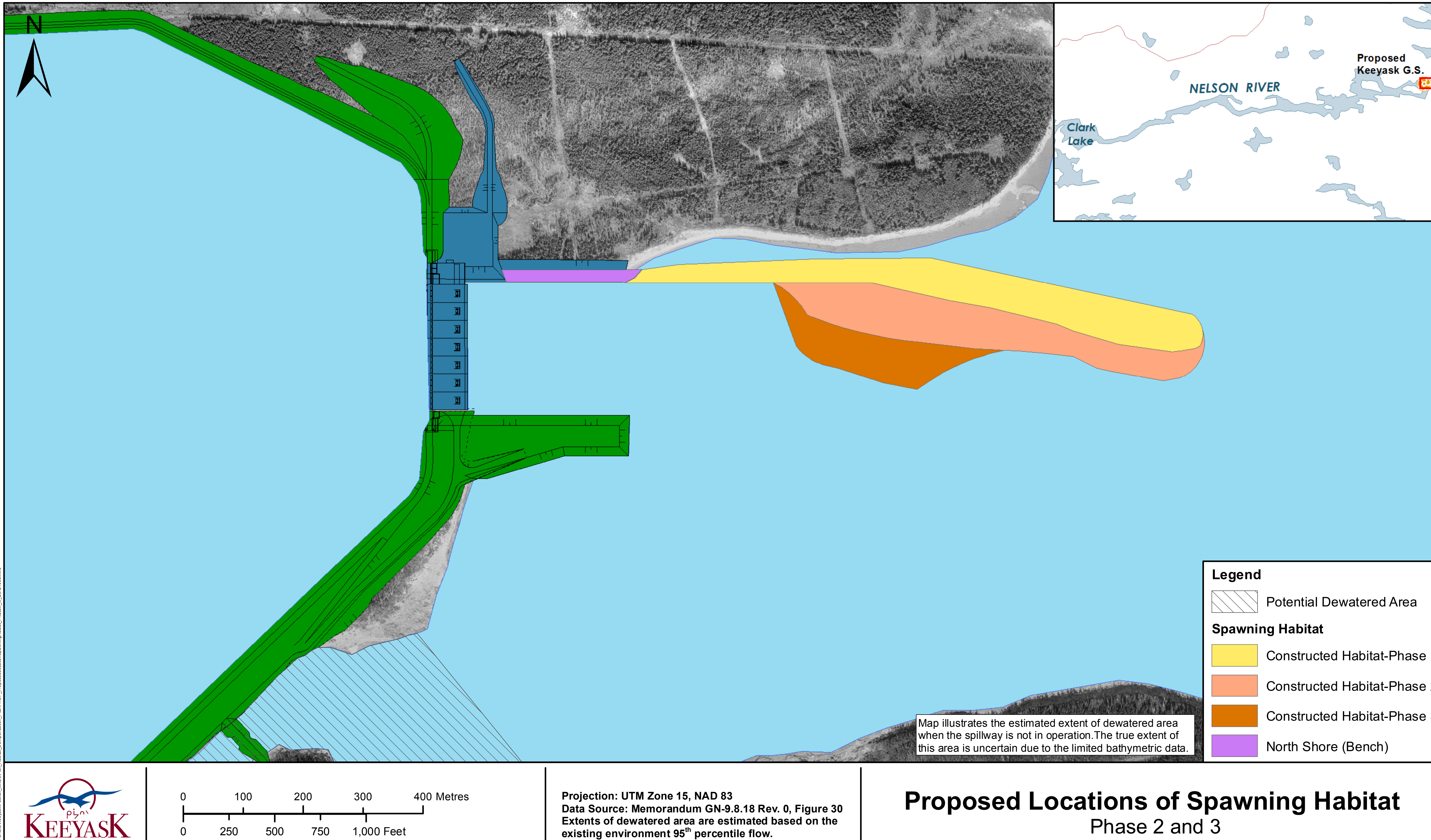


KEEYASK
Hydropower Limited Partnership

0 100 200 300 400 Metres
0 250 500 750 1,000 Feet

Projection: UTM Zone 15, NAD 83
Data Source: Memorandum GN-9.8.18 Rev. 0, Figure 26
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Proposed Location of Spawning Habitat
Phase 1



