Appendix A: Application for gravel removal prepared by Emergency Management BC, Scott Resource Services Inc. and northwest hydraulic consultants, dated November 20, 2008 and titled "**Fraser River Gravel Removal Plan: Proposed Tranmer Bar Extraction – 2009**".

Fraser River Gravel Removal Plan

Proposed Tranmer Bar Extraction – 2009

Prepared By:

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and

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DRAFT SUBMITTED
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Introduction

Emergency Management BC (EMBC) is proposing to complete gravel extraction works on the Fraser River at Tranmer Bar during the winter 2009 gravel extraction window (January 1 – March 15) defined by the *Letter of Agreement: Lower Fraser River Gravel Removal Plan 2004-2008* (LOA). The purpose of the extraction, in accordance with the LOA, is to reduce the flood potential at this section of the Fraser River.

This document provides additional project review information requirements for Items 1 through 9 of the *DFO Information Requirements* listed in the LOA. The LOA is included for reference as Attachment 1.

A Section 9 Application for *Works In and About a Stream* has been submitted to the Ministry of Environment and is being expedited. A copy of the Notification will be made available to DFO once EMBC receives it prior to the 2009 winter fisheries work window.

In addition EMBC has applied for a Section 17 Map Reserve over this area. The application has been accepted by Front Counter BC, statused and referred by the Integrated Land Management Bureau and the reserve is being expedited. Once the Map Reserve is in place, a copy of the reserve will be submitted to DFO

1. Proponent Information

Proponent:	Emergency Management BC (EMBC)
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2. Proposed Works

2.1 Justification

EMBC is responsible for mitigating flood risk by strategically removing gravel from the Fraser River in the interest of public safety. The LOA (Attachment 1) states that "Gravel removal from the Fraser River is one of the methods used to manage flood levels, control erosion, and maintain navigable channels." Tranmer Bar is a component of a multi-site, multi-year gravel extraction strategy designed to reduce the overall flood risk in the Lower Fraser Valley.

Potential extraction sites are identified through collaboration with Fisheries and Oceans Canada (DFO), Navigable Waters, the Ministry of Environment (MOE), and EMBC, through a Technical Committee. The Technical Committee has identified the downstream end of Tranmer Bar as suitable for consideration for a winter extraction. A 2006 report by BGC Engineering Inc. and Kerr Wood Leidal (KWL) identified the lower end of Tranmer Bar as a significant zone of gravel deposition (Weatherly and Ellis, 2006[1]). The KWL report stated that approximately 200,000 m^3 of gravel could be removed from Tranmer Bar. Based on calculation by Northwest Hydraulic Consultants (NHC), there has been a net deposition within the footprint area of the proposed extraction of 163,000 m^3 since 1999. Details of erosion and deposition history at Tranmer Bar are provided by NHC in Attachment 7.

Tranmer Bar was identified by BGC and KWL (Weatherly and Ellis, 2006[1]) as a potential gravel extraction site for the period from 2007 to 2001. The Technical Committee has identified the downstream end of Tranmer Bar as suitable for consideration for an extraction in winter 2009. The extraction methodology is based on recommendations from hydraulic specialists at NHC. The extraction design was also prepared by NHC. The extraction is designed to increase flow on to the bar surface and divert flows to the southwest, towards the main channel and away from the flood dykes and bank protection along the right bank. This analysis is presented in greater detail in the NHC report included as Attachment 7.

2.2 Description of Proposed Works

An extraction volume of 186,000 m^3 of gravel is proposed. The site was surveyed by Tunbridge & Tunbridge (Attachment 2). A detailed extraction design was generated by NHC based on this survey and is included as Attachment 3. The extraction will be bar edge and bar top scalping. The extraction consists of two sites that connect a lower elevation chute channel. The upstream extraction area (as described by NHC, Attachment 7) is approximately 94, 000 m^2, and will lower the elevation of the bar edge to facilitate greater flow volumes through the bar surface. The downstream site is approximately 50,000 m^2 and is designed to divert flows to the southwest towards the main channel and away form the flood dykes and bank protection along the right bank floodplain.

Prior to January 2009, a full scale Construction Plan, stamped and signed by both Scott Resource Services Inc. (SRS) and NHC will be submitted. This Construction Plan will incorporate any revisions or additions of compensation habitat features that DFO requires.

Access to the site will be by road. Road access to the bar will require construction of a temporary bridge across the side channel near its downstream confluence with the main channel. A draft bridge design was completed by Jakes Construction (Attachment 4); a final bridge design by Associated Engineering (AE) will be submitted as an addendum. A preliminary engineered bridge design by AE, as well as photographs of the bridge location, are included in Attachment 4. Two bridge locations have been proposed, as shown on the extraction design (Attachment 3). The north location would span a wetted channel that was approximately 93 m at the time of the extraction. This width is a conservative maximum; the actual wetted width during construction is expected to be less. The alternate location to the south (230 m downstream) would span a channel with a maximum wetted width of approximately 140 m. A 54 m long bridge deck with steel piles has been designed.

[1] Weatherly H, Ellis E. 2006. Fraser River Potential Gravel Removals 2007-2011. BGC Engineering Inc. and Kerr Wood Leidal Associates Ltd. Final Report submitted to Integrated Land Management Bureau.

At either location, a causeway would be required to span the remaining wetted width of the channel. Three 1200 mm culverts are included in the design so that flow would not be restricted. Additional culverts may be required based on the exact water level during the extraction. Abutments will be constructed of precast concrete lock blocks with rip rap armouring.

The preliminary haul road location is shown on the extraction design (Attachment 3). The exact location will be determined in consultation with the contractor, based on existing site conditions at the time of the extraction. If the haul road must pass over any residual channels, culverts will be used to maintain connectivity with downstream habitat. Once works are complete and before the end of the winter work window, the haul road will be fully decommissioned through scarification with an excavator.

Gravel will be extracted from the site using excavators and trucked to an off-site stockpile. The exact location of the stockpile will be determined by the contactor. Any pit work, screening, crushing or washing of gravel will be conducted off-site by the contractor.

The volume of gravel removed will be confirmed through surveys of both the extraction area and the stockpile. A daily count of the number of truckloads leaving the site will provide an up-to-date volume estimate during the works.

Biological monitoring and habitat assessments will be completed by SRS in accordance with the protocol outlined in the LOA, with amendments at the discretion of the Technical Committee.

3. Location of Works

The proposed gravel extraction would occur on the Fraser River at Tranmer Bar, located approximately 5 km upstream of the Agassiz-Rosedale Bridge. The UTM coordinates of the centre of the proposed extraction are 10U, 593508 E, 5453645 N. A location map is provided as Attachment 5.

Tranmer Bar is situated in the Herrling sub-reach, which covers Herrling Island, lower Seabird Island, the town of Agassiz, and Popkum IR No. 1.

4. Timing of Works

Gravel extraction work will be scheduled to be completed in the dry during the January 1 to March 15, 2009 winter gravel extraction window. Any required site reclamation, including haul road deactivation, will occur once the works are completed and before the end of the window.

5. Fish Habitat Assessment, Mitigation Plan and Monitoring Program

An assessment of fish habitat, environmental mitigation, and biological monitoring was completed by SRS and is included with this document as Attachment 6.

6. Channel Hydraulic and Morphological Assessment

A geomorphic assessment by NHC is included as Attachment 7. A separate report on the hydraulic effects of the proposed extraction using 2-D numerical modelling is in preparation.

7. Habitat Compensation Plans

The LOA stipulates that:

"Habitat compensation may not be required where it is determined that features that fully mitigate habitat impacts shall be constructed as part of the gravel removal."

Habitat complexing features such as open nooks are included in the extraction design (Attachment 3). Data collected as part of the ongoing biological monitoring program will be used to asses the productive capacity of the extraction area before and after the removal. The biological monitoring program is described in Attachment 6, and is designed to meet the requirements of the LOA.

To date, DFO has not required compensation for gravel removals where, following one to three freshets, there has been recruitment, replenishment and re-stabilization of the bar's productivity. NHC's geomorphic assessment includes expectations for gravel recruitment (Attachment 7). This report states that the excavation "will take a decade or more to refill in the absence of a major flood event."

8. Maps and Drawings

A pre-extraction topographic survey was completed by Tunbridge & Tunbridge and is included as Attachment 2. An extraction design prepared by NHC is included as Attachment 3. A preliminary bridge design is included as Attachment 4. A location map is included as Attachment 5.

9. First Nations Requirements

Integrated Land Management Bureau has sent referral packages to all applicable First Nations. The deadline for First Nations responses is November 10, 2008.

Ann Griffin is in ongoing consultation with First Nations. Letters of support for EMBC's gravel extraction at Harrison Bar are anticipated.

10. Environmental Monitoring

Environmental monitoring at Tranmer Bar will be provided by SRS. Monitors will be on site as required. Upon completion of the works SRS will provide a post-construction report with photographs and descriptions of the works.

Attachment 1

Letter of Agreement:

Lower Fraser River Gravel Removal Plan 2004-2008

Feb 4 08

Fisheries and Oceans Canada | Pêches et Océans Canada
Canada

Partners

Letter of Agreement: Lower Fraser River Gravel Removal Plan

Land and Water BC Inc. and Fisheries and Oceans Canada are committed to work together to take immediate action on the progressive reduction of the flood hazard risk to communities along the Fraser River between Seabird Island and the Vedder River confluence over the next five years and beyond.

Land and Water BC Inc. and Fisheries and Oceans Canada have engaged the assistance of the Fraser Basin Council to develop a long-term plan (Attachment A) for reducing the flood hazard risk in the lower Fraser River.

Land and Water BC Inc. and Fisheries and Oceans Canada will incorporate collaborative management, adaptive management and sustainability principles into decisions regarding gravel removal and river management.

Land and Water BC Inc. and Fisheries and Oceans Canada will apply these principles as follows:

1. The need for gravel removal:

- by recognizing that gravel removal from the Fraser River is one of the methods used to manage flood levels, control erosion, and maintain navigable channels;
- by recognizing that there has been significant accumulation of gravel in the past five years, with limited gravel removals occurring;
- by recognizing that decisions on gravel removals must respect the regulatory and consultation requirements of federal and provincial government decision-makers;

2. Process and timelines for annual removals:

- by agreeing to a common timeline and process for annual decision-making on gravel removals (Attachment B), that will include sites selected on an annual basis;

3. Information requirements:

- by agreeing to information requirements and working to incorporate updated information (e.g. 2-D hydraulic modeling) in a timely manner into annual decision-making for candidate sites.

4. Annual removal quantities:

- by Authorizing an estimated removal quantity of approximately 500,000 cubic meters / year over the next two years, and 420,000 cubic meters / year over the following three years, based on the best available science, with provision for additional sites as a contingency to meet agreed upon annual removals.

This letter of agreement signifies a renewed spirit of collaboration between Land and Water BC Inc. and Fisheries and Oceans Canada to implement the principles and goals above.

The Honourable George Abbott
Minister Responsible for
Land and Water BC Inc.

The Honourable Geoff Regan
Minister
Fisheries and Oceans Canada

Attachment A

LOWER FRASER RIVER GRAVEL REMOVAL PLAN 2004-2008

1.0 PREAMBLE

This five-year gravel removal plan for the lower Fraser River was developed through the collaborative efforts of Land and Water BC Inc. representing the Province of B.C., Fisheries and Oceans Canada and the Fraser Basin Council.

The plan is intended to describe objectives associated with gravel removal in the lower Fraser River as well as the decision-making process that will be followed by all parties involved in the authorization and implementation of gravel removal proposals. In doing so, the plan will clarify uncertainty encountered in recent years associated with the authorization process -- e.g., information required to process gravel removal proposals and deadlines.

2.0 OBJECTIVES

- Recognition that gravel removal from the Fraser River is one of the methods to be used to provide hydraulic benefits including managing flood levels, controlling erosion, and maintaining navigable channels.
- Recognition that the need for gravel removal must be balanced with the regulatory and consultation requirements of federal and provincial government decision-makers.
- Establishment of common timelines and process for annual decision-making on gravel removals (Attachment B) that will include sites selected from a long term plan and which demonstrate a hydraulic benefit.

3. ROLES AND RESPONSIBILITIES

This section describes the role of the parties involved in gravel removal. Those interested in receiving gravel removal Authorizations are required to meet mine plan information requirements and adhere to the schedule outlined in (Attachment B).

British Columbia

Land & Water BC Inc. (LWBC) is committed to addressing the increasing risks associated with continued accumulation of gravel in the lower reaches of the Fraser River and to the develop a long term comprehensive flood hazard management strategy that is cost effective and environmentally sustainable.

LWBC believes that that unless this mounting accumulation of gravel is reduced, the risks to human safety and property will continue to grow.

LWBC is committed to working with the Council, the federal government, First Nations, local government and other parties to develop a long term solution.

Canada

Fisheries and Oceans Canada (DFO) is committed to working collaboratively with provincial and municipal governments, First Nations and stakeholders to facilitate the orderly and planned removal of gravel for flood prevention, erosion control and navigation safety. DFO's primary role is to ensure that the gravel removal plan meets the regulatory requirements under the *Fisheries Act* and *Canadian Environmental Assessment Act*, and will furthermore:

- ensure that requirements for fish and fish habitat protection are clearly articulated and reviews completed in a timely way.
- address First Nations concerns that arise as a result of authorizations issued to address habitat problems.

Fraser Basin Council

The Fraser Basin Council will play the role of coordinating and facilitating the development and ongoing implementation of the plan, working with the parties. This will include, for example, facilitating studies in relation to River 2D hydraulic modelling for the parties and other interested organizations.

4. AUTHORIZATION PROCESS

It is recognized by the parties that there has been accumulation of gravel over the past five years, with limited gravel removals occurring. Consistent with the objectives outlined in Section 2, it is agreed that gravel removal Authorizations under the *Fisheries Act* over the period 2004 to 2008 for hydraulic benefit(s) will be guided by the following removal objectives (per calendar year):

Year *	Cubic Meters	Removal Year **
2004	500,000	to be removed in 2005
2005	500,000	to be removed in 2006
2006	420,000	to be removed in 2007
2007	420,000	to be removed in 2008
2008	420,000	to be removed in 2009

* This is the year the Authorization is approved.
**Authorizations processed each year result in gravel removal the following year.

5. DURATION

This plan will be in effect until March 15, 2009. The plan will be reviewed on an annual basis and with the agreement of both parties may be renewed at the end of its five year term.

Attachment B: Annual Process and Timelines: Winter Window

	Milestones	Key Regulatory Responsibilities	
		DFO	LWBC
May	Specific annual primary and contingency sites selected from candidate sites.	DFO & LWBC agree to priority list of candidate sites that demonstrate hydraulic benefit	
June	Pre-removal biological monitoring 1	See information requirements	
June	Pre- consultation	Pre-consultation with First Nations	Pre-consultation with First Nations
August	Consultation		Formal consultation package to First Nations for review
Sept	Pre-removal biological monitoring 2		
Sept 15			LWBC tendering / direct award
	Initial site design complete (site surveys, initial mining plan)	See information requirements	
Oct 1	Final sites selected		LWBC *Land Act* approval
		CEAA listing, formal DFO consultation package to First	

		Nations	
Oct 10	Site designs finalized (habitat mapping, habitat enhancement features)	See information requirements	
Nov 1		Final DFO *Fisheries Act* approval	
Dec 15	Pre-removal biological monitoring & other pre-removal site information 3 complete as conditions of authorization	See information requirements	
Jan 1	Fisheries window begins, gravel removal begins		
Mar 7	Work in the river is completeSite reclamation and post-assessment		
Mar 15	Winter work window ends		

***Refer to "Key Steps to Authorization Process" and "Information Requirements"**

- Where possible, LWBC and DFO will seek opportunities for joint consultation with First Nations.
- Similar timelines will be developed for work that occurs in the Summer Window.

Key Steps to Authorization Process

- May - Specific Annual Primary and Contingency Sites Selected: These are sites agreed to by the parties from a prioritized list of sites that demonstrate a hydraulic benefit. This selection should occur in May in preparation for the following winter fisheries work window.

- June - Pre-removal Biological Monitoring (fish sampling): The gravel reach provides rearing habitat for at least 28 fish species. The edges of gravel bars represent perhaps the most important rearing habitat and high densities are commonly found during summer months. Periodic samplings taken from selected sites and reference sites will assist in minimizing long term impacts and may also be used for the purposes of adaptive management with respect to future removal proposals. Samples are taken three times a year (June, Sept., and Dec.); this is the first sampling episode.

- June - Pre-consultation with First Nations: Wherever practical, the parties will jointly conduct consultations with First Nations in preparation for authorization under the *Fisheries Act*. In addition to its fiduciary responsibility to consult, DFO has an additional responsibility under CEAA to assess potential impacts to traditional use, in this case, traditional fishing sites, by First Nations.

- August - LWBC formal consultation package: LWBC will conduct formal consultations with First Nations for the candidate removal sites.

  September – Pre-removal Biological Monitoring (fish and invertebrate sampling): This is the second sampling episode.

- September - LWBC Tendering/Direct Award and *Land Act* Approval: LWBC will have completed its tendering process for operators of gravel removals from crown-owned lands and will have issued required permits under the *Land Act* and the *Water Act*. Initial site design (site topographical or bathymetric surveys, mining plan) will be completed for referral to DFO on or before October 1.

- October 1 – LWBC *Land Act* Approval and Final Sites Selected: LWBC *Land Act* and *Water Act* documents will be referred to DFO. At this point, the final sites for the following winter work window will have been selected for review and assessment. Information requirements for each site will be complete.

- October 10 - CEAA Listing & Formal DFO Consultation Package to First Nations: Upon review of the information submitted, DFO will submit the projects proposals for posting on the CEAA public registry. DFO will also commence CEAA proceedings, such as Federal Co-ordination requirements, and will consult First

Nations potentially affected by specific proposals. At this point, all information requirements (site designs, habitat mapping, habitat enhancement features) in relation to the projects must be complete and in hand.

- November 1 - DFO *Fisheries Act* Decision: DFO will have completed its CEAA and *Fisheries Act* review and assessments. This is the decision point to authorize (or reject) based on all of the foregoing information submitted and reviewed pursuant to the *Fisheries Act* and the *Canadian Environmental Assessment Act*.
- December 15 - Pre-removal Biological Monitoring (fish and invertebrate sampling): This is the third sampling episode
- January 1- Fisheries Window Begins: The winter work window opens January 1 for authorized gravel removals. It is anticipated works will commence at that time in order to allow for orderly and safe operations, and for post project activities to occur, such as site reclamation requirements, and post-extraction surveys.
- March 7 – In-river work complete: It is anticipated that removal operations will be finishing up to allow for post project activities to begin, such as site reclamation and post-extraction surveys, in anticipation of closure of the winter work window.
- March 15 – Winter Work Window Ends: The winter work window will close March 15, at about the time of rising water and downstream juvenile migrations. There will be no further in-river works beyond this point. In accordance with conditions of the Authorizations, post project monitoring and summary reports will be required.

Information Requirements

Fisheries and Oceans Canada

Lower Fraser Area

The information requirements on this form relate specifically to Gravel Removal operations in the Gravel Reach of the Fraser River, Hope to Mission.

The information Proponents provide on this form is the minimum necessary for Fisheries and Oceans Canada to evaluate compliance with the Federal Fisheries Act.

This information may also be required for Fisheries and Oceans Canada to conduct an environmental review and assessment (screening) under the Canadian Environmental Assessment Act.

The following information should be prepared by qualified professionals and must be attached for review of your project.

1. **Proponent:** ______________________________
   Address: ______________________________
   City: ______________________________
   Postal Code: __________ Contact: ______________
   Telephone: __________ Fax: ______________
   E-mail: ______________________________
2. **Proposed Works:** Provide a description of the proposed works including the mine excavation and access to the mine site such as haul roads, culverts or bridges, barge landings and moorages, etc. A detailed plan should include site specific information on pre-excavation site surveys (an up-to-date topographic survey of the removal area and the surrounding area - the survey area and survey point density will vary based on site conditions, removal design and existing habitat features), excavation designs (removal design with habitat mitigation features included in the design – this may alter the removal volume), and excavation methodology.
3. **Location of Works:** Provide a description of the location of the works. Descriptive location references as

well as positional information such as latitude and longitude or UTM coordinates are appropriate. In addition, indicate your tenure to the land and tenure to access routes. Include appropriate maps (refer to maps and drawings below).

4. **Timing of Works:** Please provide a schedule for the start and finish dates for each of the following. It is expected these dates will fit within the fisheries timing window, and will ensure that the last steps, project decommissioning, equipment removal and post-project surveys, are completed well in advance of the spring freshet.
   1. Proposed gravel extraction works;
   2. Post extraction site remediation or reclamation;
   3. Decommissioning (i.e. access roads, culverts, bridges), equipment removal and post-project site survey.

5. **Fish Habitat Assessment, Mitigation Plan and Monitoring Program:** Impacts on fish and other aquatic habitats are carefully considered in the approval process. A detailed site inventory and habitat assessment is required and should include information on all potentially affected fish species and their habitats. The assessment must detail steps taken to mitigate potential impacts to fish habitat. The assessment is to be completed by a registered professional with appropriate expertise in biological sciences.

