TECHNICAL MEMORANDUM

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Re: Phase 3: Preliminary Basis of Design for Parker's Brook, Newfoundland

This memorandum summarizes the preliminary basis of design for the Parker's Brook habitat restoration project in Newfoundland.

INTRODUCTION

On the Great Northern Peninsula of Newfoundland, near Cook's Harbour, Parker's Brook flows into Pistolet Bay and supports a small localized population of Arctic charr (*Salvelinus alpinus).* This population is the southernmost anadromous charr population in the province (Dempson 1982 and references therein) and is/has been subjected to several cumulative threats including overfishing, climate change, and adverse changes in the stream morphology of Parker's Brook their principal freshwater habitat.

Conditions in the Newfoundland and Labrador marine ecosystem are changing (DFO 2018), and populations at their southern limits, are particularly vulnerable (Atkinson et al. 2011). This charr population was severely reduced several years ago by commercial seining for pelagics (herring *Clupea harengus*, Atlantic mackerel *Scomber scombrus*, capelin *Mallotus villosus*) in the area (Caputo 2013). In response to this, a local conservation group was formed (2007) called the Save Our Charr Committee (SOCC). SOCC was an initiative to monitor and preserve charr stocks in Pistolet Bay. Local knowledge of this population was collected in an interview-based survey in 2009. The survey findings indicated that fisherpeople in Pistolet Bay supported the listing of charr in that area as a species at risk, and largely considered purse seine practices to be the cause of decreasing stock size (Caputo 2013). Concerned citizens have recently highlighted new challenges that have emerged for this charr population by contacting Fisheries and Ocean's Canada and WWF Canada: To compound matters in recent years, Arctic charr and Atlantic salmon (*Salmo salar*) originating in Parker's Brook, Newfoundland have suffered mass die-offs (The Northern Pen, 2017).

Parker's Brook (known locally as "West" or "Western" Brook) largely originates in Eastern Long Pond, flowing north through a series of ponds (including Western Long Pond) and ultimately into Pistolet Bay. Habitat conditions near the mouth of the river in its intertidal zone are

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suspected to contribute to the high rate of mortality in this population of Arctic charr as several mortality events have been observed and documented (The Northern Pen, 2017). These mortality events follow significant sediment deposition in the intertidal delta area that has altered the depth of what was historically a deep intertidal pool used by charr and salmon on their migration from Pistolet Bay to the brook. While the infilling of the former pool is a significant habitat loss, the greater mortality burden on these fish is not fully understood and may be due to a single cause or the cumulative effects of multiple factors. Ongoing observations and monitoring continue the effort to help understand the occurrences more fully.

WWF Canada intends to move forward with habitat restoration at Parker's Brook with the goal to improve habitat conditions for charr and other native species returning to Parker's Brook. To design an effective restoration strategy at Parker's Brook, the first step involved a site assessment (August 2019) to examine the physical conditions and establish an understanding of the cause(s) of charr mortality. The site assessment also established a general understanding of fluvial habitat and geomorphic conditions/processes in Parker's Brook as the basis to understand the conditions that led to the observed changes in delta form (e.g., an extreme but rare flood event or a more typical high-water event) and the source of the sediment that constitutes the depositional areas. The initial site assessment (Phase 1) aimed to understand the site processes and provide restoration alternatives. In collaboration with stakeholders, Phase 2 (May 2020) chose a preferred restoration alternative that was then developed to the conceptual design level.

The current effort of Phase 3 continues the design process from the conceptual level provided in Phase 2 to preliminary design. This technical memorandum provides a brief summary of the previous project phases and describes the preliminary design updates developed under this Phase 3 effort for Parker's Brook.

For a detailed background summary of geology, geomorphology, fish use, and hydrology, please see the Parker's Brook Site Assessment (Inter-Fluve, 2019).

PHASE 1 & 2 SUMMARY

Inter-Fluve staff, including a fluvial geomorphologist, water resources engineer, and fisheries biologist, visited Parker's Brook to conduct a geomorphic assessment and topographic survey between July 30 – August 1, 2019. Prior to the site assessment, a desktop analysis identified four geomorphically-derived reach breaks within the study area.

