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June 30, 2011

Nunami Project No: 123510486

Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0

Attention: David Hohnstein, Director of Technical Services

Dear Mr. Hohnstein:

Reference: 8BW-REP---- Application for New Water License – Response to Request for Additional Information

On June 16, 2011, Nunami Stantec Ltd. (Nunami) received a request for additional information in regards to the new water license application, submitted on behalf of the Hamlet of Repulse Bay, for Construction and Operation of an Access Road and Borrow Sources. The request for additional information was submitted by Indian and Northern Affairs Canada (INAC) and requested the following:

- A stand alone project/site specific spill contingency plan;
- Flow estimates and drainage areas to explain culvert sizing;
- Information regarding culvert alignment and stream bed changes;
- Information regarding the four general drainage culverts; and,
- Details regarding progressive reclamation and timing of reclamation.

In response to the request for additional information, Nunami has prepared the following letter to provide the required details.

Spill Contingency Plan

A project/site-specific spill contingency plan was prepared and submitted along with the new water license application in April 2011. The project/site-specific spill contingency plan was included in Appendix D of Nunami's Environmental Screening document, which was posted on the Nunavut Water Board's Public Registry. An additional copy of the project/site-specific spill contingency plan is attached to this letter.

Culvert Sizing

FSC Architects and Engineers (FSC) completed the final design of the access road, including culvert sizing. Due to the lack of available terrain information for the Repulse Bay area (after FSC's field survey and from available mapping data), FSC was required to rely on past experience and judgment to size culverts in a way to exceed the probable

design flows over a reasonable rate of return for the roadway. Therefore culvert sizes (i.e., minimum of 800 mm) were set to a larger than 'normal' size (e.g., 500 mm) for similar installations and, as such, will assist with preventing upstream ponding and washouts and any required contingencies.

To note however, effects from any upstream ponding and frost melting are expected to be minimal. In the Canadian Arctic, the rainfall peak hydrograph has an extremely short period, typically not exceeding one day and in less than 10 hours. Any upstream ponding should not become an issue for this roadway as it would only be on the order of hours. Conversely, the snow melt hydrograph is typically lower in peak flows but continues for a much longer duration (several days). During this time however, the ground is still frozen and frost degradation should not be an issue.

Culvert failure can typically result from runoff of snow melt combined with ice and/or debris plugging the culvert and limiting flows. This type of failure can happen whether a culvert is properly size for the peak design flows or not. Regular culvert maintenance, as described in Section 3.1.2.2 of Nunami's Environmental Screening document, will help prevent the accumulation of debris and sediment and protect against culvert failure.

The initial explanation for culvert sizing was provided in a letter from FSC, dated February 10, 2011, and was included in Appendix B of Nunami's Environmental Screening document. This was reiterated in a letter from FSC, dated June 29, 2011. Both FSC's letters are attached here.

Culvert Alignment

Due to the topography of the Repulse Bay area, it was not possible in all cases to cross the streams at right angles with the road. However the design intent for this roadway is to set all culverts at the lowest flow channel, parallel to the flow direction, whether the road crosses the stream at a right angle or not. Installation of the culverts will follow the natural slope and course of the stream channel (stream alignment will not be altered) and excavation of the streambeds will be kept to a minimum.

General Drainage Culverts

The four general drainage culverts have been included within the road design by FSC to provide general cross-drainage along/under the roadway; they have not been sized for flow capacity but exist strictly to prevent water entrapment. The general drainage culverts will act to divert runoff to the low side of the road to prevent excessive runoff in ditches, reduce potential for erosion of the roadbed and subsequent maintenance issues. The general drainage culverts have been placed at specific locations based on topography, where ponding adjacent to the roadway is anticipated. They are either situated at the toe of a slope to receive and transport localized overland flow (with no defined channel) from the slope, or near the top of a steep gradient to intercept overland drainage and prevent accelerated ditch or roadbed erosion.