   A monitoring program, conducted by consultants acceptable to DFO, is also required to monitor impacts to fish habitat from the gravel removal operation, Conditions relating to the Habitat Assessment, Mitigation Plan and Monitoring Program are as follows;

   - Topographic and Bathymetric Surveys: These will be used to assess the volume of gravel removed and the morphological impacts of the removal. The survey area should extend beyond the removal area to cover the area of potential morphological impact, for example, 500 metres downstream and 200 metres upstream of the removal area. Bathymetric and topographic survey points shall be chosen, at the discretion of the surveyor, to provide a sufficiently dense set of survey points to produce a detailed contour drawing of the bar area and stream bed with 1 metre contours. The accuracy of the topographic survey points shall be ±0.04 metres horizontally and vertically. The surveyor shall tie the survey into survey hubs, which will remain in place for the duration of a monitoring period of 5-years. All elevations shall be local geodetic elevations. The surveyor shall provide 1:500 scale contour drawings of the monitoring area, showing survey point locations. Survey information shall be collected during winter low-flow and distributed prior to sediment removal; following sediment removal (in the removal area) and prior to March 15; and following the first of either a freshet with a peak daily flow of over 8,766 cubic metres per second (major freshet) or after three freshets following gravel removal.

   - Surface Sediment Sampling: Grain Size distribution of surface sediment shall be characterized using the Wolman or photographic method, within the removal area and at one reference area;
     - before removal
     - after gravel removal, following spring freshet, and
     - following the first of either a major freshet or after three freshets. A major freshet shall be considered to be a freshet with a peak flow exceeding 8,766 cubic metres per second (the average freshet peak flow).

   - Juvenile Fish Sampling: Juvenile fish sampling should be conducted during two sampling episodes (when the flow is at 5,000 cubic metres per second and again at 2,500 cubic metres per second) at the proposed removal site and at reference sites. Each sampling episode should be conducted during the first inundation of the removal site and reference sites when juvenile fish are rearing along bar edges (Jun-Aug). The sampling should consist of a minimum of 5 beach seines in each habitat type represented.

   - Benthic Invertebrate Sampling: Pre-extraction benthic invertebrate sampling involving two sampling episodes is required within the removal boundary and within three designated reference areas:. The episodes should be at least a month apart, in the fall (Sep – Dec) and again in early winter (Jan – Feb).

     Following gravel removal three sampling episodes are also required, within the removal area and at three designated reference areas.

     For each episode, 5 replicate samples collected by Surber net at each site are required. Attempt to sample the identical habitat type at each site and in each sampling episode.

Inventory and assessment of benthic invertebrates shall be conducted soon after water has covered the site; in the fall or winter after freshet; and after the first of either a major freshet or after three freshets following gravel removal. The post freshet sampling shall be conducted during the same month as one of the pre-removal sampling episodes.

- Habitat Mapping: Four episodes of habitat mapping shall be carried out at the proposed removal site and surrounding area (on-site and photos from a fixed wing aircraft).
  - after gravel removal,
  - after the peak of the freshet when the discharge is approximately 5,000 m^3/s,
  - when the discharge is approximately 2,500 m^3/s, and
  - repeated at the same flows following the first of either a major freshet or after three freshets following gravel removal.
  - Alternatively, habitat mapping may be carried out using River 2-D modeling with high resolution survey information.

- Gravel Removal Supervision: Monitors, acceptable to DFO, will also be required to monitor and supervise compliance of the works during the operational stages, including for example, construction of access roads, culverts or bridges, the gravel extraction operation, and reclamation and decommissioning of the roads and the work site. These monitors will be empowered to take immediate corrective measures where required and to immediately report to DFO on issues of non-compliance with the Authorization and the *Fisheries Act*.

Proponents are to submit a monitoring program with their applications, including information relating to professional experience and qualifications of the monitors they will be using.

6. **Channel Hydraulic and Morphological Assessment:** A detailed assessment of changes to channel hydraulics, including flow pattern changes, and the benefits to flood protection, erosion or navigation from the proposed works and the potential impacts on channel morphology is required. The assessment will include areas upstream and downstream of the proposed removal site, which are likely to experience flow and water level changes. This assessment is to be completed by a registered professional with the appropriate expertise in river engineering or fluvial morphology. The River 2-D modeling recently conducted at Queens Bar and Spring Bar, and the modeling currently under way in the Harrison Bar to Power Line Island Reach are examples of this type of assessment. Sites outside of the area modeled will require this level of assessment.

7. **Habitat Compensation Plans**: Habitat compensation may not be required where it is determined that features that fully mitigate habitat impacts shall be constructed as part of the gravel removal. The productive capacity of the habitat at the removal site shall be monitored following gravel removal and compared to the pre-removal capacity and reference site conditions. (Note; to date, DFO has not required compensation for gravel removals where, following one to three freshets, there has been recruitment, replenishment and re-stabilization of the bar's productivity). In the event that riparian vegetation is removed, replanting of vegetation native to the removal area shall be required to compensate for the loss of riparian vegetation, at a rate of 2:1 (e.g. 2 square metres replanted for each square metre of removal).

8. **Maps and Drawings**: The maps and drawings that accompany the application are necessary for the review of project proposal. The maps must include suitable cross-sections, topography at standard contour intervals, and any other information needed to develop an estimated removal quantity. All pipelines, power lines, railways, roads, bridges, dikes, rock groins and other types of infrastructure should be identified. Generally, three maps or drawings will be required with each application:

   - Location Map: The location map is a broad overview map that depicts the general application area in relation to major geographic and cadastral features. The location map will be used by the Department and the public that may have questions about the application, its general location and general proximity to an area in which they may be interested. It is usually produced at a scale of approximately 1:50,000.

   - Site Plan: The site plan is the medium scale map that shows the application area and its dimensions, in relation to detailed, larger scale features such as smaller roads or creeks. The site plan is usually at a scale of 1:10,000 to 1:20,000, but will vary depending on the size of the application area.

   - Detailed Plan: The detailed plan is the largest scale map and shows the details of the project and proposed related works. The detailed plan or plans might be an integral part of a report, assessment or survey which accompanies the application. It is the visual description of the work plan. The detailed plan will show any placement or removal of rock/gravel with pre- and post- work elevations. The detailed plan(s) will also show proposed habitat restoration features and the location of natural and social features, such as vegetation, wetland, side channels and archaeological and recreational sties. The detailed plan should have a comprehensive legend to explain the different symbols used to describe the various values and interests of and in the area as well as the works proposed. Scale should be 1:2,000.

9. **First Nations Requirements**: Although it is understood that whenever possible, LWBC and DFO will conduct joint consultations with First Nations, proponents are encouraged to attempt to carry out their own consultations wherever possible. In those situations where proponents are able to carry out their own consultations with First Nations, DFO asks that the following information be provided.

- Identification of any potential adverse effects that the project may have on the current use of lands and resources for traditional purposes by aboriginal persons. Traditional uses and activities, and potential effects would usually be identified through direct consultation with First Nations.
- Details of specific measures that will be employed to avoid and mitigate potential adverse effects that the project might have on the current use of lands and resources for traditional purposes by aboriginal persons.
- Details of consultations that the proponent has undertaken and carried out with First Nations with respect to this matter. This includes plans for ongoing (i.e. post-environmental assessment) consultations with First Nations.

Summary

***Fisheries Act Assessment*: This application guide has been provided to assist all parties involved in the review and referral process for gravel removals on the Fraser River, between Hope and Mission. It is intended to clarify the information requirements of the application process and to ensure that adequate, accurate and complete information is submitted and reviewed in a timely and open manner. This will result in a comprehensive description of all projects, their benefits, their impacts and the steps being taken to mitigate and minimize those impacts.**

It is understood that completion of these information requirements does not constitute approval or Authorization under the Federal *Fisheries Act.*

***Canadian Environmental Assessment Act (CEAA)*: It is also understood that the proposed works are likely to require screening under *CEAA*. Please note that Section 55 of *CEAA* requires that a public registry be established and that the public can have convenient access to this registry. Consequently, any information provided by you related to the Environmental Assessment for this project will be part of the CEAA Public Registry and will be made available to a member of the public, if requested. In addition, as part of the *CEAA* public notification, the Department of Fisheries and Oceans is required to post the particulars of your project on the *CEAA* public registry for a minimum of fifteen days prior to completing its review and assessment of your project.**

Should you provide a record that contains confidential or sensitive information, such information must be clearly identified and a rationale provided in writing regarding its possible protection. Your rationale should demonstrate the likelihood of probable prejudice on he basis of facts and not just refer to the various injuries cited in the Act

First Nations Consultations: In addition, it is understood that the Department of Fisheries and Oceans has a fiduciary responsibility to consult with First Nations prior to issuing an Authorization for the proposed works.

***Species At Risk Act (SARA)*: Please note that new requirements pursuant to *SARA* may modify the foregoing environmental assessment requirements.**

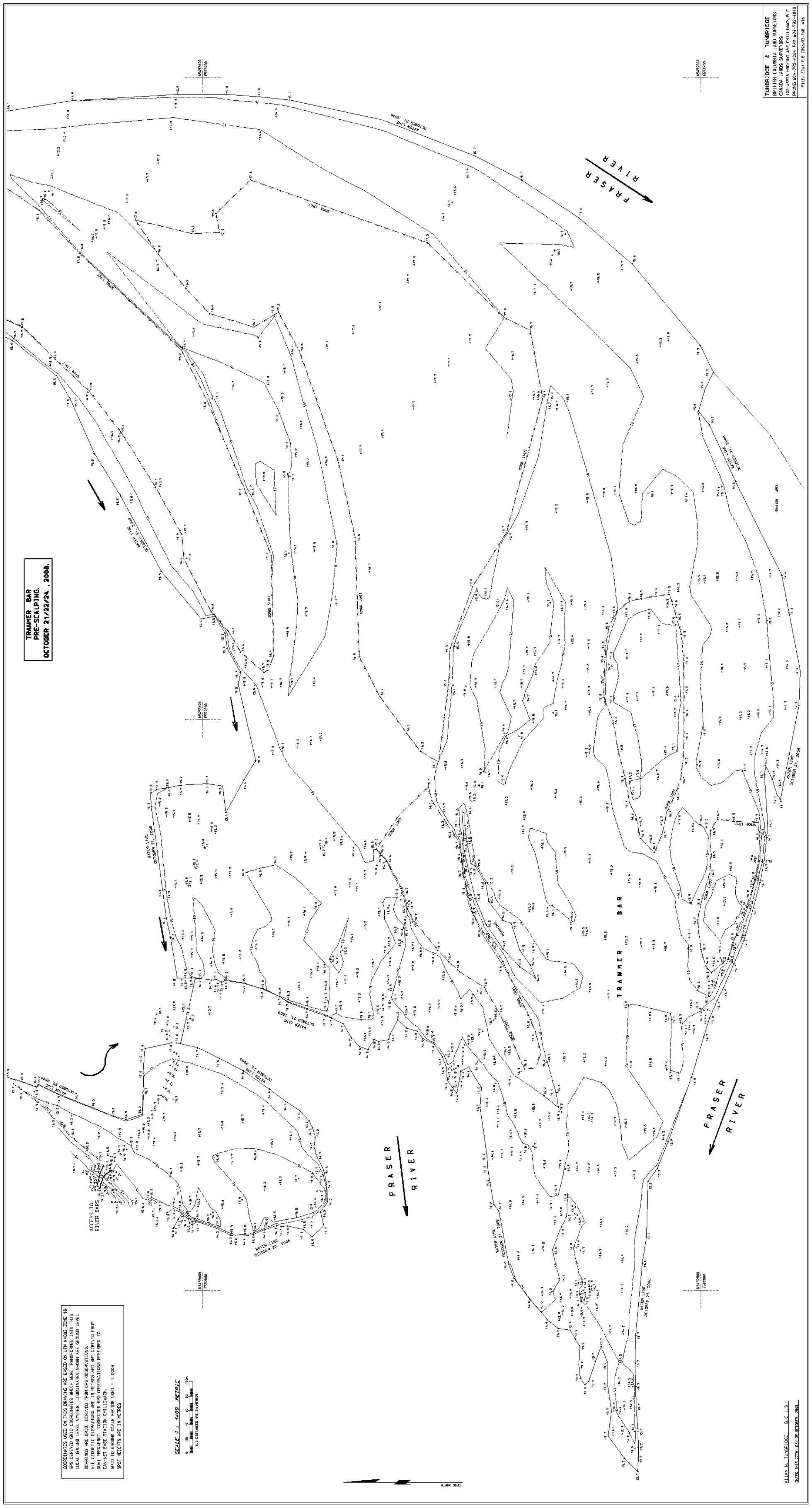
Last updated : 2007-01-27

Attachment 2

Site Survey

Prepared by

Tunbridge & Tunbridge



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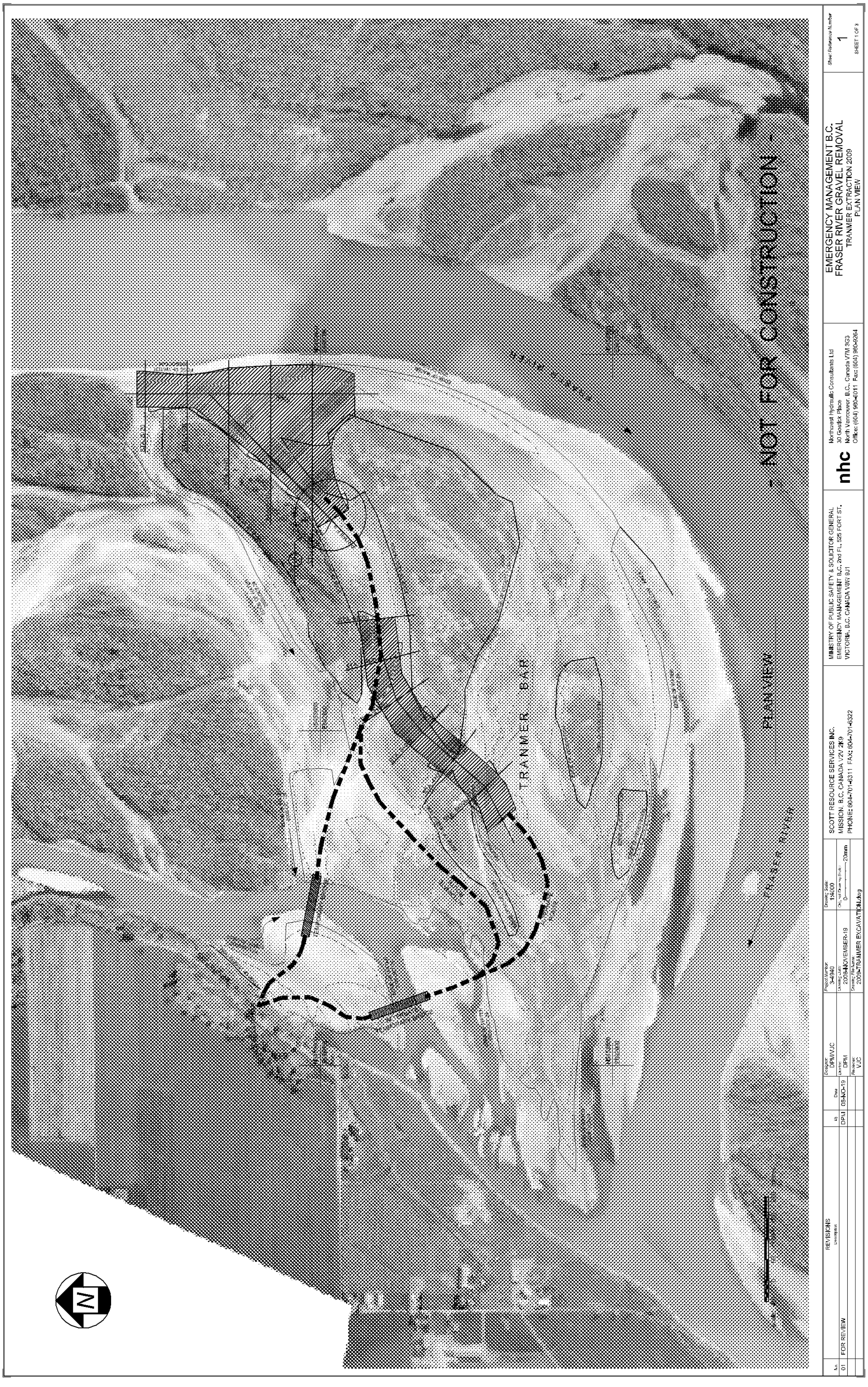
Attachment 3

Extraction Design

Prepared by

Northwest Hydraulic Consultants



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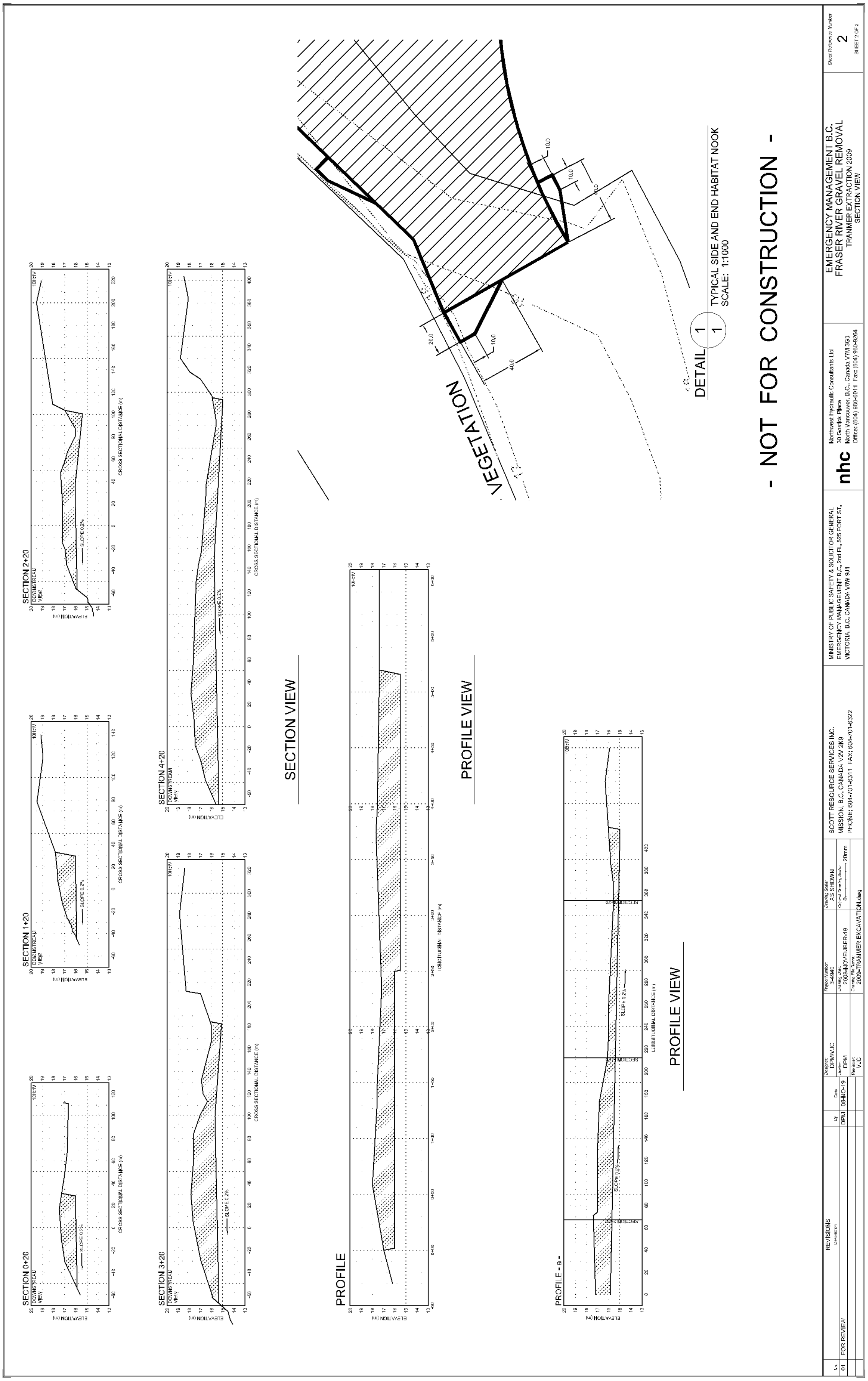

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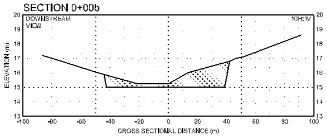
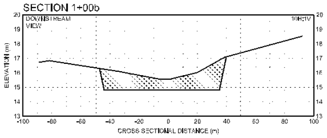
NOTES ON TRANMER BAR GRAVEL EXTRACTION PROJECT