- Reach 1 occurs from the mouth of the river upstream to RKm 1.5.
- Reach 2 is located between RKm 1.5 and RKm 2.4.
- Reach 3 is located between RKm 2.4 and RKm 2.95, and
- Reach 4 is located between RKm 2.95 and RKm 4.2 ending at the Western Long Pond.

The topographic survey was conducted using a Real-Time Kinematic (RTK) GPS. Water level and temperature data loggers were placed in Parker's Brook for the duration of the site assessment, and stream velocity measurements were collected using a Marsh-McBirney flow meter.

Dissolved oxygen was measured at several locations from Western Long Pond to the mouth, and aquatic insects were sampled to assess stream ecology health. Sixteen Wolman pebble counts, from the delta up through Reach 4, were conducted to characterize sediment throughout Parker's Brook.

High water temperatures (anything over 16-18°C) increase the physiological stress on salmonid fish species such as char and salmon and can lead to mortality. Mid-morning water temperature measured during the site visit in August 2019 in Western Long Pond was 18°C. The weather at the time of the recording was cloudy, cool with rain. Water temperatures recorded in the pool at the brook outlet varied between 13°C to 19°C, fluctuating with the tides and solar radiation during this same time period. It is possible that temperatures measured in the pond and at the brook outlet were warmer due to unseasonably hot weather conditions during the Phase 1 visit. Water temperatures observed elsewhere in Parker's Brook appeared to be mediated somewhat by cooler-water tributary inputs, but generally remained around 17 – 19°C.

A number of other poor water quality conditions may also have contributed to char and salmon mortality events experienced in Parker's Brook in recent years. These may have included one or more of the following: warm stream water temperatures, low dissolved oxygen levels, increased ocean water temperatures, changes in salinity, or chemical contamination. Dissolved oxygen saturation in water is inversely proportional to water temperature. Warm water holds less oxygen than cold water. In warmer waters such as in Parker's Brook, and especially as air temperatures increase in summertime, dissolved oxygen may reach levels that are too low and stressful for salmonids. The fish may find relief by occupying deeper and cooler water, particularly where cold ocean water fills deep pools during high tide near the mouth. Therefore, pools in the tidal area could be critical habitat, and the volume of these pools is important for several reasons:

(1) space for multiple fish,
(2) refuge from harassment or predators,
(3) depth for cooler water, and
(4) volume of water (hence volume of available dissolved oxygen) to sustain the fish oxygen demand through a tide cycle
(5) mixing and transition zone of fresh and saline waters.

Conversations with local residents and precipitation records indicate that a large flood occurred within the past 5 – 10 years. There is evidence of channel avulsions and bank erosion in Reach 2 that appear to be from approximately the same time period. These changes in Reach 2 may have resulted in an unusually high sediment load delivered to Reach 1. Most of Reach 1 can be defined as a "transport reach", meaning that roughly all sediment that enters Reach 1 is quickly sent all the way through to the delta area with little storage in the transport reach. This could explain an unusually large volume of sediment delivered to the mouth of Parker's Brook following an unusually large flow event. Several factors could cause sediment to aggrade (deposit) at the mouth of Parker's Brook, including:

- High sediment load,
- Low slope (the lower 250 meters of the channel has a mild slope),
- High tide,
- Downstream constriction (narrow bridge),
- Ice jam at bridge or delta, and
- Ice or snow “banks” causing channelization and sediment concentration.

It is possible that several of these factors combined at the time of the sediment producing flood event, resulting in channel filling in the low-slope area near the delta. Filling of the intertidal pools could have effectively reduced the volume of deep-water holding habitat for returning adult char and salmon and created a temporal migration barrier at lower tides. The reduction in pool volume could also result in increased fish stress if their oxygen demand exceeded the dissolved oxygen in the smaller post-flood pools during low tide cycles. Mortality events associated with hypoxia have been observed in western North American rivers during periods of low water and high densities of Pacific salmon (Sergeant et. al. 2017).