KEEYASK
Hydropower Limited Partnership

Projection: UTM Zone 15, NAD 83
Data Source: Memorandum GN-9.8.18 Rev. 0, Figure 30
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Proposed Locations of Spawning Habitat

Phase 2 and 3

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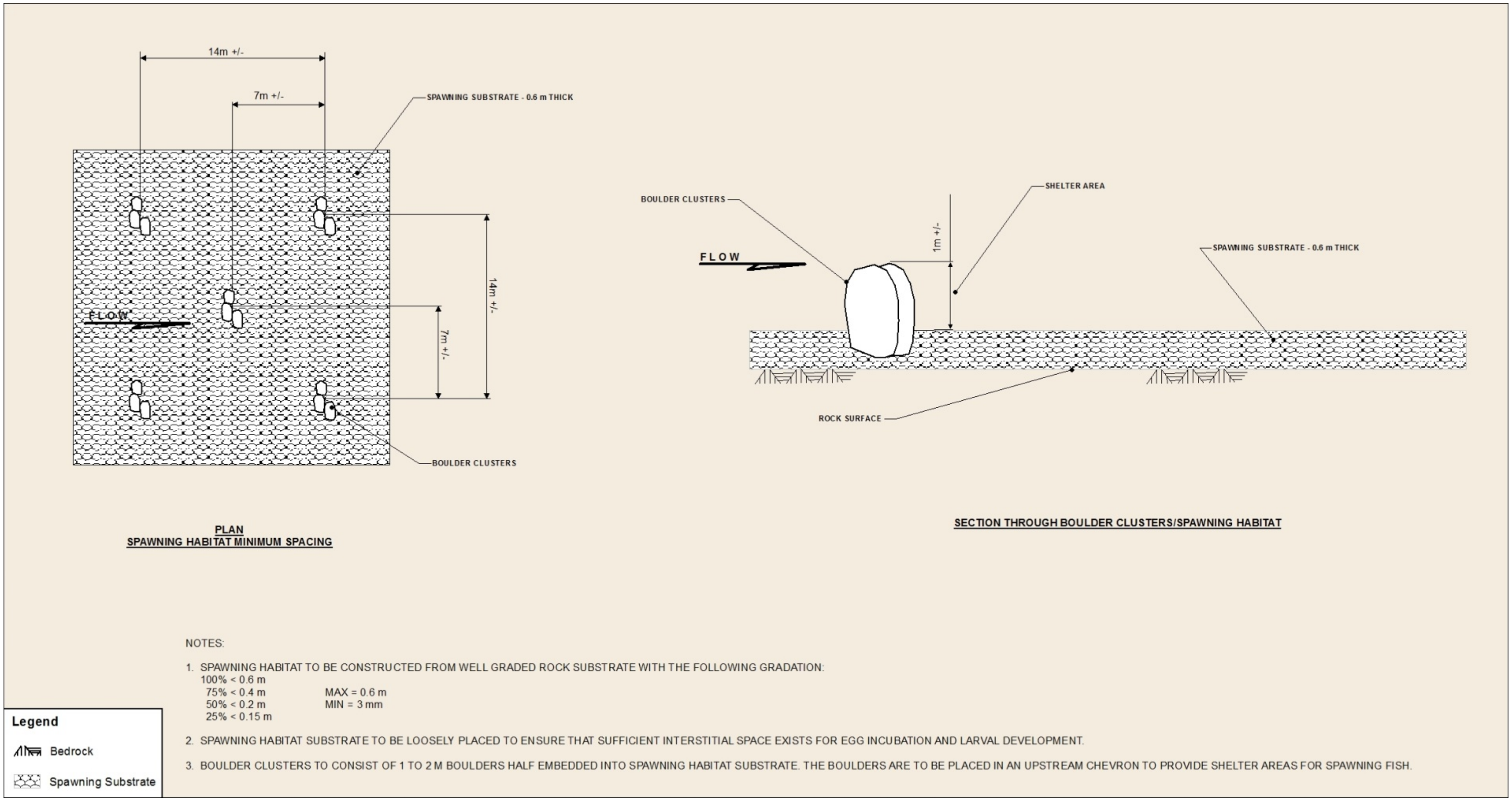


Figure 1. Spawning habitat details showing the arrangement and spacing of boulder clusters.