1. DESIGN
   - 1.1 DESIGN HYDRAULICS
     - 1.1.1 DESIGN TO BE CONDUCTED DURING LOW WINTER FLOW
     - 1.1.2 PEAK DESIGN FLOW DURING CONSTRUCTION = 10-YR WINTER DAILY FLOOD
     - 1.1.3 DESIGN FLOW = 2363 m³/s
   - 1.2 DESIGN EXCAVATION
     - 1.2.1 EXCAVATION TO BE LIMITED TO 186,000 m³
2. CONSTRUCTION
   - 2.1 CONSTRUCTION SEQUENCE
     - 2.1.1 CONSTRUCT ACCESS BRIDGE
     - 2.1.2 LIMIT DISTURBANCE TO EXCAVATION LIMITS AND ACCESS ROUTE. ANY STOCKPILED MATERIALS TO BE DONE OUTSIDE OF RIVER'S EXTENTS OR WITHIN EXCAVATION LIMITS.
3. ENVIRONMENT
   - 3.1 CONSTRUCTION IS TO PROCEED IN THE DRY AS PRACTICALLY AS POSSIBLE. WORK IS TO BE IN ISOLATION FROM MAIN CHANNEL UNTIL FINAL TIE-IN. LIMIT EXTENT OF DISTURBANCE. PRACTICE ACTIVE EROSION CONTROL AND WATER MANAGEMENT TO REDUCE THE POTENTIAL FOR GENERATING SEDIMENT DURING CONSTRUCTION.
   - 3.2 STORAGE OF EQUIPMENT AND FUEL, AND FILLING OR MAINTENANCE OF EQUIPMENT MUST BE DONE ABOVE AND BACK FROM THE TOP OF BANKS.
   - 3.3 EQUIPMENT MUST BE IN GOOD CONDITION WITHOUT LEAKS. SPILL KITS AND TRAINED PERSONNEL MUST BE ON SITE AND ACCESSIBLE.
   - 3.4 ALL ACTIVITIES, INCLUDING THE STORAGE OF MATERIALS, HANDLING OF FUELS, AND EQUIPMENT OPERATION WILL BE CONDUCTED IN ACCORDANCE WITH THE GOVERNING ENVIRONMENTAL PERMITS. PERMITS MUST BE ON SITE.
   - 3.5 FINAL SHAPE OF HABITAT NOOKS TO SET ON SITE.
4. DIMENSIONS
   - 4.1 ALL ELEVATIONS, DIMENSIONS, AND STATIONING SHALL BE VERIFIED BEFORE CONSTRUCTION BEGINS.
   - 4.2 ALL DIMENSIONS ARE EXPRESSED IN METRES WITH +/- 15% TOLERANCE UNLESS OTHERWISE SPECIFIED.
   - 4.3 ALL ELEVATIONS ARE EXPRESSED IN METRES LOCAL DATUM.
   - 4.4 SURVEY WAS CONDUCTED BY TUNBRIDGE & TUNBRIDGE LAND SURVEYORS, 102-45928 HOCKING AVE, CHILLIWACK, B.C. 604-792-4264. FILE NUMBER: E261 F.B.C296/93-968 AT6.
   - 4.5 COORDINATES USED ON THIS DRAWING ARE BASED ON UTM NAD83 ZONE 10 GPS DERIVED GRID COORDINATES WHICH WERE TRANSPRMED TO LOCAL GROUND LEVEL SYSTEM. COORDINATES SHOWN ARE GROUND LEVEL.
   - 4.6 BEARINGS ARE GRID DERIVED FROM GPS OBSERVATIONS. ALL GEODETIC ELEVATIONS ARE IN METRES AND ARE DERIVED FROM DUAL FREQUENCY CORRECTED GPS OBSERVATIONS REFERRED TO CAN-NET BASE STATION CHILLIWACK.
   - 4.7 GRID TO GROUND SCALE FACTOR USED = 1.0003 SPOT HEIGHTS ARE IN METRES.

SECTION 0+00b



SECTION 1+00b



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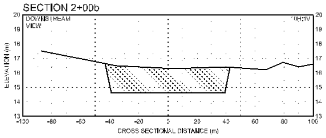
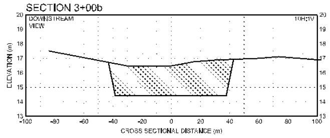
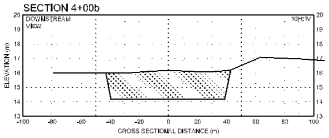


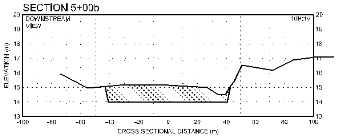
SECTION 3+00b



SECTION 4+00b

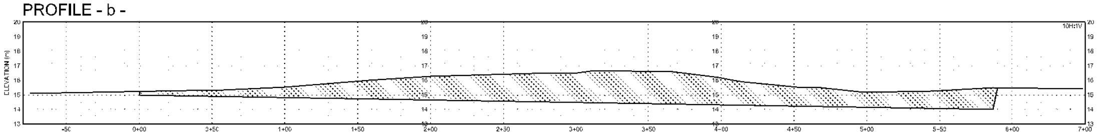


SECTION 5+00b



SECTION - B -

PROFILE - b -



PROFILE - B -

- NOT FOR CONSTRUCTION -

No.	REVISIONS Description	By	Date	Designer: DPM/VJC	Project Number: 3-4940	Drawing Scale: AS NOTED
01	FOR REVIEW	DPM	08-NO-19	Drafter: DPM	Drawing Date: 2008-NOVEMBER-19	Original Drawing Scale: 0—20mm
				Reviewer: VJC	Drawing File Name: 2009-TRANMER EXCAVATION.dwg	

SCOTT RESOURCE SERVICES INC.
MISSION, B.C. CANADA V2V 2K9
PHONE: 604-701-6311 FAX: 604-701-6322

MINISTRY OF PUBLIC SAFETY & SOLICITOR GENERAL
EMERGENCY MANAGEMENT B.C. 2nd FL. 525 FORT ST.
VICTORIA, B.C. CANADA V8W 9J1

nhc Northwest Hydraulic Consultants Ltd
30 Gostick Place
North Vancouver, B.C., Canada V7M 3G3
Office: (604) 980-6011 Fax: (604) 980-9264

EMERGENCY MANAGEMENT B.C.
FRASER RIVER GRAVEL REMOVAL
TRANMER EXTRACTION 2009
SECTION VIEW

Sheet Reference Number 3
SHEET 3 OF 3

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Attachment 4

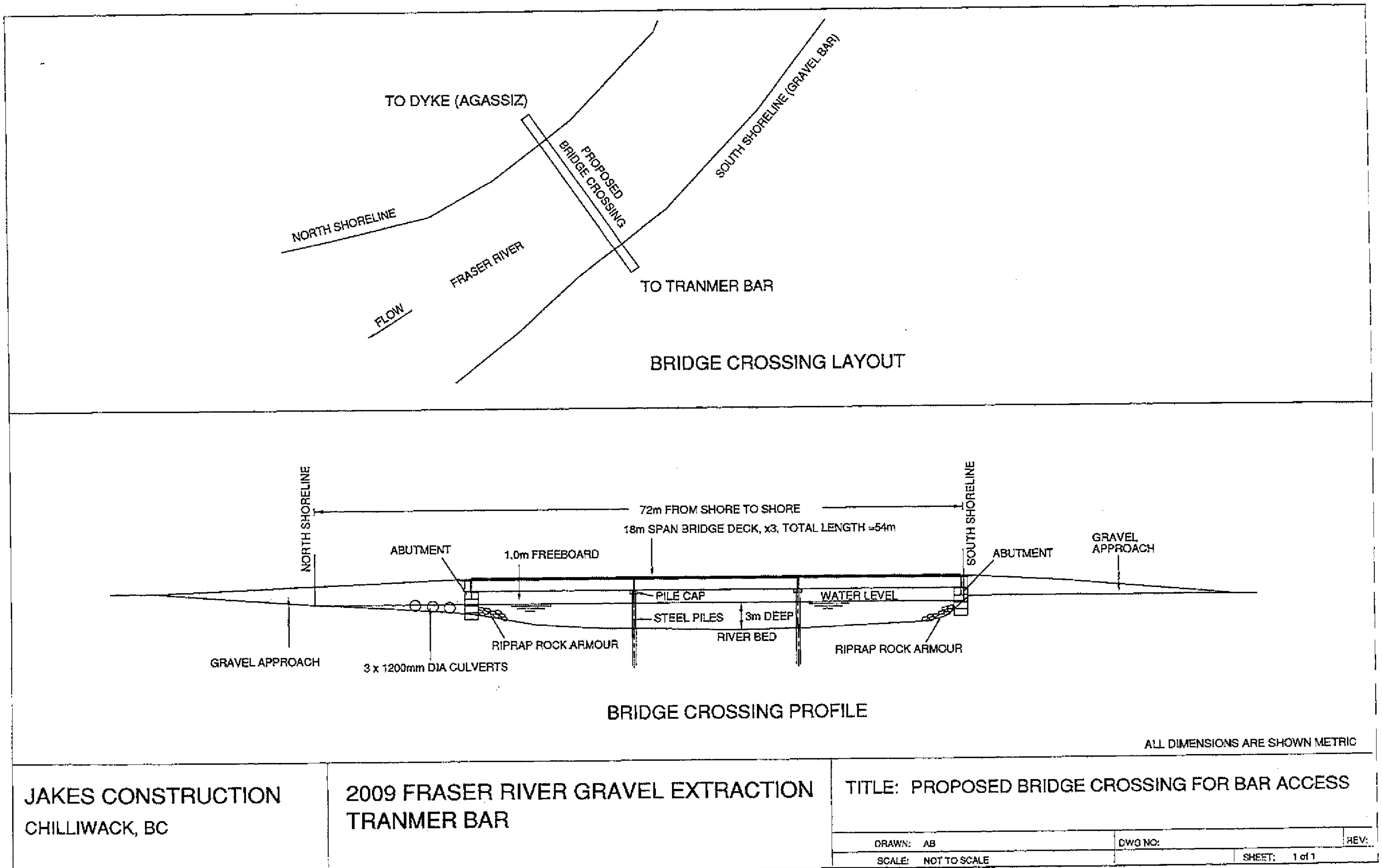
Preliminary Bridge Designs

Prepared by

Jakes Construction

and

Associated Engineering



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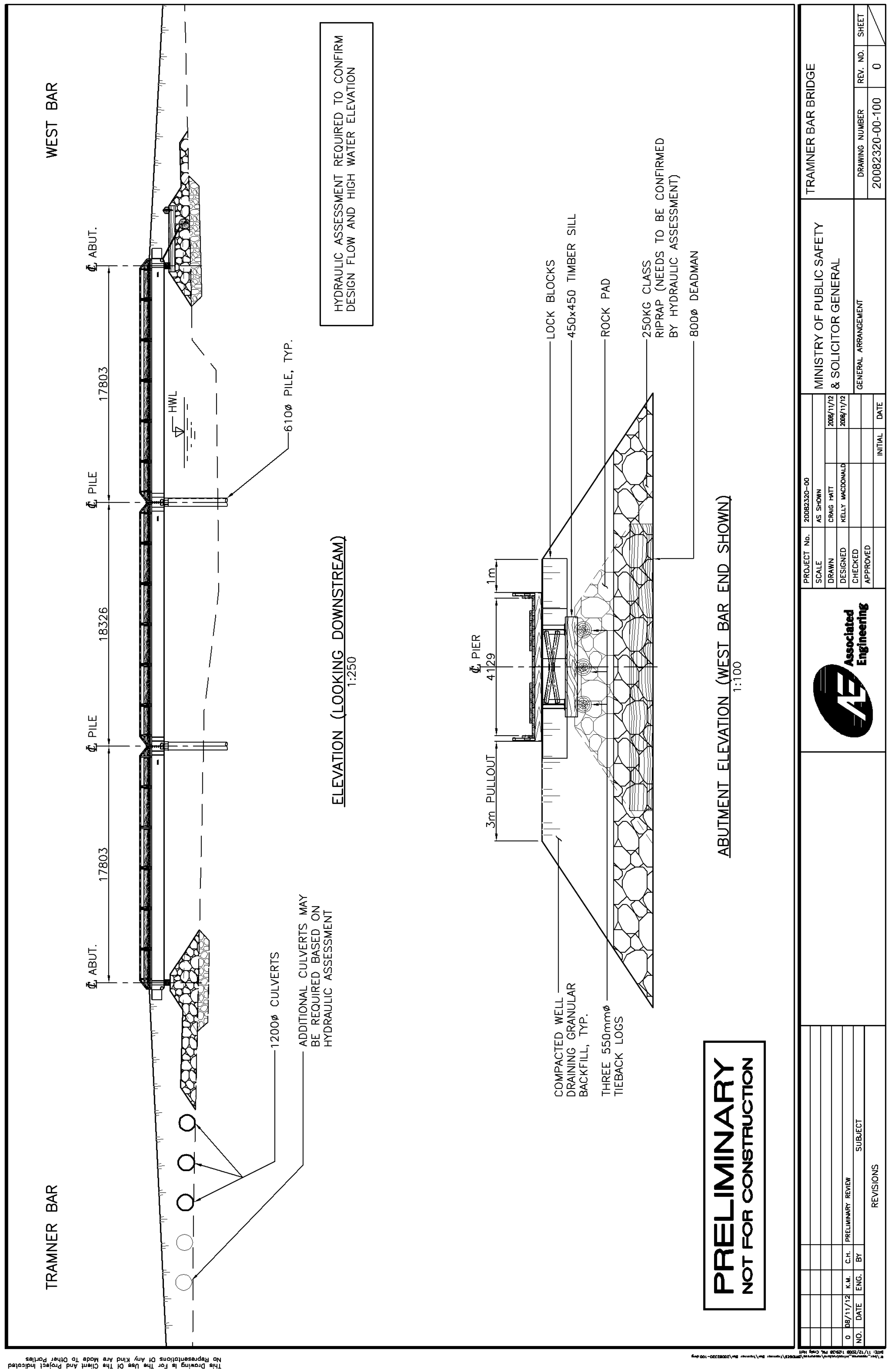

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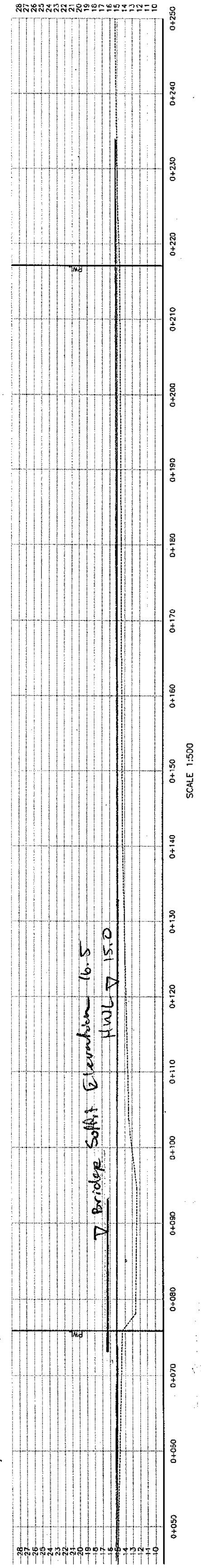
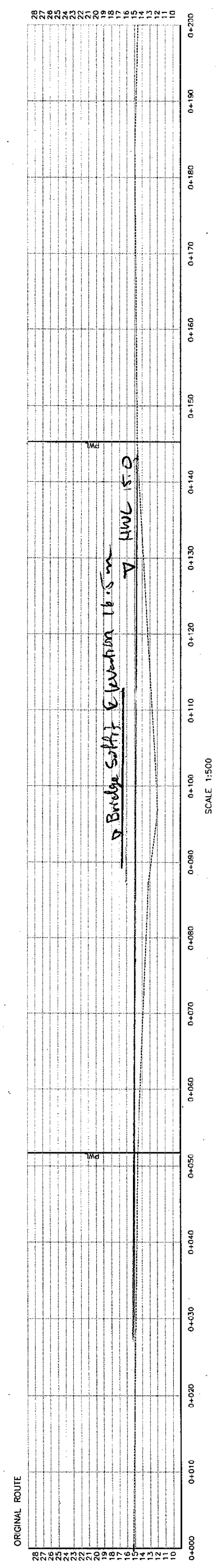
Alternate Option (230m downstream of original crossing)





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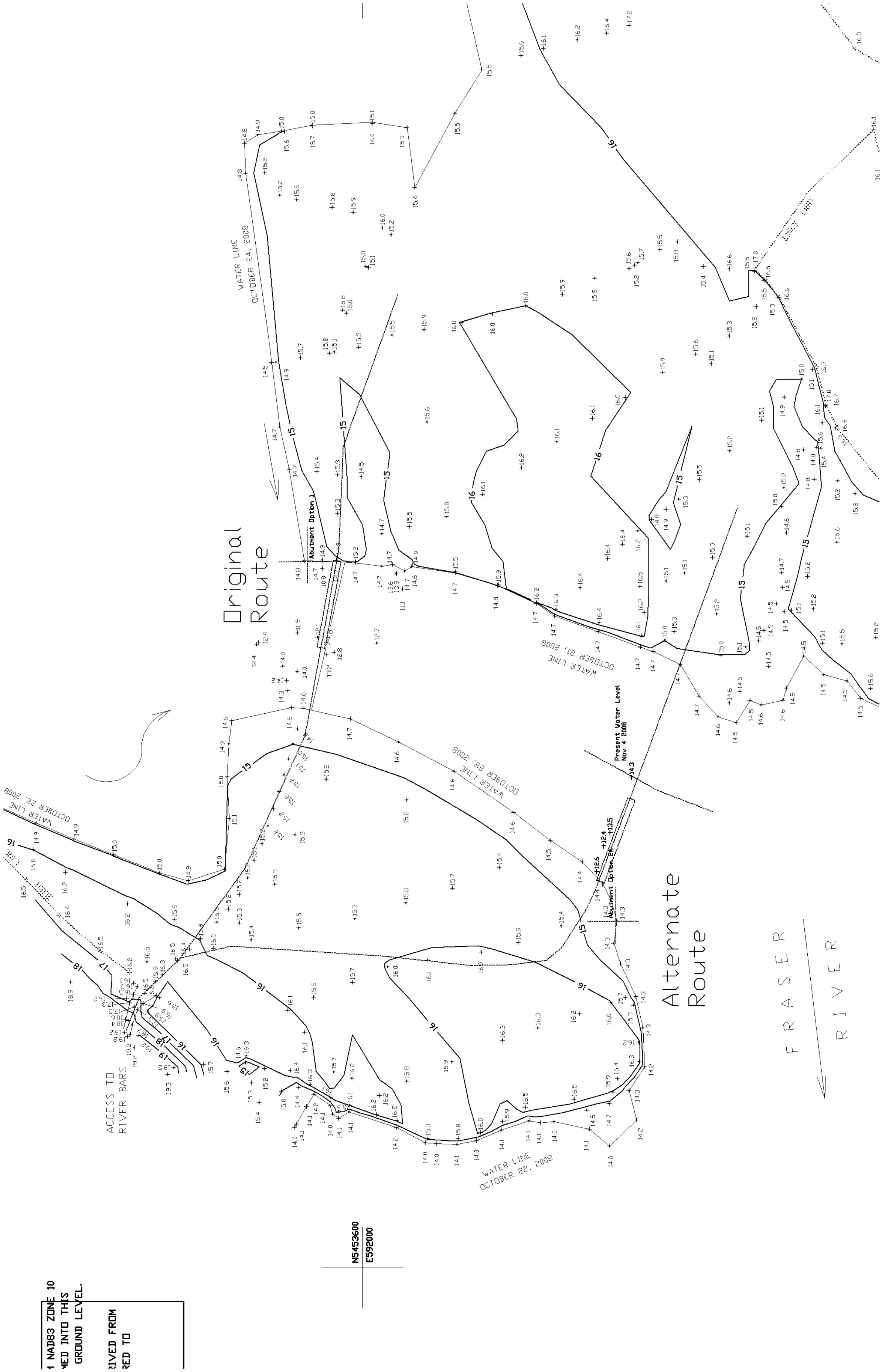

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Tramner Bar Nov 4, 2008

Looking upstream from Tramner Bar abutment (orignal crossing)

Looking downstream from Tramner Bar abutment (orignal crossing)

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Tramner Bar Nov 4, 2008

Looking across to Agassi from Tramner Bar abutment (original option)

Looking east from Tramner Bar abutment (original option)

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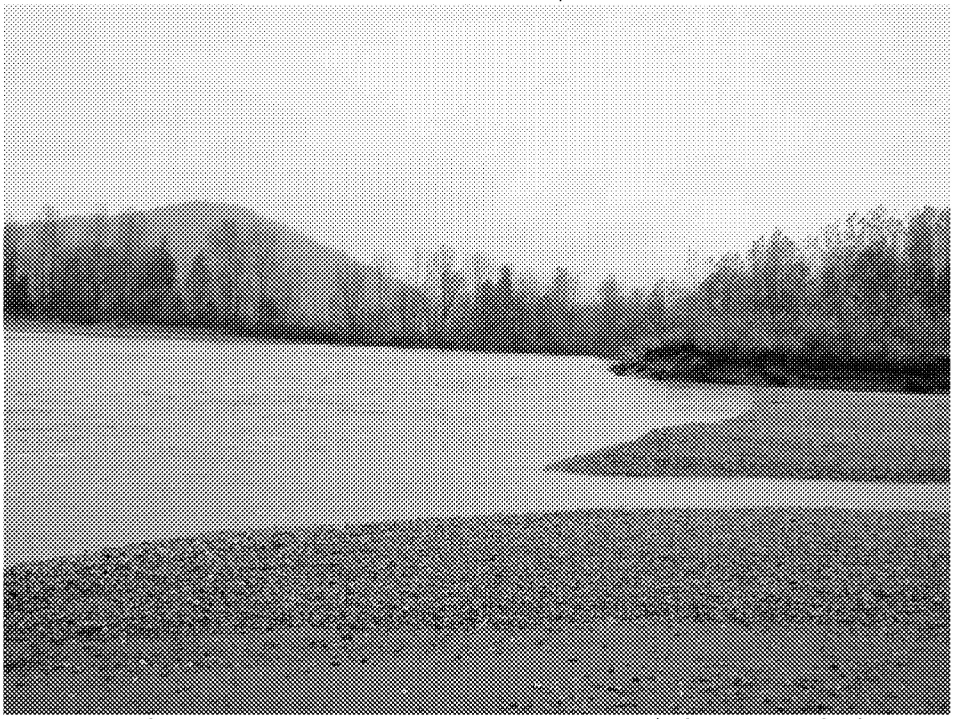
Tramner Bar Nov 4, 2008



Looking upstream at Tramner Bar abutment (orignal crossing)

Looking downstream at Tramner Bar abutment (alternate option)

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Tramner Bar Nov 4, 2008

Looking at Tramner Bar abutment from Agassi abutment (alternate crossing)

Looking upstream from Agassi abutment (alternate crossing)

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Tramner Bar Nov 4, 2008

Looking upstream from Agassi abutment (alternate crossing). Note, Tramner Bar in background.