Reference: 8BW-REP---- Application for New Water License – Response to Request for Additional Information

Reclamation

In Section 3.2 of the Environmental Screening document, Nunami identifies that a mitigation measure to protect underlying permafrost will include "*establishing progressive reclamation of depleted sources (smaller pits) or depleted areas of larger borrow pits*". Here, progressive reclamation refers to reclaiming disturbed areas (borrow pits) as soon as excavation in a specific area is complete; this may include an entire borrow pit if it is small, or portions of larger borrow pits as they are depleted. Timing of this progressive reclamation will be site-specific and depend upon completion of excavation activities.

For this project, Deposit Nos. 1 and 3 will primarily be used for access road construction and will be reclaimed following completion of the access road (between 2011 and 2013). Deposit No. 2 will likely be developed by the Hamlet within the next five years and would be used for municipal projects. Reclamation of Deposit No. 2 would potentially begin within one year of pit operation and take place over the life of the deposit. All borrow pits will be reclaimed in accordance with the INAC's *Northern Land Use Guidelines: Pits and Quarries*.

Closure

We trust the information provided above is sufficient to address the additional information requested by the NWB and INAC. Should you have any further questions or comments, please do not hesitate to contact us.

Respectfully submitted,

Nunami Stantec

Reviewed by:

Original signed by:

Carey Sibbald, B.Sc., EPt
Environmental Biologist

Original signed by:

Nick Lawson, B.Sc.
Project Manager

CS/NL/

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SPILL CONTINGENCY PLAN FOR CONSTRUCTION AND OPERATION OF AN ACCESS ROAD AND BORROW SOURCES

Repulse Bay, NU

FINAL

Prepared for:

Community & Government Services
Government of Nunavut
P.O. Box 002
Rankin Inlet, NU X0C 0G0

Prepared by:

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Project No.:

123510486

March 2011

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ABBREVIATIONS

GN-CGS.....Government of Nunavut Department of Community and Government Services

Hamlet..... Hamlet of Repulse Bay

INAC ..... Indian and Northern Affairs Canada

SAO ..... Senior Administrative Officer

SCP..... Spill Contingency Plan

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1 INTRODUCTION

This Spill Contingency Plan (SCP) has been developed for use by the Government of Nunavut Department of Community and Government Services (GN-CGS) and the Hamlet of Repulse Bay (the Hamlet) during construction and operation of an access road to granular resources (Access Road) and development and operation of borrow sources in Repulse Bay, NU. The purpose of this SCP is to provide a guide to operators and other Hamlet personnel in the event of an accidental release of fuel or other waste during construction of the Access Road and/or development of borrow sources. The SCP can also be used during operations of the Access Road and borrow sources. The SCP was developed based on NWTWB (1987) and INAC (2007) and is planned to be protective of the local environment and public and personnel health and safety.

All persons involved with construction and operation activities along the Access Road route and borrow sources footprints should read and be familiar with this SCP. To be effective, it is important that all personnel are familiar with their responsibilities and steps to take in the event of a spill. Personnel should not be reading the SCP for the first time during an emergency.

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2 SITE DESCRIPTION

Figure 1 in **Appendix A** shows the routing of the access road and borrow source areas. The Access Road is 8.729 km in length and, as of January 2011, the first 4 km of the Access Road were constructed. Completion of the Access Road is anticipated by fall 2012. Six borrow sources have been identified for use by the Hamlet. Two borrow sources (Deposit nos. 1 and 3; see Figure 3 in **Appendix A**) will be developed and used for construction of the Access Road. The remaining borrow sources will be developed over time, as the Hamlet needs granular material for municipal projects.

Much of the Project area is covered by large bedrock outcrops and hills, interspersed by valleys and lowlands. Bedrock outcrops are unvegetated, except in depressions where soil has accumulated. Cobble, gravel and sandy substrates typically occur on the tops of small hills and on steeper slopes; these sites were dry with little to no standing water. Wet areas occur within valley bottoms, on flatlands and shallow slopes where standing and running water from snow melt and streams are present. These areas generally have greater soil development and cobbles and boulders were interspersed throughout the area.

Permafrost is continuous throughout the region and Project area, implying the area is underlain by 90 to 100% permafrost.). Very little site specific information related to permafrost conditions is available for the Repulse Bay area however depth to permafrost is estimated at 0.60 m (Collins 1991) or deeper (S. McCuaig, *pers.comm.)*, depending on the terrain and landform.