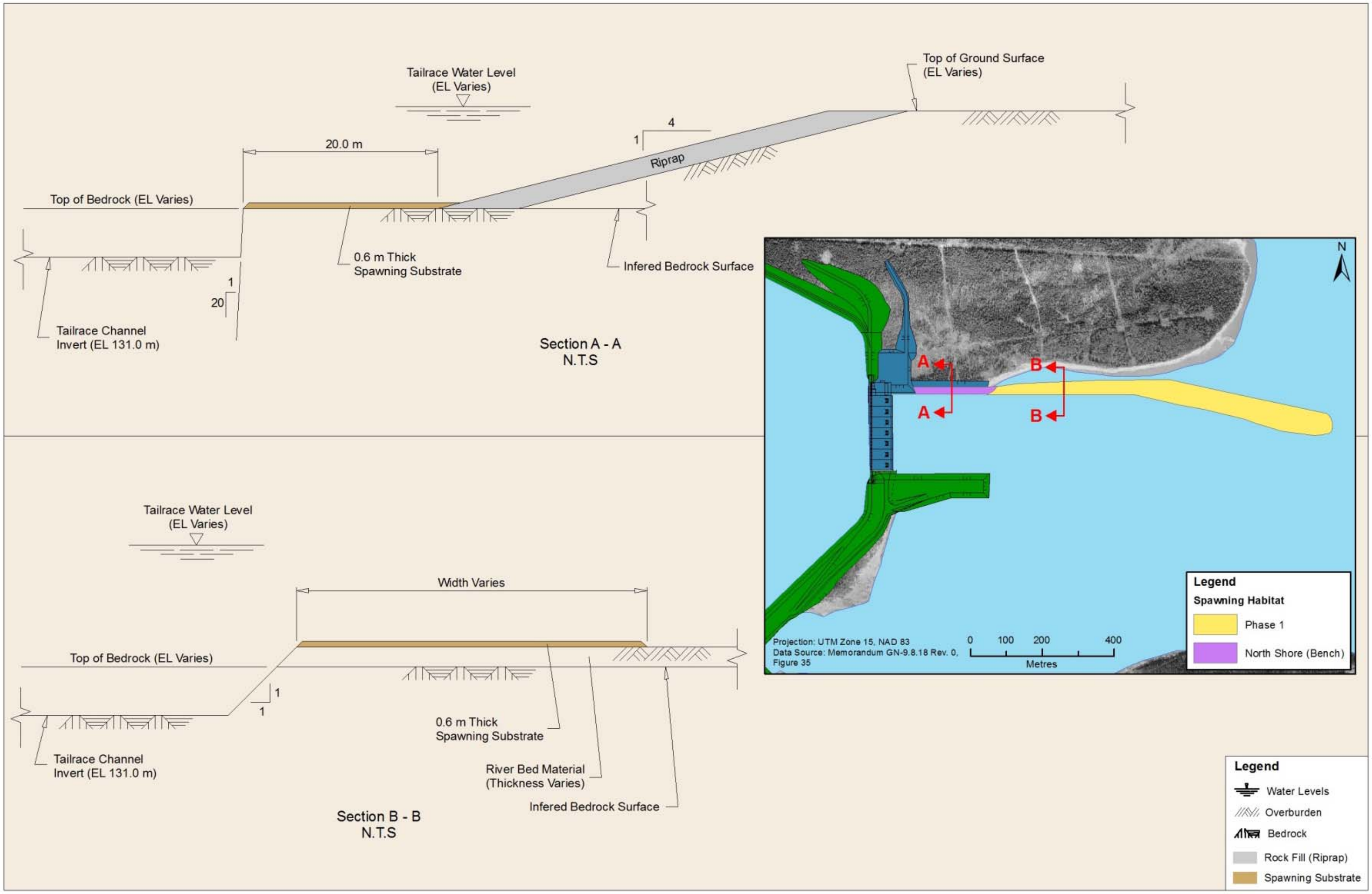


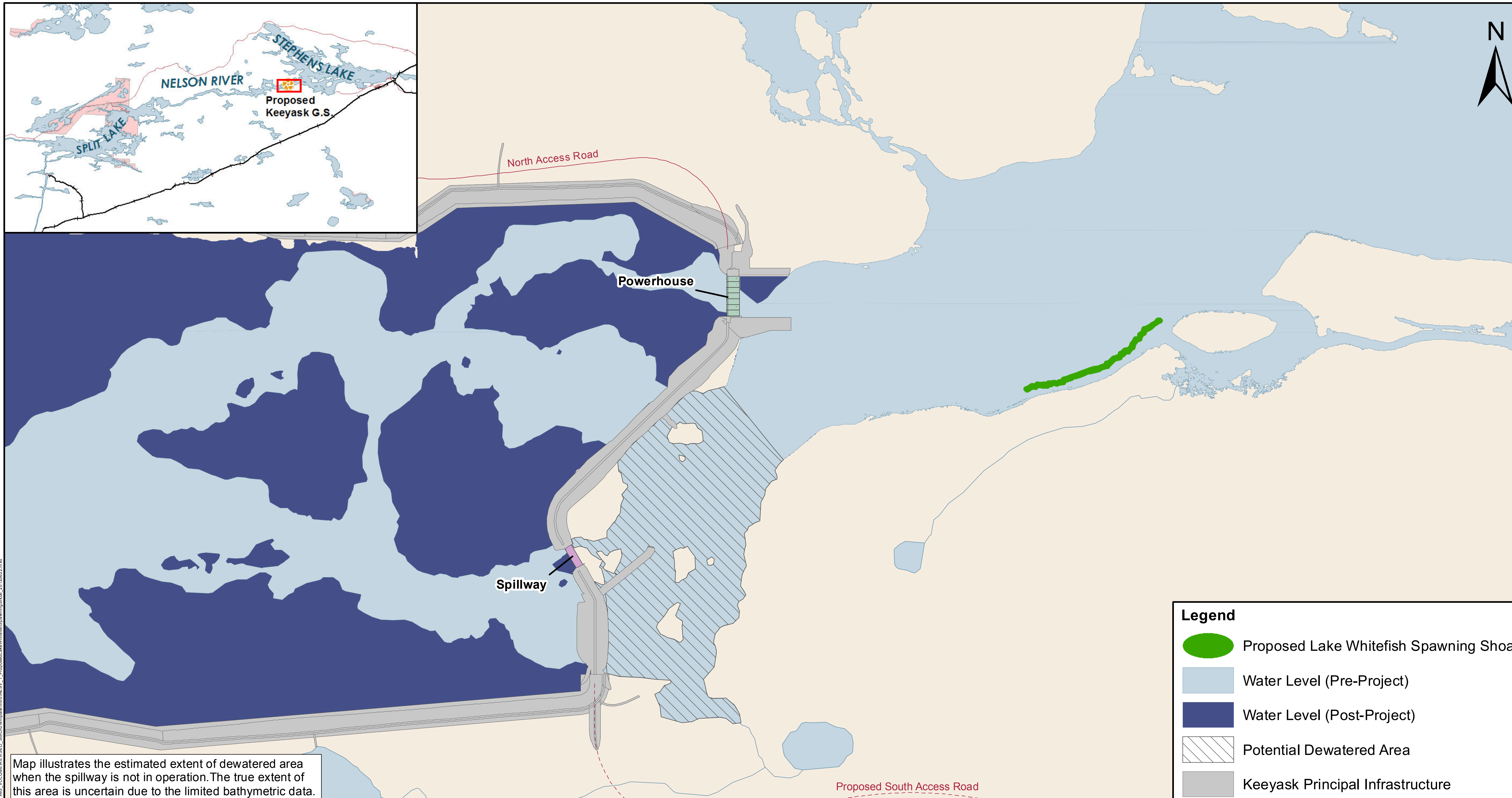
Figure 2. Cross sections of modifications to north bank of tailrace channel to create sturgeon spawning habitat