Looking upstream from Agassi abutment (alternate crossing).

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Tramner Bar Nov 4, 2008

Looking downstream at Tramner abutment (alternate option). Note temporary channel in background

Looking downstream at Agassi abutment (alternate option). Note, Tramner Bar abutment in background.

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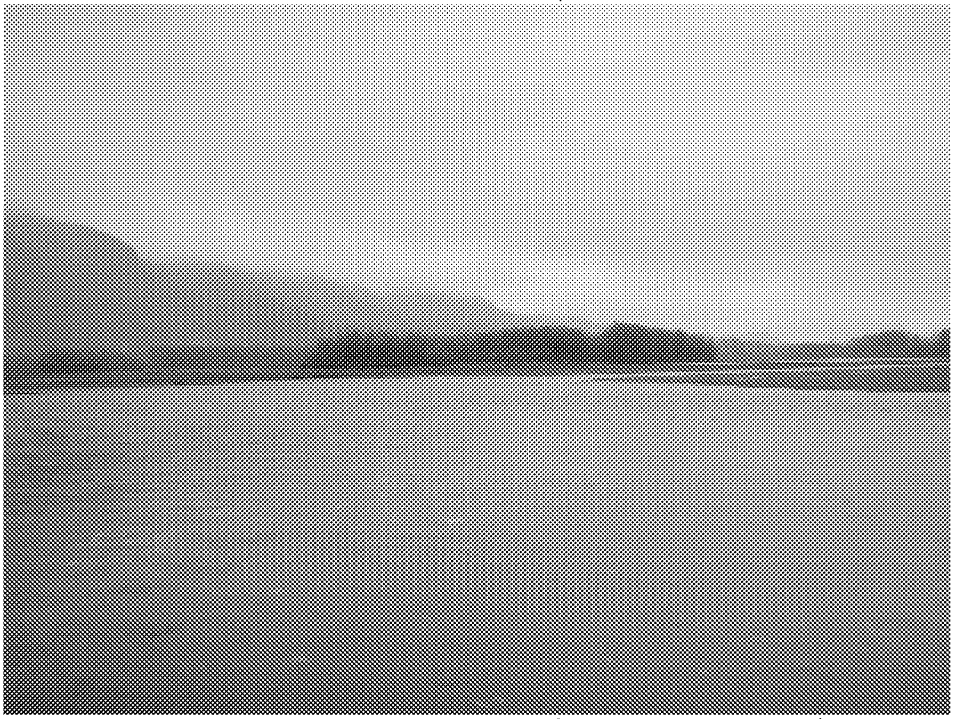
Tramner Bar Nov 4, 2008



Looking downstream at temporary channel east of Tramner abutment (alternate option)

Looking upstream at temporary channel east of Tramner abutment (alternate option)

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Attachment 5

Location Map

Location of Tranmer Bar.

Attachment 6

Fish Habitat Assessment, Mitigation Plan

and Monitoring Program

Prepared by

Scott Resource Services Inc.

SCOTT RESOURCE SERVICES INC.
Environmental Consultants
Mission: 31856 Silverdale Avenue 604-820-1415
Chilliwack: 202 – 9300 Nowell Street 604-701-6311

Fish Habitat Assessment, Impact Mitigation and Monitoring Program

Tranmer Bar

Prepared by:

Scott Resource Services Inc.
202-9300 Nowell St.
Chilliwack, BC V2P 4V7

for

Emergency Management BC
2nd Floor 525 Fort Street Victoria BC
PO Box 9223 Stn Prov Govt
Victoria, BC V8W 9J1

November 20, 2008

SRS File: 813.0303

SCOTT RESOURCE SERVICES INC.

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Chilliwack: 202 – 9300 Nowell Street 604-701-6311

Ann Griffin
Emergency Management BC
2nd Floor 525 Fort Street Victoria BC
PO Box 9223 Stn Prov Govt.
Victoria, BC V8W 9J1

Letter of transmittal: Fish Habitat Assessment, Impact Mitigation and Monitoring - Tranmer Bar

Emergency Management BC (EMBC) is proposing to complete gravel extraction works on the Fraser River at Tranmer Bar during the winter 2009 gravel extraction window (January 1 – March 15). The gravel extraction is to be undertaken per the *Letter of Agreement: Fraser River Gravel Removal Plan* (LOA) issued by Fisheries and Oceans Canada (DFO). Specifically, and as part of the *Fish Habitat Assessment, Mitigation Plan and Monitoring Program* of the LOA, the following information was required:

1. Habitat mapping
2. Surface sediment sampling
3. Benthic invertebrate sampling
4. Juvenile fish sampling
5. Topographic and bathymetric surveys
6. Gravel removal supervision

Scott Resource Services Inc., has collected biomonitoring data (fish sampling, benthic invertebrate sampling surface sediment sampling and habitat mapping) consistent with requirements of the LOA, and has compiled, reviewed and analysed relevant data and information provided by other consultants working on this project. The enclosed *Fish Habitat Assessment Mitigation Plan and Monitoring Program* report will be appended to an application submitted to DFO along with separate specialist reports submitted by Northwest Hydraulic Consultants Ltd., Associated Engineering and Tunbridge and Tunbridge Surveyors Ltd.

Bridge designs and access routing were at a conceptual or preliminary stage during the SRS fish habitat assessments described in this report. Additional site assessments to address data gaps at the crossing location are currently scheduled for late-November 2008.

Sincerely,

SCOTT RESOURCE SERVICES INC.

Martin Stol, *BSc., Dipl. Tech.*
Project Manager

Jenni Konken, *BSc., Dipl. Tech., BIT*
Project Biologist

Reviewed by:
David E. Neufeld, *RPBio*

202 – 9300 Nowell Street Chilliwack B.C. V2P 4V7 Tel. 604-701-6311 Fax. 604-701-6322 email: infosrs@telus.net

SUMMARY

Emergency Management BC (EMBC) is proposing to complete gravel extraction works on the Fraser River at Tranmer Bar during the winter 2009 gravel extraction window. Gravel extraction is being undertaken to take action to progressively reduce the flood hazard risk to communities along the Fraser River between Seabird island and the Vedder River confluence.

The proposed extraction, designed by Northwest Hydraulic Consultants (NHC), would remove 186,000 m^3 of gravel and sand from the eastern bar edge through to the centre of lower Tranmer Bar.

The enclosed report provides information required to satisfy conditions of the Letter of Agreement: Fraser River Gravel Removal Plan - *Fish Habitat Assessment, Mitigation Plan and Monitoring Program*.

As part of the Fish Habitat Assessment, Mitigation Plan and Monitoring Program the following information was required:

1. Habitat mapping
2. Surface sediment sampling
3. Benthic invertebrate sampling
4. Juvenile fish sampling
5. Topographic and bathymetric surveys
6. Gravel removal supervision

Information addressing these aspects of the program are contained within this report.

Sampling methodology used to gather data for this report was based on a standard program required by the LOA, with timing amended through consultation with Fisheries and Oceans Canada (DFO).

In addition to the standard methodology required in the LOA, information garnered through a review of the literature and past extraction assessments, was used to assess fish habitat and the potential impacts of the proposed gravel extraction on fisheries values.

At the time of the biomonitoring data collection, gravel extraction site access option analysis was still in development. Consequently, additional field investigations are scheduled for late November to obtain requisite information for ascertaining bridge and access route impacts. This information will be provided to DFO, as an addendum to this report.

TABLE OF CONTENTS

LIST OF FIGURES

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1.0 INTRODUCTION

Emergency Management BC (EMBC) is proposing to complete gravel extraction works on the Fraser River at Tranmer Bar during the winter 2009 gravel extraction window (January 1 – March 15). The proposed extraction, designed by Northwest Hydraulic Consultants (NHC), would remove 186,000 m^3 of gravel and sand from the eastern bar edge through to the centre of lower Tranmer Bar. Site access will require construction of a bridge spanning the wetted width of the side channel which flows between Tranmer Bar and the northwest (right) bank of the Fraser River. The extraction design and crossing location are shown on the NHC extraction design, included as Attachment 3 of the Application entitled *Fraser River Gravel Removal Plan Proposed Tranmer Bar Extraction – 2009* (the "Application").

EMBC has contracted Scott Resource Services (SRS) to complete pre-extraction biological monitoring tasks at Tranmer Bar, as outlined in the *Fisheries and Oceans Canada Information Requirements* listed in the *Letter of Agreement: Lower Fraser River Gravel Removal Plan 2004-2008* (LOA). Sampling methodology was based on a standard program required by the LOA with timing amended through consultation with Fisheries and Oceans Canada (DFO). SRS utilized the results of the sampling data, along with a review of the literature and past extraction assessments, to assess fish habitat and the potential impacts of the proposed gravel extraction on fisheries values.

The LOA stipulates requirements for ongoing biological monitoring of available habitat, surface sediment composition, juvenile fish habitat utilization, and benthic invertebrates. Methods and schedules for each item are detailed in the corresponding sections of this report.

The extraction design was in draft form at the time of the biological sampling conducted to date by SRS. Additional field data collection and ground truthing based on the final extraction design are scheduled for late November.

2.0 METHODS

2.1 Habitat Mapping

Habitat mapping standards were outlined in the LOA. These standards were based on ecological effects assessment techniques developed in a gravel extraction effects assessment report (Rempel, 2004).

Pre-extraction flight photographs from low-level, fixed wing aircraft were taken at approximately 5,000 m^3/s and 2,500 m^3/s river discharge recorded at the Water Survey of Canada Hope hydrometric station. Post-extraction overflight photographs will be taken during the 2009 freshet, and following the first of either three freshets or a major freshet (Fraser River discharge recorded at Hope hydrometric station >8,766 m^3/s). The pre-extraction habitat mapping will be compared to post-extraction photographs to determine the extent and characteristics of changes to available habitat resulting from the proposed extraction.

Habitat mapping methodology followed that described by Church *et al.* (2000), who also identified and defined habitat types encountered on gravel bars in the Fraser River gravel reach.

Flights were conducted by SRS and Nova Pacific Environmental (NPE) at river discharge rates of 5,600 m^3/s and 2,350 m^3/s. Additional photographs from Northwest Hydraulic Consultants (NHC) overflights were used to illustrate habitat availability at intermediate flow levels (i.e. between 5,600 m^3/s and 2,350 m^3/s).

SRS classified the pre-extraction habitat types present at lower Tranmer Bar using flight photographs and ground inspections conducted concurrent with biological data collection. Habitat types were assigned after habitat types in Church *et al.* (2000); Bar Head, Bar Tail, Bar Edge, Riffle, Bay, Open Nook, and Channel Nook.

Bar Head is defined as the upstream end of a gravel bar, where surface substrate is typically coarse and flow velocity is typically high. Bar Head habitat is observed at the entrances to channels flowing laterally across the bar complex. Bar Tail habitat is observed at the downstream end of a gravel bar and is typically a zone of deposition of smaller sized substrate. Bar Edge habitat is oriented parallel to the flow and may contain a range of substrate types and velocities. Bar Edge habitat has been further delineated based on slope perpendicular to the shoreline. Riffle habitat is a high gradient area of shallow, rough, fast flowing water over coarse substrate. Bay habitat is a semi-enclosed area with no flow velocity and fine bed material. Open Nook habitat is a shallow indentation along the bar edge that is connected to the channel and is often ephemeral (i.e. loss of function can occur with small changes in water level). Channel Nook habitat is a dead-end channel of standing water which conveys flow at higher discharge and typically has a substrate of sand/silt with embedded gravel.

2.2 Surface Sediment Sampling

As outlined in the LOA, surface sediment sampling was to be conducted using the Wolman method or the photographic method described by Church *et al.* (2000). SRS utilized the photographic method, which uses stone density (number stones per m^2) in a 0.25 m^2 quadrat to calculate median grain size (D50) and the size of the coarse (D95) and fine (D5) fractions. Mean grain sizes can then be compared before and after an extraction has taken place. Five replicate photographs were required within all major sedimentary units of the surveyed extraction area. Similarly, five replicates were taken at a suitable reference site. Timing of sampling is also outlined in the LOA. Samples were to be collected pre-extraction, when the extraction area is dry (i.e. fall or winter). The surface sediment sampling will be repeated twice following the extraction; once after the first post-extraction freshet in 2009 and once after either three freshets or the occurrence of a single major freshet. A major freshet is defined as Fraser River discharge at Hope >8,766 m^3/s.

2.3 Benthic Invertebrate Sampling

DFO provided SRS with a sampling timeline and protocol for Tranmer Bar. Benthic invertebrate sampling is required in September or October of 2008 and again from November 2008 to January 2009. Post extraction sampling is required after the first freshet following the extraction within the wet extraction area, typically in August. A fourth sampling episode is to take place in 2009 during the same month as either the first or second pre-extraction samples. The final sampling session will be conducted after the next major freshet (>8,766 m^3/s) or at latest following the third freshet after the extraction.

The sampling method employed to collect benthic invertebrates is detailed in the *Freshwater Sampling Methods* (RISC 1997). A Surber sampler is used to collect samples from a fixed area. Five replicates are collected at each sampling location.

Samples collected were submitted for taxonomic analysis by and independent invertebrate taxonomy specialist. Organisms were identified to the family level when possible, allowing densities and diversity of organisms to be compared over time at the extraction site and at unaffected reference sites.

2.4 Juvenile Fish Sampling

The LOA stated that juvenile fish should be sampled by beach seine when the river flow is approximately 5,000 m^3/s and 2,500 m^3/s. Sampling was to be scheduled at the proposed extraction site and at a reference site, both prior to the extraction and following the first post-extraction freshet. Methodology for collecting fish by beach seine is outlined in *Fish Collection Methods and Standards* (RISC 1997).

Catch Per Unit Effort (CPUE) was calculated as the number of fish caught per m^2 of swept area in any given seine set. Species Per Unit Effort (SPUE) was also calculated as number of species captured per m^2 of swept area, as a measure of species richness at each site. Values were calculated as an average of five sets.

The juvenile beach seine sampling methodology specified within the LOA was not intended to target white sturgeon (*Acipenser transmontanus*) during any of its life stages. Sampling for this species was not specifically part of the methodology outlined in the LOA, and was therefore not part of SRS's scope of services for this project.

A literature review was undertaken to locate existing information on potential white sturgeon use at the Tranmer Bar complex.

2.5 Topographic-Bathymetric Surveys, extraction plans and access location designs

A topographic survey of the Tranmer Bar extraction location and downstream habitat was completed by legal surveyors. The survey information is used to assess extraction area boundaries and extraction volumes. The survey information will also be used to track bar morphologic changes that result from extraction.

Post-extraction surveys will be completed following gravel removal prior to March 15, 2009 and following the first of either a major freshet (Fraser River discharge at Hope >8,766 m^3/s) or three freshets less than 8,766 m^3/s.

Extraction planning, was undertaken by Northwest Hydraulics Ltd. concurrent with or after collection of monitoring data and information conducted by SRS. Access planning and design were undertaken after onsite pre-extraction investigations conducted by SRS. Therefore SRS has not yet completed a field assessment of the crossing location and access route. A preliminary assessment of access and bridge related impacts is provided in Section 4.5. The current assessment is based on a site survey, bridge design drawings, and past site visits and reports. Additional assessment will be required, which can be completed during a site visit currently scheduled for late November.

3.0 RESULTS

3.1 Habitat mapping

Downstream of the forested islands of Tranmer Bar, deposition within the inside of the main channel meander has formed crescent shaped bar deposits, interspersed with channel nooks and bays at varying water levels. The lower portion of the bar complex consists of a sand and small gravel core, and an armoured perimeter along the main channel of cobbles and large gravel.

At high Fraser River discharge (5,600 m^3/s), lower Tranmer Bar was a complex network of shallow, partially submerged bars (Figure 1), downstream of a series of forested islands. The proposed extraction area consisted of open water, bar edge with flat to steep slope and shallow riffle over the submerged bar. The upstream extraction area north boundary consists of a forested island. The southern boundary consists of a bar head and a bar top surface with emergent riparian vegetation in the form of immature willows and other low growing shrubs. The downstream portion of the extraction area was partially exposed bar top with a flat bar edge.

An additional overflight was completed by NHC on August 15, 2008 at a mid-level flow of 3,500 m^3/s discharge (Figure 2). At this discharge, Tranmer Bar was a network of relatively shallow side channels and bays, some of which later formed strand pools as water levels receded. The proposed extraction area was mostly exposed with a channel nook draining to the west. There was an increased area of bar top exposed, thereby increasing the area of bar edge habitat available to fish.

Habitat mapping at the lower flow rate of 2,350m^3/s is shown in Figure 3. The exposed bar surface was generally flat bar edge with a complex network of side channels, nooks, bays, and strand pools. Habitat available in the immediate vicinity of the proposed excavation was main channel flat bar edge on the outer gravel lobe, a series of strand pools remnant of the channel nook at higher flows, and a bay at the downstream end of the extraction area.

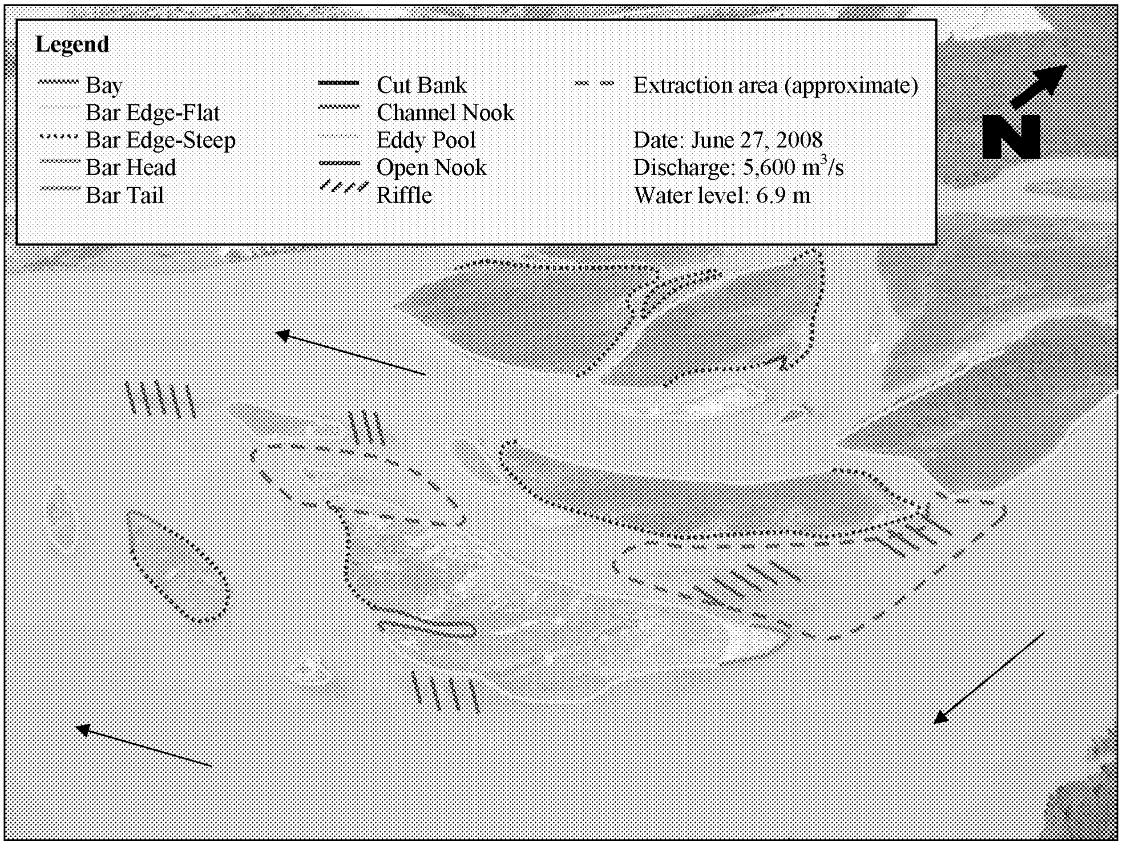

Figure 1. Tranmer Bar under high flow conditions (June 27, 2008) photographed by NPE and annotated by SRS. The discharge rate in the Fraser River recorded at Hope was approximately 5,600 m3/s.