Dramatic increases in sediment deposition have been perceived at the delta since the flood event (R. Hedderson, pers. comm.). However, it is likely that the area has been in flux for decades, filling and scouring in response to the flow and sediment conditions of each year. Figure 1 shows that in 2009, similar depositional patterns existed at this site upstream of the bridge and in the delta. The more recent deposition occurring over the last 5-10 years may have created a larger bar that is less frequently covered by high tide, and composed of larger and more stable sediment that is slow to mobilize out onto the delta.

Figure 1. 2009 aerial photo provided by Sheldon Eddison showing depositional patterns.

The deposition at the river mouth may have been exacerbated by the road bridge crossing the channel at the delta, creating a constriction in the channel and causing water to back up, slow down, and drop sediment from the water column.

While recent changes in observed pool conditions appears to have been a result of an unusual flood and sediment event, it is important to note that with climate change, the frequency of similar flood events could be increasing and risk of similar deposition and impacts to fish may become more commonplace.

The Phase 1 site assessment identified several opportunities to restore deeper pool habitat at the mouth of Parker's Brook.

1. No action (natural sediment clearing).
2. Channel dredging – removal of accumulated sand and gravel within the channel and delta.
3. Bridge replacement – replace the existing bridge with a wider bridge to provide more flow capacity thereby reducing flood flow backwater and improve sediment transport to maintain pool volume.
4. Dredging and bridge replacement – a combination of Options 2 and 3 above.

A meeting with WWF Canada and Parker's Brook stakeholders to discuss Phase 1 alternatives was conducted on May 26, 2020. It was decided that both the bridge replacement and the channel dredging options could take place as individual projects or combined. In Phase 2, both

opportunities, 2 and 3, were developed to the conceptual design level. After approval of conceptual designs, Inter-Fluve was directed to complete preliminary restoration designs (Phase 3). Through further discussions and evaluation of construction costs, WWF Canada and Parker's Brook stakeholders decided to focus preliminary and final design phases on the removal of accumulated material from the channel and not pursue the bridge replacement. Phase 3 preliminary basis of design components and analysis for this channel work are described below.

PHASE 3 – PRELIMINARY RESTORATION DESIGN

The goal of this project is to restore or enhance the mouth of Parker's Brook to improve salmon and charr survival during migration. The proposed method to achieve this goal is to create increases in pool volume and pool depth that has been lost due to recent flooding and sediment deposition.

The preliminary restoration design includes channel dredging to address immediate impacts to fish movement in and out of Parker's Brook. Three primary project areas have been developed in the preliminary design phase and are described in more detail below (Figure 2). The preliminary restoration design drawings are provided in Appendix A.

Figure 2. The three areas of proposed pool creation in the lower Parkers River as shown in the preliminary design drawings.

Lower Pool

The location of the proposed lower pool is where a large gravel bar has developed and filled in the channel from approximately 30 to 100 meters upstream of the Route 435 bridge. The proposed excavation of the lower pool would remove these sediments to widen and deepen the channel in this area creating a long and deep holding pool for migrating salmonids.

The lower pool would extend from the toe of the left bank (looking downstream) into the channel approximately two meters and about two-thirds of the channel width. The pool would be approximately 90 meters long and average approximately 18 meters wide. The portion of the channel that remains wetted at low tide along the right bank would be utilized as a diversion channel during construction. An estimated 1800 cubic meters (CM) of gravel and cobbles are anticipated to be excavated to create the lower pool. The lower pool can be expected to slowly fill in with sediment over time, but the oversize shape should provide pool habitat for an extended period as it absorbs the periodic incoming sediment. Trapping incoming sediment at the lower pool may also increase the longevity of the proposed pools downstream (under the bridge and in the delta).

A temporary cofferdam will be installed where feasible to isolate the excavation area from the stream. The stream should be temporarily diverted along the right (east) bank during construction.