4.7 LAKE WHITEFISH SPAWNING HABITAT DOWNSTREAM OF KEEYASK GS

Lake whitefish currently spawn in the South Moswakot River, Gull Rapids (AE SV sections 5.3.2.3 and 5.3.2.4) and Ferris Bay (Michaluk et al. 2011). The creation of a lake whitefish spawning reef at a location along the south shore of Stephens Lake (Map 10) will mitigate the effects of the loss of lake whitefish spawning habitat at Gull Rapids. Biological design criteria for the spawning reef (Table 4) suggest a minimum area of 1,000 m² of spawning habitat be created, with depths of 1.5–2.5 m below the Stephens Lake MOL and depth-averaged velocities between 0.2–1.0 m/s.

Table 4. Biological design criteria for the construction of lake whitefish spawning habitat in Stephens Lake.

Parameter	Design Criteria	Additional Considerations
Substrate	A mix of coarse materials as follows: 25% boulder (750-500 mm); 35% cobble (256-64 mm); 25% large gravel (64-32 mm); and 15% small gravel (32-8 mm).	Substrate layer should have minimum thickness of 0.75 m, and substrate material should be free of silt and clay. Important that there be ample interstitial space for egg incubation and larval development.
Velocity over Spawning Habitat	Minimum = 0.2 m/s, Maximum = 1.0 m/s, at 0.6 of depth (depth-averaged). If water velocity is less than 0.2 m/s, then location requires wave generated circulation (i.e., exposure to NE – NW winds).	
Depth	Crest of spawning shoal: 1.5–2.5 m below MOL.	Lake whitefish eggs incubate over winter; eggs deposited at depths less than 1.5 m below MOL will be vulnerable to freezing at maximum ice thickness.
Size of Spawning Area	Minimum crest area at preferred depth should not be less than 1000 m².	Shape of shoal should maximize surface area (long and rectangular as opposed to round or square).
Slope	Slope of spawning area should not exceed 10%.	
Location	Select areas where mineral substrate is present or areas adjacent to bedrock. Where placement occurs over organic substrates, gabion basket wire should be laid over the bottom prior to placement.	At standing water sites, orient shoals to maximize exposure to wave action.
Critical Annual Period	Late October to late April	



KEEYASK Hydropower Limited Partnership

0 0.5 1 1.5 Kilometres

0 0.5 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewaterd area are estimated based on the existing environment 95th percentile flow.

Proposed Lake Whitefish Spawning Shoal

Due to the dynamic nature of the shoreline and bathymetry along the south side of this reach, the depths will need to be confirmed post-Project during the final design phase and possibly just before installation. Post-Project velocity measurements collected near the proposed lake whitefish spawning habitat area will be needed to determine the optimum location for the spawning shoal. Once the shoal is constructed, monitoring will be conducted to confirm fish use of the habitat (see Section 5.2.3.2 of the AEMP for monitoring details).

4.8 STOCKING OF LAKE STURGEON IN STEPHENS LAKE

Recruitment of YOY lake sturgeon in Stephens Lake will be adversely affected during the construction of the Keeyask GS, as spawning habitat will likely not be available in Gull Rapids. In addition, as discussed in the AE SV, an unknown proportion of the young sturgeon currently in Stephens Lake may originate from upstream, as the spawning population in Stephens Lake itself is extremely small. This downstream transport of young sturgeon (possibly as drifting larval fish) will no longer occur after impoundment of the Keeyask reservoir. Stocking of lake sturgeon in Stephens Lake will commence during construction and continue during operation to assist in the recovery of the population (see Section 4.9), as well as compensate for any reduced recruitment that occurs due to the above-stated causes. Details of planned stocking are provided in the AE SV Appendix 1A-Part 2.