An additional overflight was completed by NHC on August 15, 2008 at a mid-level flow of 3,500 m^3/s discharge (Figure 2). At this discharge, Tranmer Bar was a network of relatively shallow side channels and bays, some of which later formed strand pools as water levels receded. The proposed extraction area was mostly exposed with a channel nook draining to the west. There was an increased area of bar top exposed, thereby increasing the area of bar edge habitat available to fish.

Habitat mapping at the lower flow rate of $2{,}350 m^3/s$ is shown in Figure 3. The exposed bar surface was generally flat bar edge with a complex network of side channels, nooks, bays, and strand pools. Habitat available in the immediate vicinity of the proposed excavation was main channel flat bar edge on the outer gravel lobe, a series of strand pools remnant of the channel nook at higher flows, and a bay at the downstream end of the extraction area.

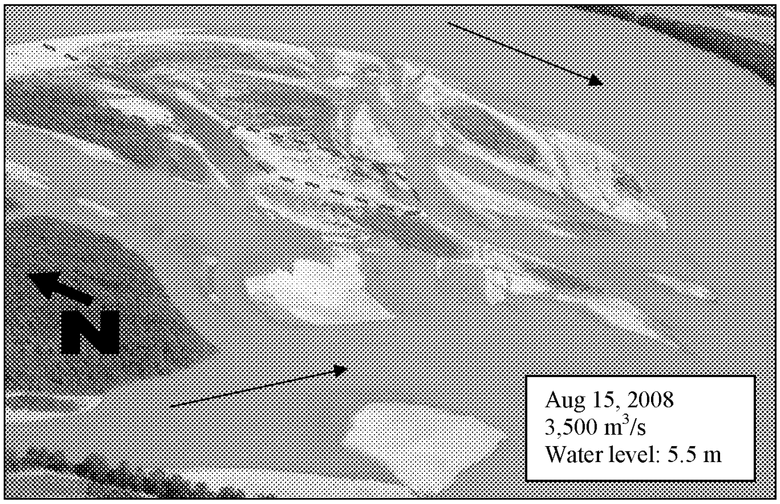

Figure 2. Tranmer Bar photographed on August 15, 2008. Fraser river discharge was approximately 3,500 m3/s. The approximate extraction area boundary is shown (dashed lines). Photograph courtesy of NHC.

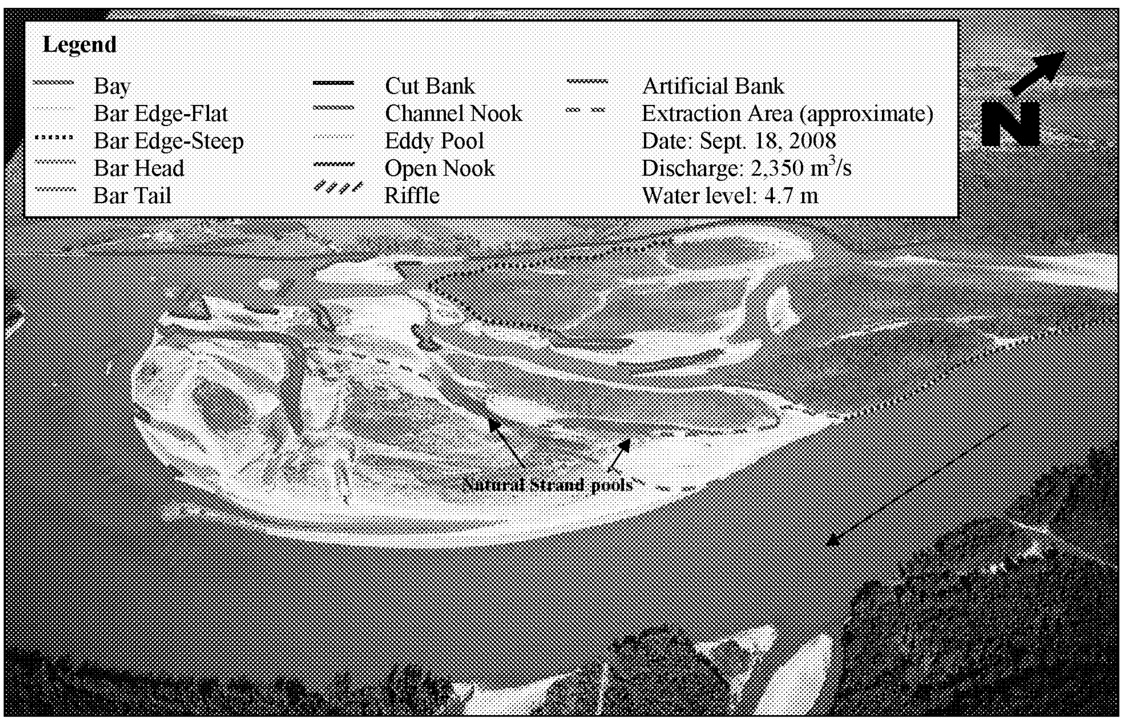

Figure 3. Tranmer Bar under low flow conditions (September 18, 2008) photographed and annotated by SRS. The discharge rate in the Fraser River recorded at Hope was approximately 2,350 m3/s.

Habitat at Spaeti's Bar consisted of an open nook on the upstream side, a bay on the lee side of the bar and flat bar edge parallel to the flow direction. Access to Tranmer Bar will cross the side channel from Spaeti's Bar, visible in the background of Figure 3.

Based on the spring low flow conditions of April 12, 2008, and barring extraordinary, unseasonal winter runoff, the proposed extraction area will be dry (Figure 4). Available habitat adjacent to the extraction area will be bar edge flat. Strand pools will likely be dry by that time.

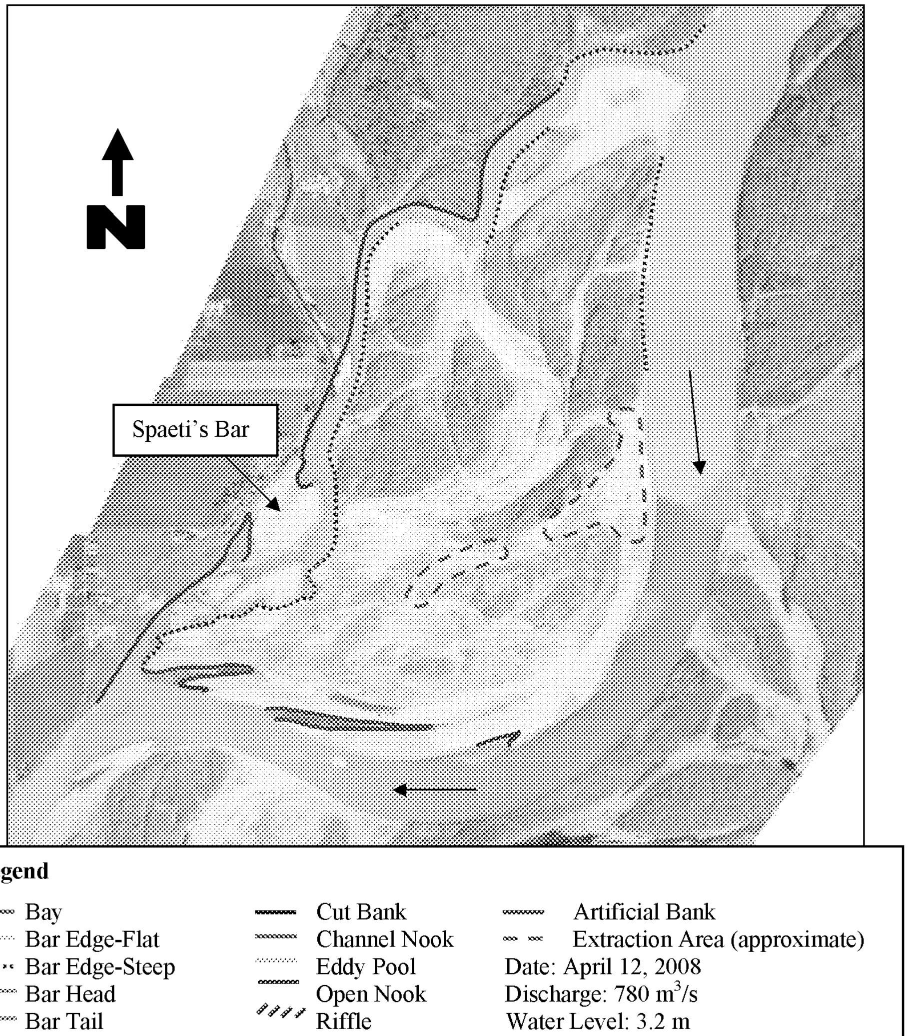

Figure 4. Habitat types at Tranmer Bar during low spring flows (April 12, 2008). The majority of the bar surface was above water level, with a narrow side channel on the west side of the bar.

3.2 Surface sediment sampling

SRS collected pre-extraction sediment samples from reference sites and within the upper bar edge extraction area on October 1, 2008. As there was no extraction plan available at that time, sedimentary unit stratification was not completed. Additional assessment will be required during a site visit scheduled for late November, which will coincide with the second episode of benthic invertebrate sampling.

Since the extraction boundaries were not known when the surface sediment sampling was sampled, therefore multiple potential sites were photographed (Figure 5). Of the multiple surface sediment sampling points, Site 1 and Site 4 were found to be included within the extraction perimeter. Site 2 was located immediately downstream of the extraction area. Site 3 was determined to be outside of the extraction area and would remain unaffected by the extraction. Site 3 was retained as a reference site. Site 3 was a single sedimentary unit, and was located on the edge of the main channel at the head of a dry summer side channel on Herrling Island, directly across from Tranmer Bar. Typical substrate photographs used for the analysis are shown in Figure 6.

At least two major sedimentary units were observed during previous site visits within the proposed extraction area boundaries. The lower portion of the bar complex consisted of an inner sand and small gravel core, and an armoured perimeter along the main channel of cobbles and large gravel.

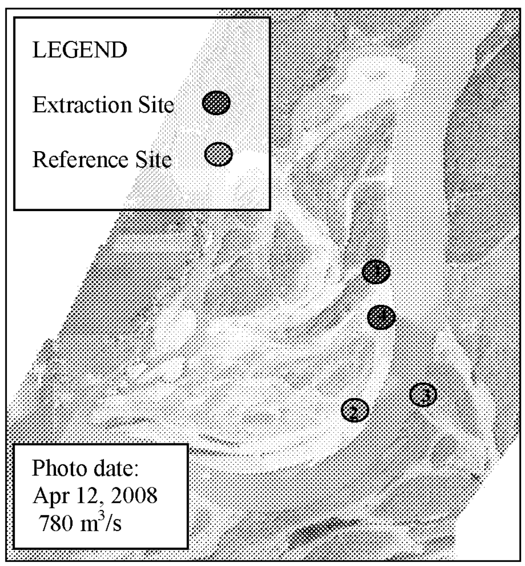

Figure 5. Locations of surface sediment samples collected at Tranmer Bar and Herrling Island on October 1, 2008.

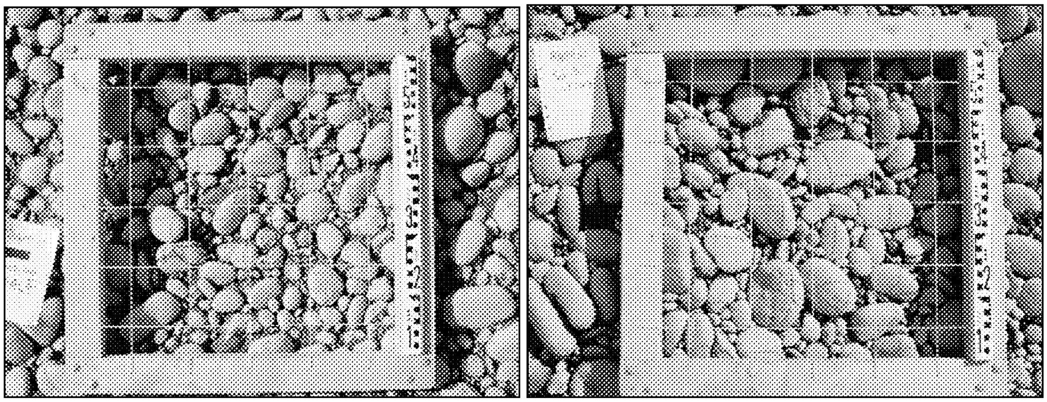

Figure 6. Typical sediment character at the Tranmer Bar extraction site (left photograph, Site 4) and reference site (right photograph, Site 3). Both photographs were taken October 1, 2008.

3.3 Invertebrate sampling results

SRS completed the first episode of pre-extraction invertebrate sampling at Tranmer Bar. on October 1, 2008. Samples were collected from the extraction site and three reference sites (Figure 7). All sites were flat bar edge habitat. One of the reference sites was located in similar habitat on mid-Herrling Island. The sampling locations were based on the original extraction location provided to SRS by NHC. After the invertebrate samples had been collected and analysis was in progress, the extraction location was shifted to its current location. As a consequence, Reference Site 1 is now within the extraction perimeter.

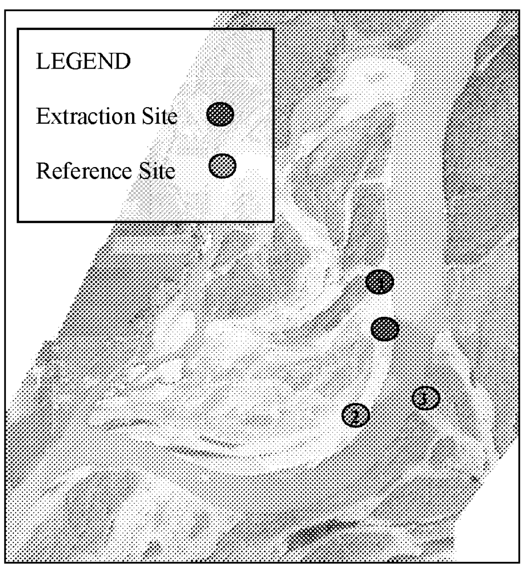

Figure 7. Benthic invertebrate sampling location at Tranmer Bar and Herrling Island. Samples were collected on October 1, 2008 at a discharge of 1,700 m^3/s.

The most common invertebrate group found in the samples at all sites was the family *Chironomidae*, order *Diptera* (flies) (Figure 8). The larval forms of these organisms, also known as bloodworms or larval midges, are common in freshwater streams and an important food source for fish (White *et. al.* 1998). The other major groups of benthic invertebrates sampled were *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), *Trichoptera* (caddisflies), and members of the subclass *Oligochaeta* (segmented worms).

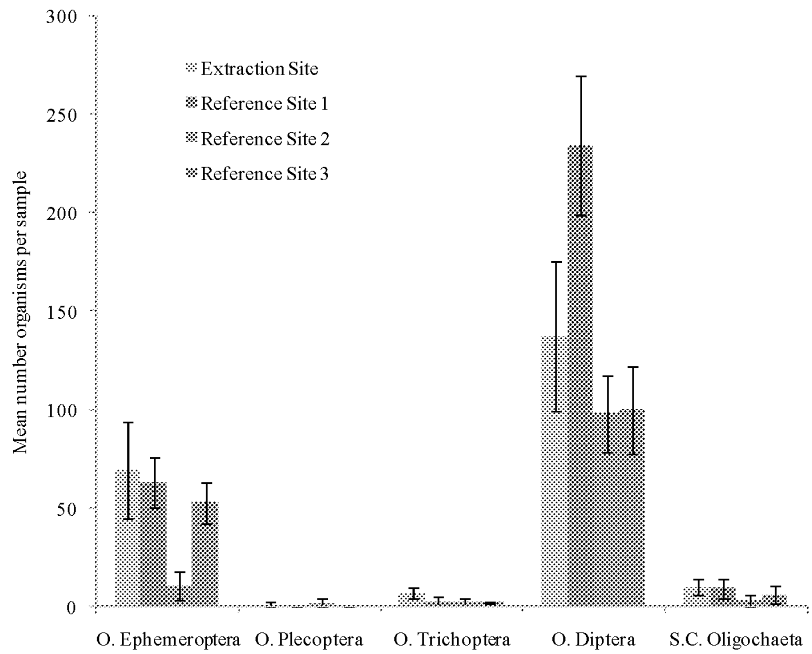

Figure 8. Mean numbers per sample of the major types of benthic invertebrates sampled at Tranmer Bar and Herrling Island on October 1, 2008.

Benthic invertebrate abundance and diversity was generally similar between sites. Exceptions were mayflies, which were less abundant at reference site 2, and chironomids, which were more abundant at reference site 1.

Benthic invertebrate sampling was not conducted at the proposed bridge location as the crossing location was not known at the time of the benthic invertebrate collection. The crossing location is within habitat that is similar to the area where samples were collected (bar edge flat). Temporary disturbance to a small area of benthic invertebrate habitat will occur as a result of the crossing installation.

3.4 Fish sampling and fish habit assessment results

SRS conducted fish sampling at Tranmer Bar on July 16-17, 2008 at a discharge rate of approximately 4,500 m^3/s (high flow) and on August 21, 2008 at a discharge of 3,500 m^3/s (low flow). Five beach seines were conducted in both the proposed extraction site and at a downstream reference site (Figure 9). Extraction site samples were collected on the closest exposed bar to the proposed extraction site. Both sites were flat bar edge. A 12.5m by 1.8m seine net with a 6.3 mm stretch mesh was used.

The majority of fish species captured at Tranmer Bar were from three families: salmonidae (salmon, trout, and char), cyprinidae (minnows), and catostomidae (suckers). The species composition was comparable between high and low flow samples.

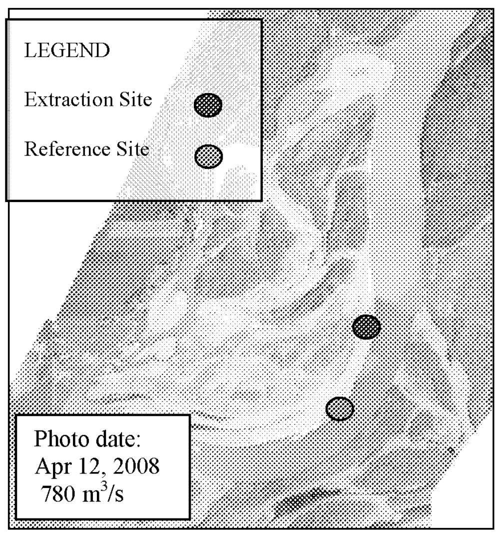

Figure 9. Fish sampling locations at Tranmer Bar. Photograph taken at low spring flows and shows more exposed bar than was present on the sampling dates.

The CPUE of the three most common families at the proposed extraction site and reference site is in (Figure 10). Cyprinidae were the most numerous group captured, the most common species being leopard dace (*Rhinichthys falcatus*), longnose dace (*Rhinichthys cataractae*), and northern pikeminnow (*Ptychocheilus oregonius*). The majority of salmonids captured were either chinook (*Oncorhynchus tshawytscha*) or coho (*Oncorhynchus kisutch*). Trace numbers of sockeye (*Oncorhynchus nerka*) and rainbow trout (*Oncorhynchus mykiss*) were also sampled. The blue listed mountain sucker (*Catostomus platyrhynchus*) was the most common sucker species encountered.