Site access for construction is proposed from river left (looking downstream) near the downstream extent of the proposed lower pool. An access haul road would be constructed and used to establish a temporary cofferdam before excavating the pool. A large wood structure is proposed at the end of the access haul road once the pool construction is completed. This large wood structure consists of eight logs with rootwads to be buried into the bank. The large wood structure is intended help support the disturbed bank soils, foster revegetation of the bank following construction, and provide some cover in the pool for migrating salmonids. Salvaged shrubs and small trees should be incorporated as slash into the structure. After excavation of the pool and construction of the large wood structure is complete, the cofferdam will be removed from the right bank.

If suitable conditions exist, standard dump trucks could be loaded directly by excavators at the lower pool. If the adjacent ground is too soft, then off-road trucks can be loaded to haul the material to a transfer site to load road haulers.

Upper Pool

The upper pool is located at a bend in the Parker's Brook channel near the head of tide approximately 200 meters upstream of the bridge and should offer additional pool area and volume for migrating salmonids. The upper pool design is approximately 50 meters long, extends five (5) meters into the channel from the toe of the right bank and excavated between 1 – 1.5 meters below the existing channel bed elevation.

Site access to the upper pool extends off-road from Route 435. Large wood would be used in the channel bank to provide cover for salmonids and help maintain pool scour over time. All trees and shrubs removed from the access and construction footprint should be salvaged and incorporated into the log structures to improve habitat.

The design of the large wood structure is composed of three, (upstream, middle and lower) bank buried structures using fourteen logs with rootwads. The upstream log jam consists of four logs with rootwads with salvaged whole trees and slash incorporated into the structure. The middle log jam consists of six logs with rootwads buried into the bank with salvaged trees and slash incorporated, and the downstream log jam consists of four logs with rootwads buried into the bank with some slash incorporated. Logs with rootwads should be approximately eight meters long, with approximately 75% of the log length buried into the channel bank. A minimum of one meter of salvaged soil should be placed on top of the logs.

A temporary cofferdam would be installed to isolate the excavation and large wood placement areas from the stream during construction.

Delta Pool

The proposed delta pool excavation would deepen and widen the existing channel along the right edge (looking seaward) of the delta downstream of the Route 435 bridge. The proposed delta pool is designed to be 28 meters long and extends approximately eight meters into the channel from the right bank downstream of the bridge. Proposed pool depth is one meter below the existing bed elevation. This location along the right bank of the delta head is the farthest away from the effects of ocean ice, longshore drift, and the sediment pushed onto the delta from storm driven wave action. Its location also falls within the suspected migration pathway of charr into Parker's Brook. The proposed delta pool is separated from the bridge pool to allow site isolation with a cofferdam during pool excavation. The small wedge of sediment between the pools may need to be excavated without site isolation (cofferdam) if permits allow.

Construction Considerations

Sequencing: Sequencing of the different project areas during construction proposed by the contractor shall be approved by the project owner. Generally, we suggest that construction occurs in the following order:

- upper pool and large wood;
- lower pool and large wood;
- delta pool.

This upstream to downstream order prevents inadvertent sedimentation caused by upstream construction from impacting downstream.

Excavation, Haul, Disposal: The cost estimate for pool excavation assumes trucks will be loaded to haul to an approved fill site. The round-trip distance to the fill disposal site will have an impact on price.

Site Restoration: Site restoration and revegetation should consist of planting and seeding native species in upland and riparian zones. Riparian zones are generally considered to be within 10 meters of the channel edge and include plant species that offer streambank stabilization while adapted to grow in wet conditions. Upland zones are further from the channel and include plant species that are adapted to slightly drier conditions. Species selected were intended to be similar to plant communities that currently exist in the Parker's Brook watershed. Sheet 15 in the Preliminary Design drawings (Appendix A) provides the proposed species lists for riparian and upland revegetation zones.

Regulations and Permitting: Permitting is being led by WWF with Inter-Fluve's support.

Long-term Maintenance – A maintenance and monitoring plan can be provided in future design phases. In principle, the lower pool should be monitored at regular intervals to track sediment filling rates, and at irregular intervals as warranted if unusual flood or ice events occur.

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