4.9 REGIONAL RECOVERY PROGRAM FOR LAKE STURGEON – STOCKING AND HABITAT ENHANCEMENT

A conservation stocking program for lake sturgeon will form an important part of the fish habitat compensation plan. Based on field studies, sturgeon use of habitat falls into three partially distinct areas of the Nelson River: the upper end of Split Lake including the lower sections of the Burntwood, Nelson and Grass rivers; the reach of the Nelson River between Long and Gull Rapids (Keeyask area); and the reach of the Nelson River from Gull Rapids up to and including Stephens Lake. Populations in all three areas appear to behave been depleted from historic numbers. Reproduction is occurring (at least sporadically) in the upper Split Lake and Keeyask areas but the populations are depleted and available habitat would support more sturgeon. The few sturgeon still present in Stephens Lake do not appear to be part of a self-sustaining population. A conservation stocking program will be conducted in all three areas for at least one complete generation (25 years) to restore the historically depleted population to self-sustaining numbers. As discussed in preceding sections, stocking will also assist in compensating for any temporary reductions in productivity that may occur as a direct result of the Project; however, the proposed conservation stocking program would extend for a full generation of lake sturgeon (25 years) rather than the few years required to address reductions in recruitment that might occur as a direct result of Project construction. The long-term objective of the conservation stocking program is to re-establish self-sustaining stocks that could support subsistence harvest without the requirement for continued stocking. It is recognized that developing such a population might require stocking to extend beyond the initial 25-year period. An important feature associated with the conservation stocking program will be the construction of a hatchery on the lower Nelson River.

In addition, the KHLP will provide annual funding in support of mitigation and stewardship activities identified by the Committee formed by the Lower Nelson River Sturgeon Stewardship Agreement[3]. The base funding will commence at approximately $110,000 annually, one-third of which would come from the Project. This funding will be in addition to funding provided to Committee members for meetings and administration. Funding for additional Committee member projects will be provided based on benefit to sturgeon stewardship. Support will continue for 30 years.

[3] The Lower Nelson River Sturgeon Stewardship Agreement is being developed by Manitoba Hydro, 5900345 Manitoba Ltd. (on behalf of KHLP), Cree Nation Partners (representing Tataskweyak Cree Nation and War Lake First Nation), York Factory First Nation, Fox Lake Cree Nation, and Shamattawa First Nation. The objectives of the Parties include establishing a committee that will develop and implement a Sturgeon Stewardship Plan to carry out specific measures to conserve and enhance populations of lake sturgeon. The text of the agreement has been agreed to by the negotiators for the various parties and is now moving through a formal approvals process with each entity.

5.0 REFERENCES

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APPENDICES

APPENDIX A
MANITOBA FISHERIES BRANCH - FISHERIES MANAGEMENT OBJECTIVES KEEYASK DAM / GULL LAKE AREA OCTOBER 2012

Drafting Note: these FMOs are draft and subject to revision.

CONTEXT

The proposed Keeyask Hydroelectric project will separate Stephens Lake (the human-created reservoir for Kettle Generating Station) from the mainstem of the Nelson River, downstream of Split Lake and Clark Lake. The proposed development is expected to back-flood the Nelson River, creating a reservoir that will change hydraulic and hydrologic conditions upstream of the proposed development at least as far as Birthday Rapids – an area understood to be a significant Lake Sturgeon habitat. These changes to the hydrograph are expected to have consequential changes to the responding physical habitat and to the biota currently within the area. These fisheries management objectives have been prepared at the request of the proponent based on the assumption that the proposed project receives regulatory approval. Therefore, the objectives are based on best-case / desired outcomes under the development scenario and reflect objectives generally for the area bounded by Birthday Rapids to the outflow of Stephens Lake. Provincial fisheries management objectives are neither an endorsement nor a criticism of any project or development, but are a solicited response to proponents who seek to mitigate the effects of their work on fish stocks and habitats and contribute to Fisheries Branch management of those stocks.