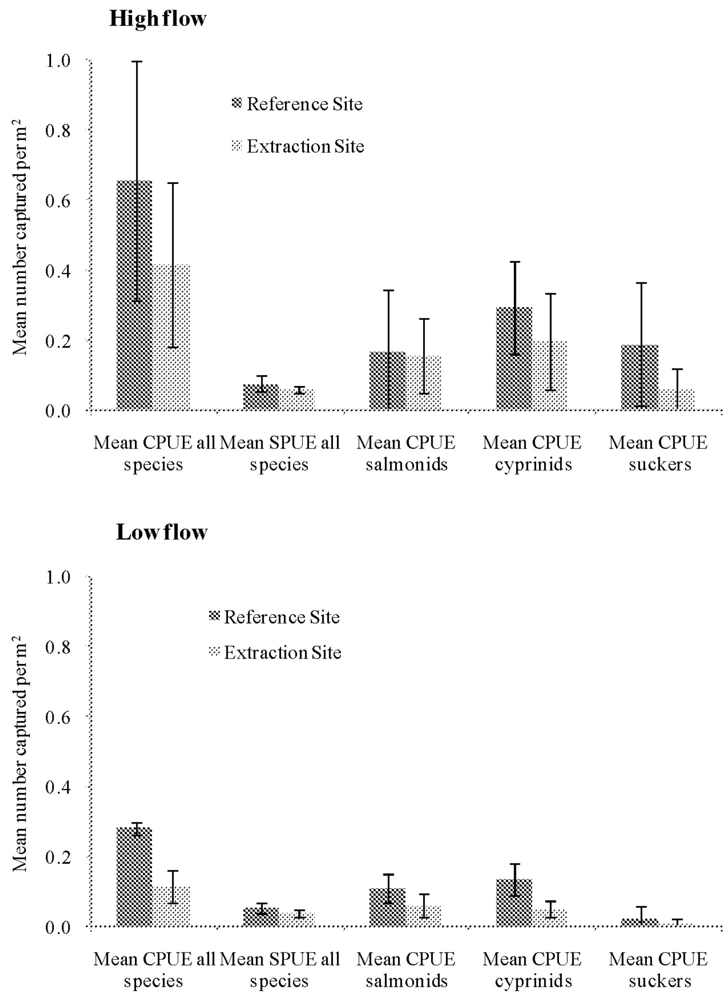

Figure 10. Mean CPUE and SPUE of all fish species sampled at the proposed extraction site and reference site at Tranmer Bar on July 16 and 17, 2008. The CPUE of three major families of fishes are also shown. All values are +/- one standard deviation.

The CPUE for each species is shown below (Figure 11). Mountain suckers and leopard dace captured during high flow at the reference site were observed to be in spawning condition (i.e. red lips and fin axils). Overall, the CPUE was higher at the high flow sampling session, due to increased numbers of mountain sucker, leopard dace, longnose dace, and coho. The significant difference in overall CPUE (all species combined) between the extraction site and the reference site at low flow was largely due to an increased number of leopard dace, other groups were comparable between the two locations.

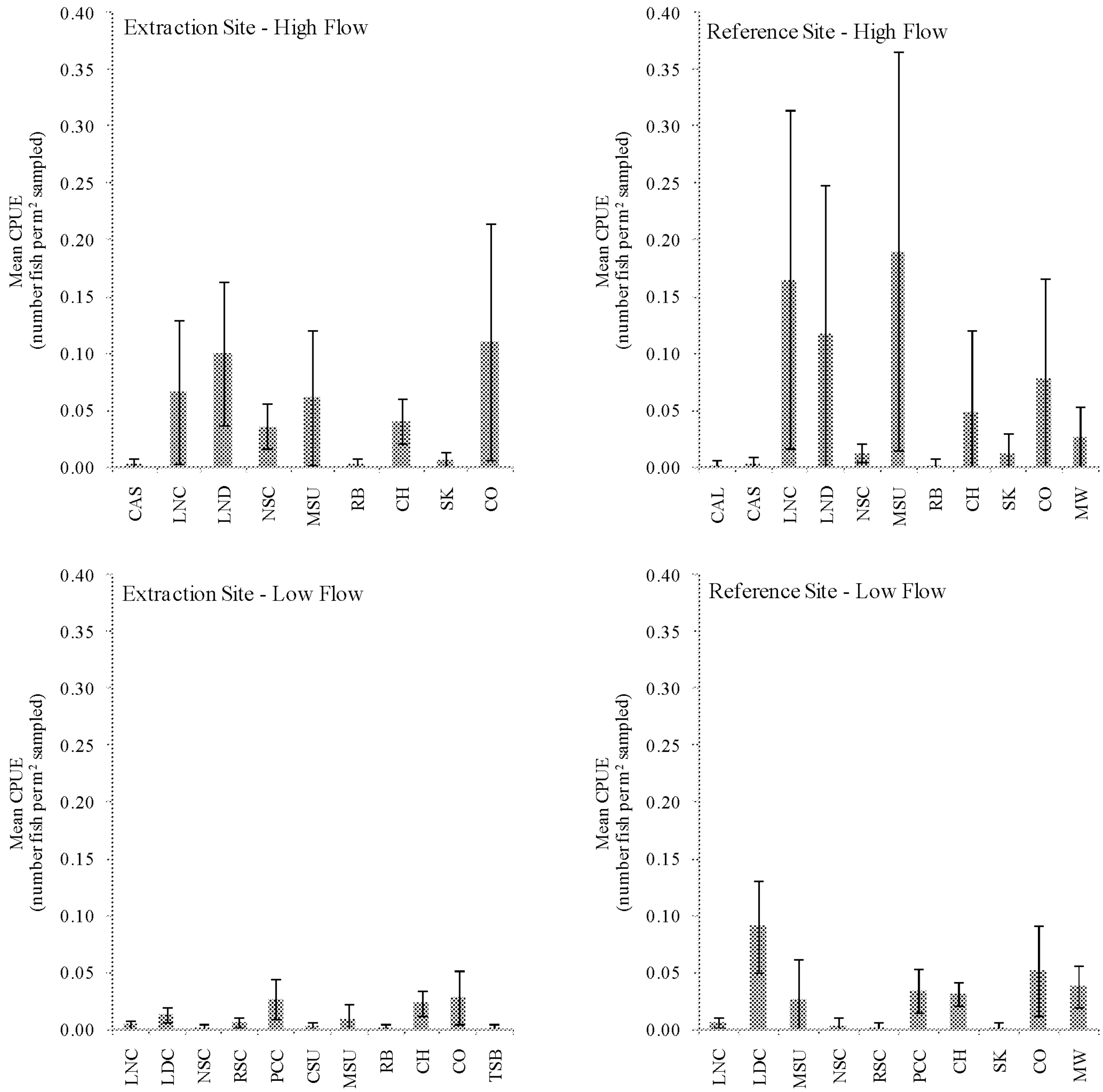

Figure 11. Mean CPUE for each species sampled at Tranmer Bar at high (4,500 m^3/s) and low (3,500 m^3/s) discharge levels.
CAL = coastrange sculpin. CAS = prickly sculpin. LNC = longnose dace. LND = leopard dace. NSC = northern pikeminnow. PCC = peamouth chub. RSC = redside shiner. MSU = mountain sucker. RB = rainbow trout. CH = chinook. SK = sockeye. CO = coho. MW = mountain whitefish. TSB = threespine stickleback.

3.4.1 Spawning salmon habitat assessment

During site visits in December 2007, salmon redds were observed along the waterline downstream of the proposed extraction area at Tranmer Bar. Flat bar edges such as that found at Tranmer Bar can be utilized by spawning salmon, especially pink salmon (*Oncorhynchus gorbuscha*). The odd-year run in the Fraser River includes nearly 20 million adults whereas the even-year run is virtually nonexistent (Beacham *et al*., 1994, cited in BCCDC 2008).

In October 2008, no redds were observed along the waterline adjacent to or downstream of the proposed extraction area. Even years are off peak cycle years for the Fraser River pink salmon run. Although, no redds were identified during October 2008, both chum salmon *(Oncorhynchus keta)* and chinook salmon were observed to be rolling or "porpoising" in deeper water of the mainstem.

The fisheries values at Spaeti's Bar were previously assessed (KWL, 2001). This assessment included a description of available habitat at different flow levels through the year. In the fall months of odd numbered years, high densities of pink salmon redds were observed along the outer bar edge at Spaeti's Bar (KWL, 2001). Since the gravel extraction and access route construction is proposed for 2009 (an off year for pink spawning), pink salmon spawning in the vicinity of the crossing and access route will be nil to very low.

3.4.2 White Sturgeon habitat assessment

A literature review was conducted by SRS, in order to gather information on sturgeon spawning, rearing, and other key life history phases. The results of this literature are outlined in Sections 3.4.2.1 to 3.4.2.4

SRS has not found specific studies of white sturgeon utilization within the Tranmer Bar complex or within its side-channel. Potential sturgeon use, through various life stages, is inferred from the various studies cited below.

3.4.2.1 Sturgeon spawning and egg development

White sturgeon are broadcast spawners. Spawning areas have generally been characterized by high water velocity, solid substrate, and moderate depth (Anders *et al.*, 2002; Parsley *et al.*, 2002). High velocity flows presumably attract mature spawners, sufficient depth is required for active staging and spawning activity, but turbulent upwelling may also be a critical factor, facilitating gamete dispersal (Coutant, 2004).

The eggs are deposited with a sticky coating, which develops within approximately five minutes and remains throughout incubation (Conte *et al.*, 1988). Coutant (2004) suggested that white sturgeon eggs may drift 1-5 km from the spawning site, eventually adhering to the substrate (submerged cobbles, riparian vegetation, etc). The proximity of a spawning site to an egg deposition site would therefore depend both on flow rates and the presence of submerged vegetation or rocky substrate, which gives the eggs a surface on which to adhere.

The following is a list of characteristics considered suitable for egg deposition, based on when and where eggs (both fertilized and unfertilized) have been located. Some characteristics of spawning habitat have been inferred from the conditions at egg deposition sites, assuming that the eggs do not drift far from the spawning site.

- Timing of spawning ranges from mid-June to mid-August (Perrin *et al.*, 2003; Coutant, 2004), when mainstem flows were at peak freshet or on a declining hydrograph (measured at Hope ranging from 11,000 m^3/s to 3,500 m^3/s). The discharge rate during the spawning period may vary greatly from year to year.

- Temperatures averaging 14.5 °C (Perrin *et al.,* 2003).

- Water depths averaging 3.4 m (Perrin *et al.,* 2003).

- Perrin *et al.* (2000) identified fast, laminar run types and large eddies as being important hydrologic characteristics for spawning habitat. Near-bed water velocities with moderate, nonturbulent flows averaging 1.7 m/s characterized egg deposition sites in the wandering reach (Laidlaw to Chilliwack) of the Fraser River (Perrin *et al.*, 2003). Sturgeon in other river systems spawn in fast turbulent flows (ex. Parsley *et al.*, 1993), and zones of hydraulic complexity were found to contain eggs in a confined section of the Fraser River (Perrin *et al.,* 2003).

- Substrates composed mostly of gravel, with some cobble and sand. Boulders were uncommon in spawning sites (Perrin *et al.*, 2003). Substrate type appears to be less important for spawning site selection than are depth and velocity (Perrin *et al*., 2003).

Coutant (2004), hypothesized that floodable riparian vegetation or rocky substrate is a key factor in successful egg development as it not only provides a surface for the eggs to adhere, but also a food-rich habitat for larval growth.

Perrin *et al.* (2003) set simultaneous traps in the wandering reach of the Fraser River at the inlets to the side channels and in the main stem of the river but no eggs were found in the main stem, indicating that the source of the eggs was within the side channels. Major side channels appear to provide critical spawning habitat. Tranmer Bar was not identified as an important spawning location. The nearest white sturgeon spawning habitat found by Perrin *et al.* (2003) was across the river at the Lower Herrling Island side channel.

3.4.2.2 Sturgeon larvae

White sturgeon larvae hatch after approximately 5-10 days of embryonic development depending on temperature (Wang *et al*., 1985 cited in Coutant, 2004; Conte *et al.,* 1988). White sturgeon larvae were sampled in the Fraser River by Perrin *et al.* (2003) in the Chilliwack side channel, Minto side channel, Herrling side channel, Jesperson side channel, Peters side channel, and in the main channel at the confluence with the Coquihalla River. Despite sampling in the main channel, only side channels in the wandering reach (between Laidlaw and Chilliwack) were found to contain sturgeon larvae.

Larvae were found in habitat with slower flow and a wider range of substrate types and depths when compared to developing eggs. Characteristics of habitat that can be considered suitable for larval development within the wandering reach of the lower Fraser River include:

- Water temperature from 13-15°C (Perrin *et al.*, 2003).
- Velocities between 0.5-1.5 m/s (average 1.0 m/s) (Perrin *et al.*, 2003).
- Depths of 0.5-6.5 m (average 2.7 m) (Perrin *et al.*, 2003).
- Substrate type ranging from mostly sand to mostly gravel with a subcomponent of cobble and sand (Perrin *et al.*, 2003). Bennett *et al.* (2007) determined form laboratory studies that sturgeon larvae prefer a substrate size of pea gravel to 0.75 mm gravel, however these substrate types may or may not be locally available.

In general, both eggs and larvae in the wandering reach were found in habitat characterized by moderate velocity and nonturbulent flow (Perrin *et al.*, 2003).

Coutant (2004) indicated that floodable riparian vegetation is a key factor in successful development as it provides both a surface for the eggs to adhere and a food-rich habitat for larval growth.

3.4.2.3 Sturgeon juveniles

White sturgeon larvae metamorphose into juveniles approximately three to four months after fertilization (Parsley *et al*., 2002). Bennet *et. al.* (2005) completed a study from 1985 to 1993 aimed at identifying and characterizing juvenile white sturgeon habitat in the lower Fraser River. Juveniles were caught almost exclusively between June and August, typically in sloughs with depths greater than 5 m and multidirectional current. The largest number of juvenile sturgeon were captured in Nicomen Slough, Lower Hatzic Slough, and Big Eddy Backwater. The majority of juveniles were located downstream of the confluence with the Harrison River, with the highest catch-per-unit-effort downstream of the gravel reach. Turbidity was variable, and substrate of most sites was fine sands, silt and clay. Similar results were found by gill netting between April and November in the lower Fraser River by Lane and Rosenau (1993).

LGL Limited (Glova *et al.,* 2008) completed a study of juvenile sturgeon in a range of habitats from Deas Island to the confluence of the Sumas River (downstream of the Fraser River gravel reach) with the majority of sample effort between September 2007 and November 2007. Very low catch rates were observed at low water temperatures (less than 7°C). Characteristics of habitat with highest catch rates were slow flowing areas less than 5 m deep with fine substrates. Habitat included side channels, side pools, backwaters and some near shore main channel areas. Sample effort was minimal upstream of river km (rkm) 100 (measured from the river's mouth) due to a lack of suitable habitat available for tangle netting.

3.4.2.4 Sturgeon adults

The Fraser River Sturgeon Society's radio-tagging program detected three white sturgeon between rkm 126 and 129, which covers the vicinity of the proposed extraction. Three pre-spawning males and one "early development" female were detected (Perrin *et. al.* 1998 and 1999). Adult sturgeon are caught by sports fishermen in the main channel in the vicinity of the extraction area.

3.5 Topographic-Bathymetric Surveys, extraction plans and access location designs

Tunbridge & Tunbridge completed a comprehensive survey of Tranmer Bar on October 27, 2008. A copy of this survey is included within the application to DFO.

There were no extraction plans or crossing location designs available at the time of the on-site pre-extraction assessments. Therefore SRS has not yet completed field inspections of the proposed crossing location and access route to the extraction site.

Additional assessment will be required, which can be completed during a site visit currently scheduled for late November.

In the absence of field investigations and ground inspections of the bridge crossing and access route, a preliminary effects assessment of the bridge crossing and access route has been provided in Section 4.5. The preliminary effects assessment is based on site survey drawings, bridge design drawings, past site visits and information provided in previous reports.

4.0 DISCUSSION/CONCLUSIONS/EFFECTS

4.1 Habitat mapping

The proposed extraction is a combination of bar top and bar edge scalping. The extraction is designed to capture additional flow into an existing side channel and directs it across the sandy bar complex towards the main channel meander, as detailed in the extraction design and geomorphic assessment sections (Attachments 3 and 7) of the Application.

The additional flow through the side channel directed to the bay may result in some scour and reconfiguration to the sand deposits of the bars. Hydrological modeling is required to reasonably predict potential changes to the downstream habitat. The extraction design will include features designed to provide additional habitat complexity to benefit rearing juvenile fish during elevated summer flow levels. These features will consist of constructed nooks along the north and south edges of the extraction, and grading to provide positive drainage to the existing stand pools within the upper extraction area and a stepped invert.

As was described in the NHC geomorphic assessment, the proposed extraction area is expected to fill in with gravel, although in the absence of a major flood event this may take a decade or longer (Application, Attachment 7). As such, the stability and long term availability of the expected habitat post extraction will be dependent on the magnitude of peak flows of subsequent freshets (Vic Galay, *pers. comm.*).

4.2 Surface sediment sampling

The proposed extraction is designed to capture additional flow into an existing side channel and direct it through a sandy bar within the core area of lower Tranmer Bar (Application, Attachment 7).

The increased flows are expected to increase the mean particle size within areas that currently consist of bar tops, as well as potentially increasing degradation of areas which are currently predominantly sand. An overall increase in mean sediment size over the extraction area and immediately downstream may occur. However, within the constructed nook habitat and on the lee side of retained bar tops, low flow velocities may cause fine sediment deposition similar in size to pre-extraction. The upstream entrance to the extraction area on the main channel edge may also remain unchanged, as the flow regime along the main channel edge is anticipated to remain similar to the pre-extraction condition and the pre-existing sediment size is generally larger than is found in the core of the bar.

As was described in the NHC geomorphic assessment, the proposed extraction area is expected to fill in with gravel, although in the absence of a major flood event this may take a decade or longer (Application, Attachment 7).

4.3 Benthic invertebrates

The extraction will be completed in the dry. Colonization of the extraction area and other dry channel features within lower Tranmer Bar complex will occur with the next freshet. Rempel (2005) found no statistical difference between benthic invertebrate numbers or species assemblages pre- and post extraction at Little Big Bar, Harrison Bar, and Seabird Island in 2004. The high degree of natural variability in invertebrate populations meant that any changes due to gravel extractions would need to be very large in order to fall outside the observed range at the reference sites (Rempel, 2005).

As the surface elevation of the bar top will be lowered, and would thus be inundated for longer periods of the freshet this area may provide habitat for aquatic benthic invertebrates later into the summer than it does currently.

However, in addition to a longer period of inundation, changes in bar deposition and erosion patterns will likely result from alterations to the hydrology of the bar. The amount of fine vs. coarse sediment available may affect invertebrate species assemblages. Burrowing organisms such as chironomids (larval flies) are more abundant in fine sediment, while mayflies, caddisflies and stoneflies are more common in larger substrate with more oxygenated flows (White *et al.*, 1998). The extent of changes in sediment is dependent on peak flow rates in subsequent freshets, and the volume and size of transported sediment which settles out across the bar surface.

4.4 Fish sampling and fish habitat assessment effects

At moderate flow, the extensive bar edge habitat available due to the complex network of side channels provided suitable rearing habitat for multiple species of fish, including salmonids.

Mountain suckers and leopard dace sampled on the outer bar edge were observed to have spawning characteristics, and may have been spawning within the Tranmer Bar complex or staging while en route to smaller streams. Mountain suckers spawn in riffles of streams adjacent to pools during late spring and early summer when waters are between 10.5-18.8°C (Wydoski and Whitney 1979). Leopard dace spawn in July and August, also in riffles (BCCDC 2008).

The extraction is designed to capture additional flow into an existing side channel and direct it across the sandy bar complex towards the main channel meander, as detailed in the extraction design and geomorphic assessment sections (Attachments 3 and 7) of the Application. The extraction will result in a reduced area of shallow riffle and bar top habitat available to rearing fish during high flows. The additional flow through the side channel directed across the bar complex is expected to result in some scour and reconfiguration to the sand deposits of the bars. Hydrological modeling may be required to reasonably predict changes to the downstream habitat, and the resulting effects on juvenile fish.

Based on 227 sets at various flat bar edge locations in the gravel reach, Church *et. al.* (2000) found a CPUE of 0.10 ± 0.01 for all fish species combined and a CPUE of 0.03 ± 0.005 for salmonids. If these values are considered average for the reach, then catch data from Tranmer Bar may be considered higher than average, especially for cyprinids. In general, Church *et. al.*

(2000) found flat bar edges to be common in all channel types in the gravel reach, and to support a relatively low abundance and diversity of fish when compared to other habitat types (i.e. open nooks and bays).

The extraction design was modified by SRS to include features designed to provide additional habitat complexity to benefit rearing juvenile fish during elevated summer flow levels. These features include constructed open nooks along the edges of the extraction boundaries, positive drainage to the existing natural stand pools within the upper extraction area, and a stepped profile to the extraction area. Based on the findings of Church *et al.* (2000), open nooks will provide valuable rearing habitat along the steep bar edges of the extraction site.

The extraction will tie in to the existing strand pools and be graded to provide positive drainage, reducing the potential for fish mortality in these pools when they dry up in winter low flows.

4.4.1 Spawning salmon -effects assessment

There will be few if any pink salmon redds at Tranmer Bar in the 2009 work window. Other salmon species may still spawn at the bar edge, most notably chum (*Oncorhynchus keta*). The edge of Spaeti's Bar, where the bridge will be installed, may also have been spawned during fall 2008.

The timing of the proposed extraction for 2009 is intended to minimize potential disturbance from extraction activities on developing fish eggs, as the Fraser River water level will be in the annual low flow period at that time. This will maximize the distance of the planned extraction from flowing water. To minimize mortalities of developing fish, the extraction boundary will be set back sufficiently from the waters edge so that no viable redds will be expected within the perimeter.

Data on salmon redd depths is variable but a comprehensive review was published by DeVries (1997). After reviewing multiple data sources from several river systems he devised the following summary of depths at which salmon redds are likely to be found (Table 1).

Table 1. Egg burial depths of Pacific salmon species present in the Fraser River. An egg pocket is defined as a cluster of five or more eggs. Table adapted from DeVries (1997).

	Depth (cm) below original stream bed level	
Species	Top of pocket	Bottom of pocket
Chinook salmon	15	50
Chum salmon	15	35
Coho salmon	15	35
Pink salmon	15	35
Sockeye salmon	10	25

Individual eggs may be scattered outside the main pocket, and alevins may migrate within the substrate prior to emergence. A site inspection following the spawning period will be necessary to determine if redds are present, and to what extent. The spawned area would be delineated on-site, and the extraction boundary adjusted accordingly. A site visit is scheduled for mid-November to collect benthic invertebrate samples; an inspection for redds can be completed at this time.

4.4.2 White Sturgeon - Effects Assessment

The proposed extraction at Tranmer Bar is at approximately rkm 126 to 129. Adult and juvenile sturgeon are known to utilize this section of the Fraser River, and some level of habitat use within the area of influence of the proposed extraction at Tranmer Bar should be expected. Since the gravel extraction will take place in winter in the dry, direct disturbance to sturgeon at any life stage during the works is not expected.

Sturgeon eggs do not adhere to the substrate immediately after spawning, but are carried downstream for up to 5 km (Coutant, 2004). This 5 km distance is greater than the total length of the Tranmer Bar side channel. Therefore, if sturgeon spawn in the upstream section of Tranmer Bar, the eggs may be carried downstream into the extraction area.

The geomorphic assessment of the extraction, prepared by NHC (Application, Attachment 7), states that the proposed extraction is designed to promote increased flows across the bar surface. This would occur during times of moderate to high discharge. The flows would be directed through what is, at Fraser River discharges greater than approximately 3,000 m^3/s, a relatively complex deposition area that may have importance to egg deposition, hatching, larval development, and some potential for juvenile rearing. An increase in discharge and/or change in flow patterns would potentially affect the location of egg deposition. The water velocity was not sampled to compare to the mean velocities recorded by Perrin *et al.* (2003) at egg and larvae sampling sites (1.7 m^3/s for eggs, 1.0 m^3/s for larvae).

Increasing flow through the bar complex may result in an increase in eddy pools and complex flow velocities, and a decrease in shallow bay habitat. Hydraulic modeling is required to predict the downstream effects of the redirected flows resulting from the extraction. There may be some level of effect to egg deposition and larval development areas. Rearing for juvenile sturgeon may be affected by the increased flow through the core of the bar complex, however the extent of this is unclear at this time.

Conditions at Tranmer Bar during the white sturgeon spawning and rearing period (late spring through summer) are variable due to its complex topography. The deposition pattern within the inside bend of the main channel meander south of the bar has resulted in a relatively complex deposition area with channel nooks, bays and crescent shaped bar tops with emergent willow vegetation. This area is partially submerged with water depths ranging from exposed bar edge to approximately 3 m deep at the start of the spawning season in a typical year (Figure 1), with increasing exposure as water recedes during the summer (Figure 2).

Main channel habitat along the bar edge, where the majority of the gravel volume is proposed to be removed, does not appear to fit the habitat characteristics suitable for active spawning. The sediment of much of the core of the lower island is sand, indicating low flow velocities which allow fine sediment to settle out of the water column. However, the complex flow pattern, low velocities, and submerged vegetation may be suitable for eggs to adhere and develop, providing spawning occurs within the side channel. The Tranmer Bar side channel may provide suitable spawning habitat locations due to increased depths and velocities and locations with observed upwelling and turbulent flows. Side channels are identified as preferred spawning habitat (Perrin *et al.*, 2003).

An observed site with potential spawning suitability, based on the descriptions provided above, was observed during field assessments by SRS (Figure 12). Sampling for eggs and larvae would be required to confirm their presence at Tranmer Bar.

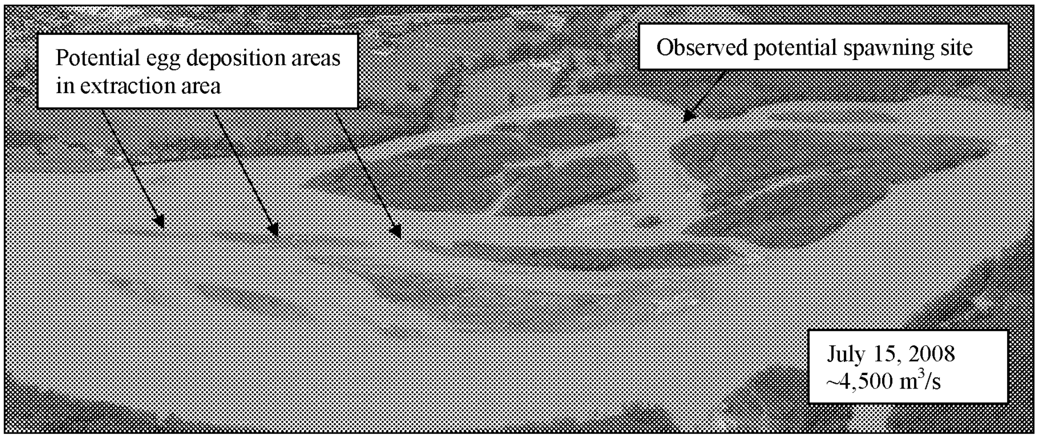

Figure 12. Possible white sturgeon spawning site and egg deposition areas adjacent to the extraction areas at Tranmer Bar. Sampling has not been conducted to confirm the presence of eggs or spawning adults.

At lower Tranmer Bar, the crescent shaped bars with emergent vegetation, a range of adjacent depths and sand to small gravel substrate may provide a development area for white sturgeon larvae.

The habitat conditions suitable for juvenile rearing seen in downstream reaches are similar at the lower section of Tranmer bar and some locations within the side channel. The bay habitat would have very low water velocities, fine substrate and depths to approximately 3 m during the spring freshet. Maria Slough enters the side channel upstream of the area of the proposed extraction, and may provide summer rearing habitat. Sampling for juveniles would be required to confirm their presence or abundance at Tranmer Bar.

Adult sturgeon distribution should not be adversely affected by the extraction. Shallow bar top habitat is not a preferred habitat for adult sturgeon (MOE 2008). By increasing the depth of the cross bar channel, additional habitat suitable for adults may be created, however this would be temporary. The NHC geomorphic assessment predicts that sediment recruitment will continue to aggrade this section of the bar (Application, Attachment 7).

4.5 Preliminary assessment of fisheries values and potential impacts at the bridge and access route location

In the interim period until additional ground investigations of the bridge crossing and access route are undertaken (late November 2008) and final bridge designs are prepared, a preliminary effects assessment for the access to the gravel extraction site is presented. The preliminary effects assessment is based on site survey drawings, bridge design drawings, past site visits and information provided in previous reports.

Access to the extraction site will require construction of a temporary bridge across the side channel between Tranmer Bar and Spaeti's Bar, located on the right (north) bank of the river. The crossing location is shown on the NHC excavation design (Attachment 3 of the Application entitled *Fraser River Gravel Removal Plan Proposed Tranmer Bar Extraction – 2009).*

The bridge and causeway design are being prepared by Associated Engineering Ltd. and preliminary designs are included in Attachment 4 of the Application.

At the time of writing this assessment, two potential bridge locations were in consideration. Both options incorporate a bridge span supported on two rows of mid channel pilings. Both options have been designed to accommodate winter flow volumes. The bridges have been designed by Associated Engineering to withstand a 10 year flow event without restricting downstream flow.

Since it is not feasible to build a bridge that spans more than the typical winter low water level, both options would require construction of a temporary road to and from the bridge span. Portions of the road leading to and from the bridge would comprise an elevated causeway.

Based on the designs provided to SRS by Associated Engineering on November 12, 2008, the causeway will be approximately 18 m wide at the abutments. Precast concrete lock block abutments with rip rap armouring will be required, at the abutments. The elevated causeway will be approximately 54 m long on the east side, and 40 m long on the west side. Depending on water levels at the time of construction, portions of this causeway could be located within the wetted perimeter of the side channel. The sides of the causeway would have to be armoured with 250 kg class rip rap.

Spaeti's Bar is connected to the north bank of the river during low winter flows and has been the site of several previous gravel extractions. During winter months, when the proposed bridge would be installed, Spaeti's Bar is exposed with an open nook and associated eddy pool at the upstream end, and a deep bay at the downstream end.

Both habitat types provide important fish habitat. Eddy pools are known to have high species diversity, especially for young fish, and pools provide important habitat for larger species such as peamouth chub and suckers, including the blue listed mountain sucker. Cutthroat trout and mountain whitefish also may utilize this habitat. The outer bar edge, where the west abutments of the bridge would be installed, may provide salmon spawning habitat and potential rearing habitat for a number of fish species.

A portion of the gravel approaches of the causeway would be within an area where potentially viable redds could be present. The exact area of the bar which will be impacted by the causeway will be determined by an on-site field inspection once a engineered bridge design in plan view has been completed, and centerline staked in the field.

Installation of the pilings will result in noise and vibrations in the channel. Pile driving has the potential to disturb fish and eggs in gravel. The effects of pile driving can be mitigated by monitoring noise and overpressures with a hydrophone. If overpressures or noise exceed acceptable levels then mitigative measures (i.e. such as bubble curtains) will be deployed to mitigate that effect.

Dewatering of downstream habitat due to bridge and causeway is not expected, due to the professional bridge and causeway design and the backwatering effect from the mainstem of the Fraser River. Mitigation strategies to reduce turbidity and other fisheries impacts during construction will be incorporated into a Construction Impact Mitigation Plan which will be developed after bridge, access routes and ground inspections are completed by SRS in late November 2008.

The disturbance to fish habitat associated with bridge and access construction is considered a temporary disturbance given the commitment by EMBC to decommission the access structures at the end of the extraction period.

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Attachment 7

Geomorphic Assessment of Gravel Removal at Tranmer Bar

Prepared by

Northwest Hydraulic Consultants

Leaders in
water resource
technology

nhc

34940.4

November 17th, 2008

Emergency Management BC
2nd Floor 525 Fort Street
PO Box 9223 Stn Prov Govt
Victoria, BC V8W 9J1

Attention: **Ms. Ann Griffin**
Manager, Strategic Mitigation Programs
Ministry of Public Safety and Solicitor General

Dear Ms. Griffin:

Subject: **Fraser River Gravel Management**
Geomorphic Assessment of Gravel Removal
at Tranmer Bar

1 INTRODUCTION

Emergency Management BC (EMBC) retained Northwest Hydraulic Consultants (NHC) to complete hydraulic and geomorphic analyses for EMBC's 2008-2010 gravel management program. This work is being conducted under contract SGEMBC0915698005. This letter report summarizes background information on past sedimentation processes at the site and assesses future trends in channel stability and erosion/deposition patterns. A separate report is being prepared on the hydraulic effects of the proposed gravel removal operation at Tranmer Bar using a 2-dimensional numerical model. This hydraulic analysis will clarify velocity and flow pattern changes that will result from the excavation.

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2 PROPOSED EXCAVATION

The extent and layout of the proposed excavation is provided in a separate CAD drawing (Tranmer Bar 2009 Excavation Plan - Draft). The excavation volume and location plan was developed over the course of several meetings between EMBC, Scott Resource Services, NHC, members of the Gravel Management Committee and Fisheries & Oceans Canada.

The proposed excavation site is located at lower Tranmer Bar, on the north side of the main channel opposite the Mid Herrling Island (Figure 1). The excavation consists of two separate sites that connect a lower elevation chute channel. The upstream site covers an area of roughly 94,000 m^2 and will lower the elevation of the bar edge, promoting increased flow on to the bar surface. The downstream site covers an area of roughly 50,000 m^2 and connects to the chute channel. The orientation of the downstream excavation is designed to divert flows to the southwest towards the main channel and away from the flood dykes and bank protection along the right bank floodplain. The total proposed dredge volume is 186,000 m^3, with excavation depths ranging up to 2 m maximum and averaging 1.28 m.

The time frame for the excavation is between January 1 and March 15, 2009. It is expected that the site would be mostly dry within this window.

3 HISTORY OF PAST REMOVALS

There have been several smaller gravel removals on a portion of Tranmer Bar that fall within private land holdings. Weatherly and Church (1999) reported that 40,000 m^3/yr was excavated between 1993 and 1995 (a total of 120,000 m^3) while the landowner removed a small volume (estimated as 3000 m^3) for fill in 1997. An additional 10,000 m^3 was removed from Tranmer in 2001 following cessation of the moratorium (KWL, 2003). In 2004, there was a small removal (5000 m^3) near the right bank of Tranmer Bar that was supervised by DFO (BGC & KWL, 2006). No material is known to have been removed since 2006.

The proposed removal volume of 186,000 m^3 is larger than the recent removal volumes (133,000 m^3 total between 1993 and 2004) but is small relative to the sedimentation volume that has occurred at this site in recent decades (see Section 4.3) and is consistent with past recommended removal volumes (KWL, 2003).

4 GEOMORPHIC CHARACTERISTICS

4.1 MORPHOLOGIC CLASSIFICATION OF SITE

The proposed excavation site is situated within an unstable sedimentation zone that extends from Spring Bar downstream to the Agassiz-Rosedale Bridge (Figure 2). The site is presently characterized by a prominent lateral / point bar complex separated from the right bank floodplain by a minor secondary channel. The upper part of the bar supports a dense cover of mature vegetation (islands) separated by small chute channels, with the lower part of the bar supporting a comparatively sparse cover of young vegetation. New unit bars – identified as narrow, elongated crescent-shaped features along the southern bar margin provide evidence of recent sediment deposition and have formed a large point bar over time. This deposition has aligned the current against mid to lower Herrling Island, where it forms a long meander bend before turning westward, then is forced to take a sharp turn south where it encounters the hardened bank.

The bars are formed of dominantly gravel-sized sediments, with a surface D_{50} of 40 mm and a D_{90} (roughly the size of the largest stones transported) of 76 mm. The subsurface is considerably finer, with a D_{50} of 20 mm, while the D_{90} is near 69 mm (Church and Ham, 2004). Sand sized sediments (material <2 mm) comprise 20% of the bar deposits, while the mature islands on the upper bar are capped with a 1-3 m thick layer of upward fining fine sands to silts (the thickness is positively correlated with deposit age).

4.2 EVOLUTION OVER TIME

Although the right bank of the channel is currently protected by riprap and flood dykes, there have been a number of major changes within this section of channel since the early part of the 20th century. An assessment of planform evolution is presented in Figure 3 based on a set of georeferenced aerial photographs and orthophoto mosaics spanning an 80-year period from 1928 to 2008. The earliest photos reveal an established island on the east side of the channel (Herrling Island; 1928-A). Adjacent to the island, a sequence of smaller bars and islands (1928B, C) effectively formed a long diagonal riffle that forced the current towards the right bank (the site of contemporary Tranmer Bar). Although high water obscures full details of the actual extent of sedimentation (Q=5780 m^3/s at Hope gauge) there would not have been any bar deposits in this deep part of the channel. High water similarly obscures bar forms in the 1940 image (Q=4870 m^3/s) but there was likely growth of a new diagonal riffle (1940-A) that forced the channel south eroding a large island (1940-B) and expansion of the existing riffle at lower Herrling (1940-C) that directed the channel towards the right bank where there was up to 375 m of erosion (Ham, 2005; site 1940-D).

The extent of sedimentation is visible for the first time in the low-flow 1949 imagery (Q=730 m^3/s). There was extensive erosion at the head of Herrling Island (not shown) with this material creating extensive lateral and mid-channel bars at contemporary Tranmer Bar (1949-A). This sedimentation caused compensating erosion on mid-Herrling Island (1949-B) to maintain flow conveyance. This material was deposited on the large growing bar at lower Herrling, causing additional compensating erosion on the then unprotected right bank floodplain (1949-C). By 1962 (Q=2940 m^3/s, lateral bar accretion at upper Herrling Island (1962-A) aligned the current more directly towards the Tranmer bar complex, destroying several islands and enlarging the right bank secondary channel (1962-B). There was continued deposition at the downstream end of Tranmer Bar that caused further erosion at mid-Herrling (1962-C) and trimming of the convex bar downstream (1962-D) that created a less sinuous alignment.

The 1971 imagery reveals channel conditions at low water (Q=800 m^3/s). There appears to have been extensive additional deposition at Tranmer Bar that began to consolidate the deposit (1971-A). Emergent vegetation on the bar surfaces provides an indication that they were becoming increasingly stable. Deposition at the bar tail continued the pattern of compensating erosion at mid-Herrling (1971-B) that subsequently created a new mid-channel and lobate bar that reduced flow conveyance (1971-C) and directed flows towards the right bank. There was no further bank retreat, however, because of bank protection measures completed after the 1948 flood. Despite high water levels in 1983 (Q=5280 m^3/s) there was active sediment exchange at Tranmer Bar with erosion and development of islands and migration of minor channels (1983-A). The significant additional erosion at mid-Herrling (1983-B) was related to further extension of the point bar at lower Tranmer (not visible because of the high water). There was also extensive apparent erosion of bar sediments near lower Herrling (1983-C) though these features may be partly obscured by the flow.

The flow was also high in the 1991 imagery (Q=4340 m^3/s), so details of major changes to bar sedimentation are again limited. There was extensive growth of vegetation at Tranmer Bar (1991-A) indicating that the upper part of the bar complex was become increasingly stable. There was probable continued extension of the downstream point bar, however (higher elevation surfaces are just visible; 1991-B) because of the extensive erosion at mid and lower Herrling Island (1991-C). The full extent of sedimentation at lower Tranmer Bar is clear in the 1999 imagery (Q=700 m^3/s). There was further consolidation of bar deposits (1999-A) into a single bar complex, though a distinct secondary channel had formed along the right bank. There was only modest additional growth at lower Tranmer Bar (1999-B) that caused minor additional erosion of Herrling Island. Overall, the lack of significant changes and development of a regularly sinuous thalweg in the upper part of the river provides an indication that the supply of sediment to the reach was declining (Ham, 2005).

There were no significant changes to 2004, though the available photographic coverage is limited. There must have been continued extension of lower Tranmer Bar, however (though obscured by the higher discharge of 1530 m^3/s) since there was further compensating erosion at Herrling Island. This erosion had accelerated by 2008, where deposition of a large new unit bar caused an additional 120 metres of lateral retreat (2008-A). Since 1949, when Tranmer Bar was first established, there has been as much as a kilometre of bank erosion at Herrling Island, with an estimated 5 million m^3 of material removed and transported downstream (Ham, 2005). It is expected that the remaining thin strip (80 m) of island will be bisected within 1-2 years and could initiate significant downstream changes. There were no other significant changes to Tranmer Bar or within this section of channel except for a minor enlargement of the right bank secondary channel (Q=780 m^3/s; compare to 1999 imagery). Continued enlargement of this channel, and increased flow across the bar through the planned 2009 excavated channel, may slow the rate at which downstream changes progress, but is unlikely to stop them.

4.3 EROSION AND DEPOSITION HISTORY

Erosion and deposition volumes were determined by comparing changes in river bed surface elevations over time. Bathymetric surveys of the gravel reach have been completed in 1952, 1984, 1999, 2003 and 2008. However, the 1984 survey did not extend upstream past Agassiz-Rosedale Bridge, while the 2003 survey ended at mid Tranmer Bar. However, Lidar data collected the following year (2004) does extend over the area of the proposed dredge cut. The topographic and bathymetric data were combined to produce a three-dimensional model of the bar surface for each date of survey, and differenced to compute net volumetric changes. A recent topographic survey of Tranmer Bar was completed late in October, 2008 in support of the proposed removal and extends across the lower point bar where the dredge would be located. An estimate of recent sedimentation over the entire area of upper and lower Tranmer Bar is made by comparing bathymetric and Lidar data collected in 1999 to a combination of bathymetric data (2008), ground survey (2008) and Lidar (2004). As there have been only modest changes to bar morphology at upper Tranmer, it is reasonable to use the Lidar data as a surrogate of recent conditions.

The most recent sediment budget data (Ham, 2005) reveals that there was significant deposition (1.07 million m^3) of sand and gravel in this region of channel between 1999 and 2003. The sediment budget data does not extend upstream to the vegetated section of Tranmer Bar, but does include the lower section where most deposition is known (see discussion in Section 4.2). Since the calculations also include the material lost through erosion of mid to lower Herrling Island, the actual volume of deposition on Tranmer Bar must be larger than 1.07 million m^3. To compute net changes on upper and lower Tranmer Bar, interpolated grids were clipped to a boundary equivalent to the outer extent of the bars. Net changes on Tranmer Bar over the period 1999-2008 are summarized in Table 1.