FISHERIES MANAGEMENT OBJECTIVES (FMOS)

Objectives

- Fish species that support local fisheries (Walleye, Northern Pike, Lake Whitefish) should exist at levels that support a sustainable harvest.
- Self-sustaining stocks) (including forage and other non VEC fish species) in the form they currently exist (i.e. acceptably similar ecological structure and function.
- In addition to this, it is noted that a viable whitefish population that is valued for subsistence harvest is found in Gull Lake. This population should continue to exist at levels that support sustainable harvest.
- A viable population of Lake Sturgeon above the proposed Keeyask Generating Station site.
- Conditions that support the development of a viable and self-sustaining population of Lake Sturgeon in Stephens Lake.

Mechanisms that support FMOs

- Mitigate habitat degradation / destruction both above and below the proposed GS.
- Avoid further decline of the existing Lake Sturgeon population.
- Use stocking to recover stocks and for rehabilitation purposes (particularly in the upstream area) to the point where over the long term a self-sustaining population more capable of meeting the domestic needs of the local communities is established.
- Stocking in the short term does nothing to increase sustainable harvest efforts until the stocked fish recruit into the fishery. The most appropriate strategy is to recruit these fish to brood stock to

increase the contribution of natural reproduction instead of using them to increase the sustainable harvest

- Since management and conservation efforts for this area are dependent on the support and endorsement of local First Nation harvesters, it is critical that the purpose of any stocking program be suitably communicated to users to ensure that the stocking does not undermine the conservation message.
- The need for local sturgeon management and conservation efforts to ensure that existing stocks are sustainable.
- Provision for future fish passage should be set aside during project planning and construction. The need for fish passage (types, means and target species) should be warranted only based on a scientifically experimental and defensible assessment in conjunction with provincial management goals and in consultation with provincial fisheries managers.
- Any sturgeon stocking plan should be presented to local users in a manner that supports the management and conservation messages planned within it, and does not present a false confidence in the robustness of stocks.
- Programs that compensate for lost fishing opportunities in the project area with increased fishing opportunities in other areas are considered a project effect and may require additional management or mitigation measures.

APPENDIX B
GULL RAPIDS CREEK WETLAND AND DEWATERED RIVER CHANNEL ENHANCEMENT PLANS

This appendix describes activities that could be conducted within Gull Rapids Creek and a portion of the dewatered river channel of Gull Rapids to compensate for lost foraging habitat within Gull Rapids following construction of the Project. This concept would maintain foraging habitat at Gull Rapids, provide access to Gull Rapids Creek, and enhance habitat within the creek itself.