Table 1: Volumetric channel changes, Tranmer Bar

Period	**Fill volume (m^3)**	**Scour volume (m^3)**	**Net change (m^3)**
1999-2008	2,973,065	89,790	+ 2,883,275

The extensive sedimentation of nearly 3 million m^3 at Tranmer Bar is consistent with the observation of continued lateral extension of the lower point bar in recent decades. The proposed removal volume (roughly 200,000 m^3) is very modest relative to the very large recent depositional volume. However, much of this material is deposited within the deep wetted channel as the bar has prograded downstream and would not be available for removal. The calculations were therefore repeated for the smaller area covered by the proposed excavation footprint only, and are summarized in Table 2.

Table 1: Volumetric channel changes, Tranmer Bar

Period	**Fill volume (m^3)**	**Scour volume (m^3)**	**Net change (m^3)**
1999-2003	169,829	1454	+ 168,375
2003-2008	2543	8275	-5732

There has been net deposition of 163,000 m^3 within the footprint of the proposed excavation since 1999, though no deposition since 2003. It is likely that a much larger volume has been deposited since 1984, but the available data are not sufficient to make this comparison. This modest volume relative to that deposited over the entire bar occurs because the river mainly aggrades laterally, with large floods required to stack gravel on the high bar top.

Based on the assessment of available data, Tranmer Bar has continued to deposit a significant volume of sediment over the past several decades. Persistent deposition along the outer margins of the point bar has resulted in extensive erosion along the right bank of mid and lower Herrling Island. It is expected that continued deposition at Tranmer Bar will bisect the island within the following 1-2 freshets, possibly initiating a partial avulsion.

4.4 EFFECTS OF 2009 EXCAVATION ON CHANNEL PROCESSES

The planned 2009 excavation will increase flow across the bar surface to rejoin the main channel, effectively increasing the gradient by reducing the flow path. The 2009 planned excavation is expected to fill in with gravel since the site has been a notable deposition zone in the past. It is expected that the excavation will take a decade or more to refill in the absence of a major flood event.

Although the excavated channel will connect to existing lower elevation chute channel and increase flows across the bar surface, it is unlikely to capture sufficient flow to cause a partial avulsion. The main channel is aligned at a steep angle relative to the dredge channel entrance and will not be impacted by the excavation. Nevertheless, increasing flows across the bar is apt to increase erosion at lower Herrling Island immediately across the downstream limit of the chute channel, but this poses no threat to any existing development or infrastructure. This may slightly decrease the rate of persistent erosion at lower and mid Herrling, but will not stop the river from breaking through the island.

* * * * *

If you have any questions, please give me a call in our Vancouver office at 604.980.6011.

Sincerely,

northwest hydraulic consultants

original signed by

Dr. Darren Ham, Ph.D.
Project Geoscientist

original signed by

Reviewed by: Dave McLean, Ph.D., P.Eng.
Principal

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DISCLAIMER

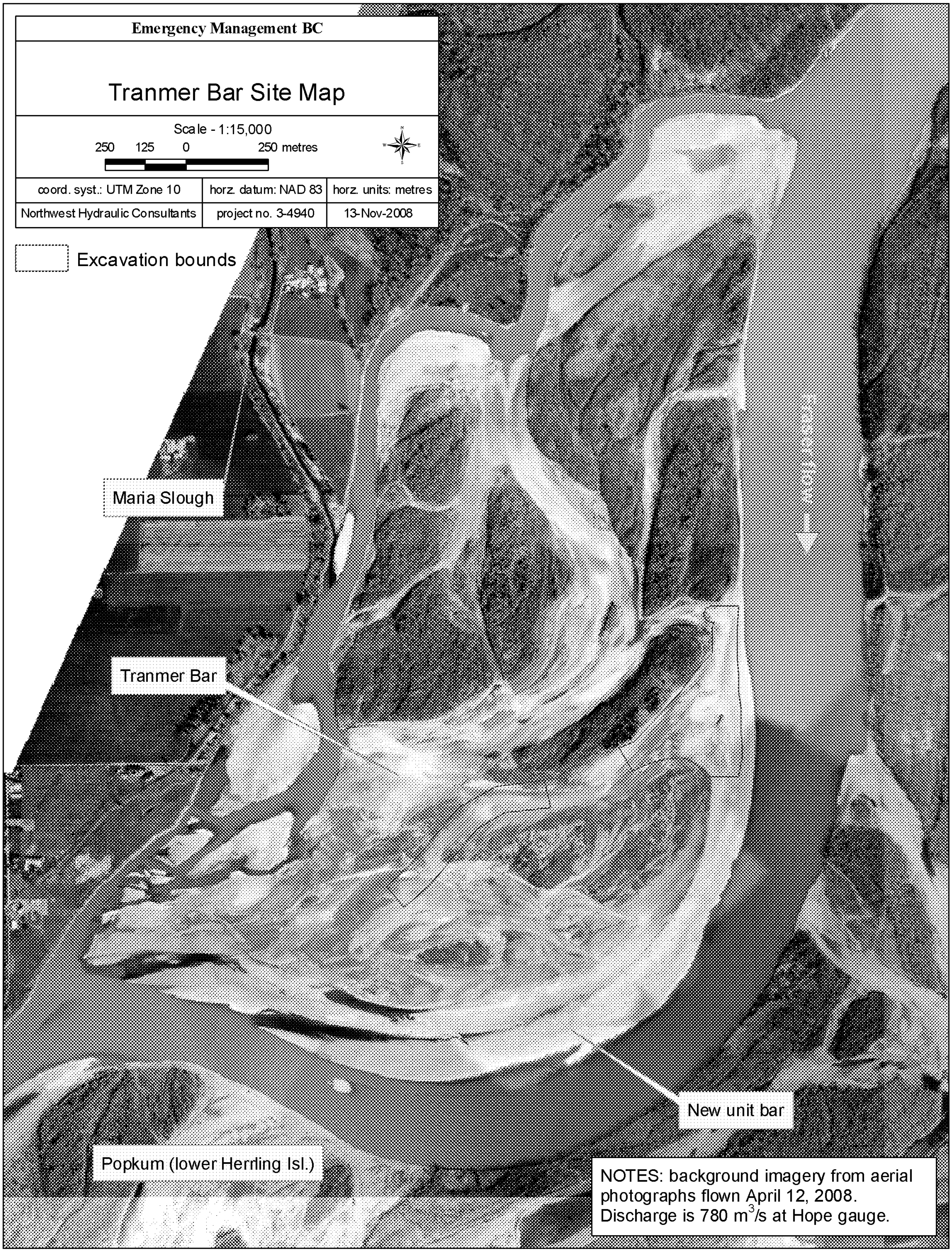

Figure 1

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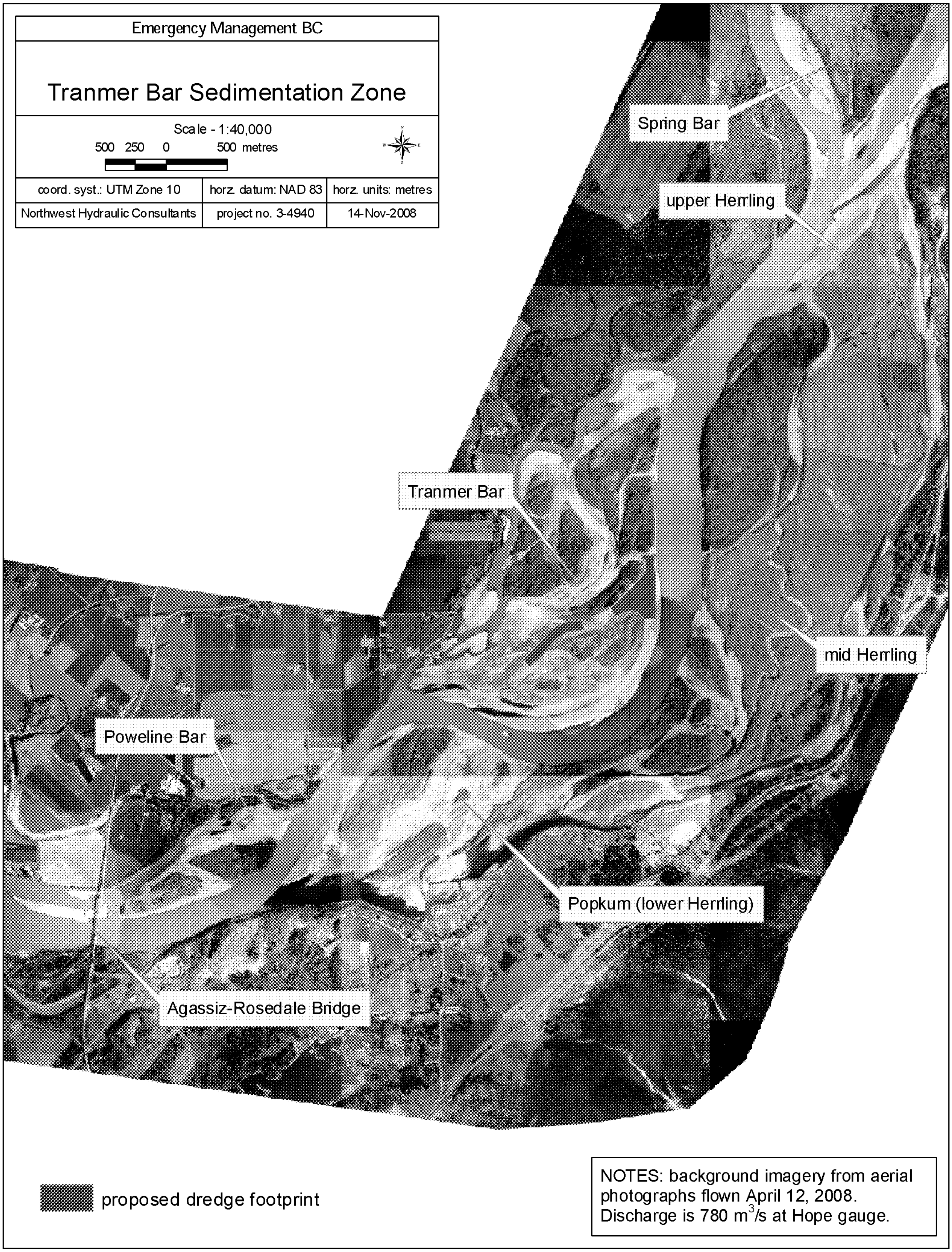

Figure 2

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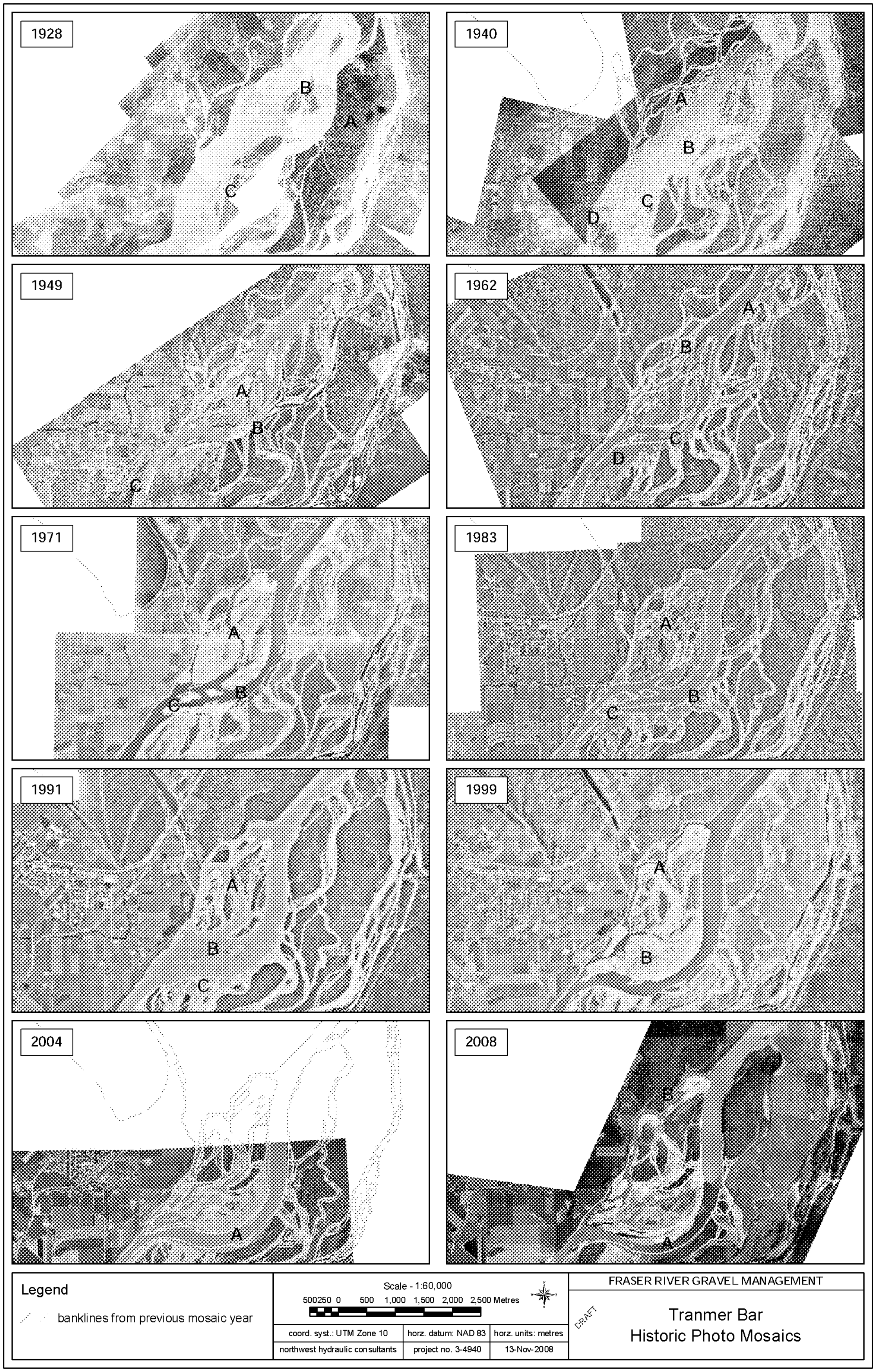

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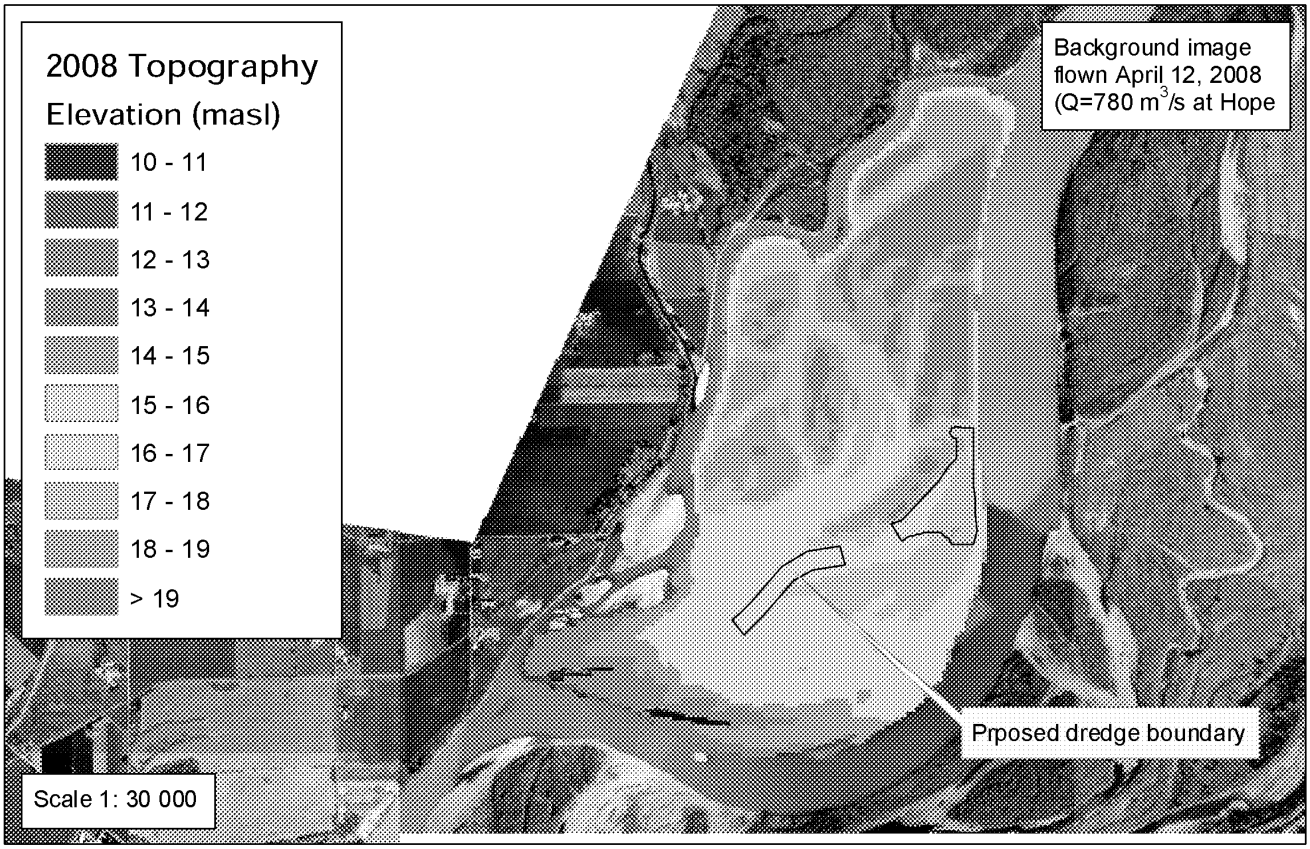

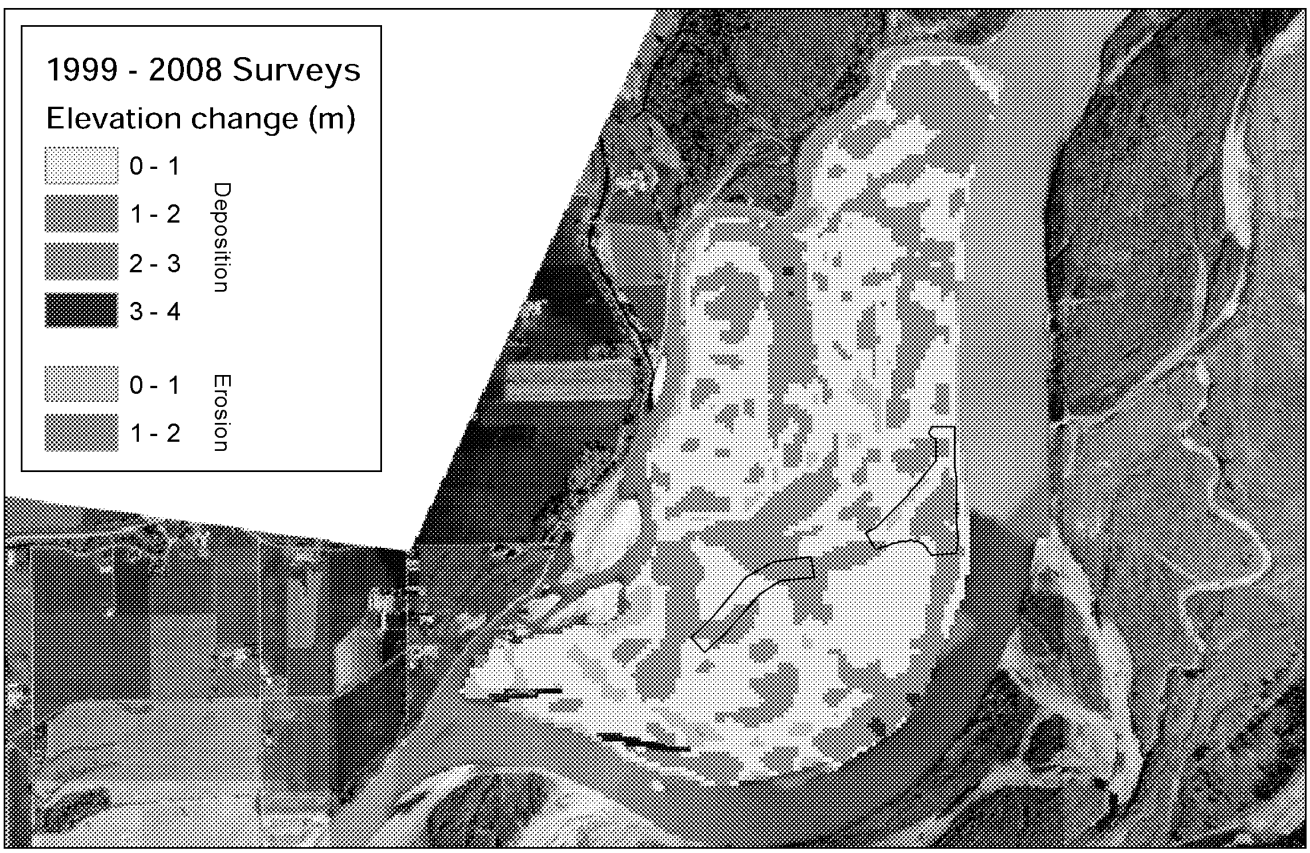

Figure 4

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