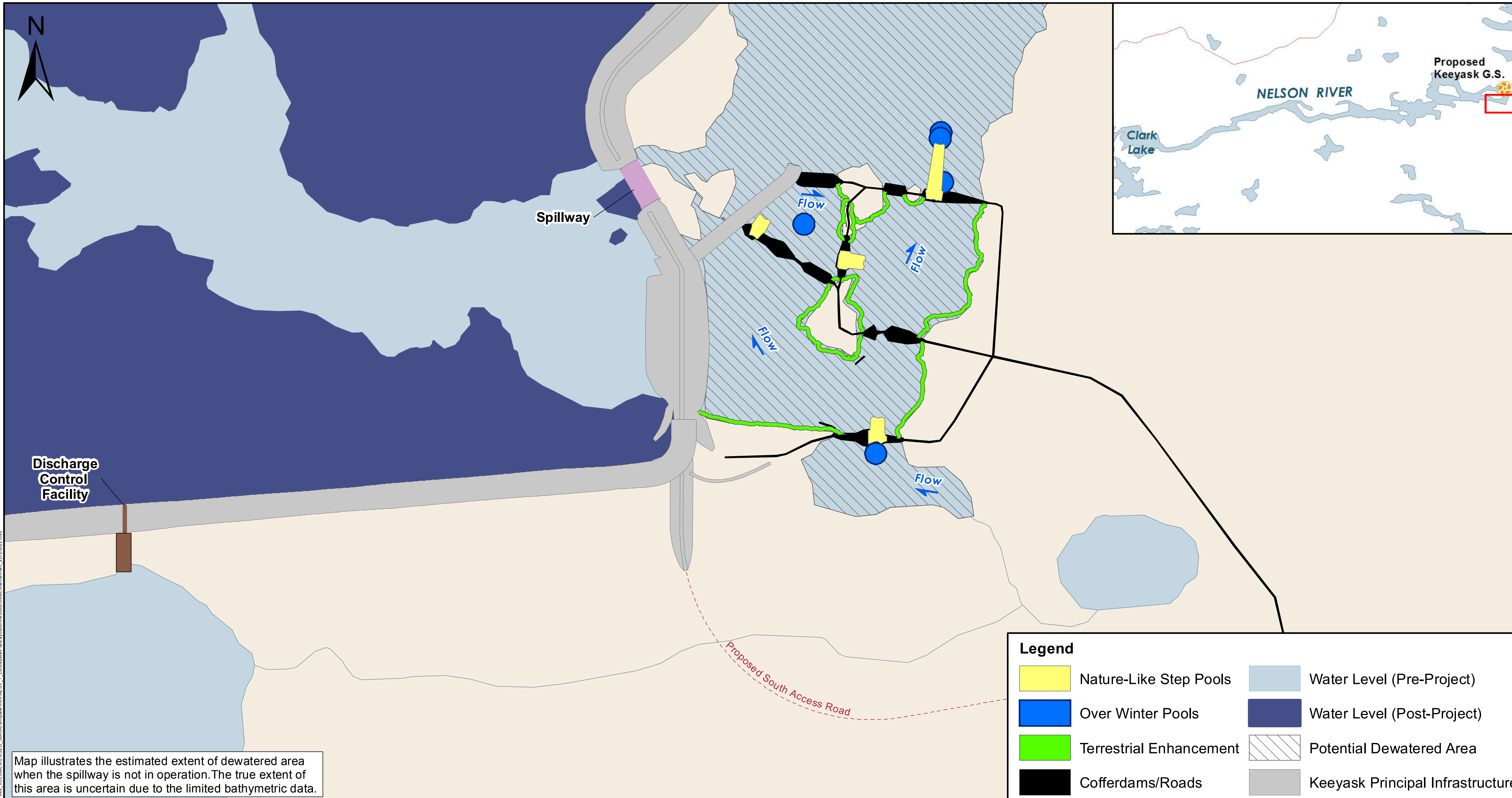
Concept Description

The proposed plan would involve construction of six low-head dams and weirs to maintain wetted habitat over a large portion of the south channel of Gull Rapids (Map B-1). Shorelines would be enhanced with mineral soils and plantings to create riparian habitat and provide cover for fish. Four rocky ramp fishways would be constructed to provide upstream and downstream access for species such as northern pike and sucker to both Stephens Lake and Gull Rapids Creek to increase the range of fish species and life stages that could access this habitat. Excavation of three overwintering pools for fish would also likely be required.

A discharge control structure built into the south dyke would typically maintain a flow of up to 1 m^3/s within Gull Rapids Creek, which would flow to the SSE area. The discharge would be required year-round for the enhancement to be effective.

The concept also includes enhancements to Gull Rapids Creek, which would entail removing floating peat to open up the waterway and improve the quality of fish habitat. Adding flow to Gull Rapids Creek would improve the quality of the fish habitat, which is currently marginal.

The combination of construction of a stream/pool system along the south channel of Gull Rapids, and the provision of year-round flow from the reservoir through Gull Rapids Creek, would result in the greatest benefit to fish productivity, as existing habitat in Gull Rapids Creek will be improved and fish will also be able to use habitat in the dewatered riverbed. As development of final construction and design plans will only be possible once the area is dewatered and site conditions can be assessed, these measures would not be implemented until after the station is in full service.



KEEYASK Hydropower Limited Partnership

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Preliminary Conceptual Plan Layout for the South Side Enhancement

Map B-1