Six streams occur along the Project route and will be crossed by the Access Road. The tip of the tidal flat of Tariugaq Inlet is also crossed by the Access Road. Five small lakes are also present within the Project area and are located adjacent to the Access Road.

2.1 Potential Contaminants

Over the course of construction, the several contaminants may be used by equipment and crews working and travelling the Access Road route. These contaminants are listed below and may be involved in a spill:

- Gasoline
- Diesel
- Hydraulic oil
- Motor oil
- Lubricating oils and grease
- Antifreeze and other coolants

Contaminant spills may occur on land or in the water along the entire Project route. Spills may result from any of the following occurrences:

- Leaks or ruptures of fuel storage tanks
- Valve or line failure in systems, vehicles or heavy equipment
- Heat expansion due to overfilling or improper storage
- Improper storage of contaminants
- Vehicular accidents
- Spill during transfer of contaminant
- Vandalism

3 RESPONSE ORGANIZATION

A Qualified Professional with expertise in northern road building projects will be contracted to manage construction of the Access Road. This contractor has not yet been selected but will be responsible for initiating this SCP during Access Road construction, as well as the Hamlet's Senior Administrative Officer (SAO) and/or Hamlet Foreman. Development and operation of the Borrow Sources will be managed by the Hamlet of Repulse Bay.

Whenever a spill is identified, the Access Road contractor, Hamlet's SAO and/or Hamlet Foreman should be contacted as soon as possible. The Access Road contractor, SAO and Hamlet Foreman are responsible for initiating the SCP. Contact information for the SAO and Hamlet Foreman are in Table 3-1 below. The SCP should be updated with the contractor contact information once they are selected.

Table 3-1 Spill Contingency Contacts for Construction of the Access Road to Granular Resources, Repulse Bay, NU

Senior Administrative Officer	Hamlet Foreman
Steve Mapsalak Hamlet of Repulse Bay Office Phone: (867) 462 – 9952 Fax: (867) 462 – 4411 Email: saorepulse@qiniq.com	Hamlet of Repulse Bay Office Phone: (867) 462 - 9952 Fax: (867) 462 – 4411

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4 INITIAL ACTIONS

The following actions should be taken by the first person(s) who identifies a spill:

1. Be alert and considerate of your safety and of those around you. If possible, identify the spilled contaminant.
2. Assess the hazard to persons in the area of the spill.
3. If possible, without further assistance, control any danger to human life or the environment.
4. Assess whether the spill can be readily stopped or brought under control.
5. If safe to do so, and if possible, try to stop the spillage of contaminant.
6. Gather information about the status of the situation.
7. Report the spill immediately to the SAO and/or Hamlet Foreman who will report the spill to the 24-Hour Emergency Spill Report Line/
8. Resume any effective action to contain, clean up or stop the flow of spilled contaminant. See Section 6.1 for more information on spill response procedures.

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5 REPORTING PROCEDURE

All spills or potential spills of contaminants must be reported to the 24-hour Northwest Territories – Nunavut Emergency Spill Report Line to ensure that an investigation may be undertaken by the appropriate government authority. Reporting of any spills associated with construction of the Access Road or development of borrow sources should be completed by the hired contractor or SAO.

To report a spill:

1. Fill out the Nunavut Spill Report Form (found in **Appendix B** of this SCP) as completely as possible before calling in the spill report.
2. Contact the Government of Nunavut 24-hour Emergency Spill Report Line

   24-HOUR EMERGENCY SPILL REPORT LINE 867-920-8130
3. Where fax is available, fax the completed Nunavut Spill Report Form to **867-873-6924**. Alternatively, if email is available, email the completed Nunavut Spill Report Form to spills@gov.nt.ca

Any person reporting a spill is required to give as much information as possible, however reporting of a spill should not be delayed if all of the necessary information is not known. Additional information can be provided later. From the *Consolidation of Spill Contingency Planning and Reporting Regulations* (1998), as much of the following information should be reported during the initial spill report:

- Date and time of spill
- Location of spill
- Direction spill is moving
- Name and phone number of a contact person close to the location of the spill
- Type of contaminant spilled and quantity
- Cause of spill
- Whether spill is continuing or has stopped
- Description of existing contaminant
- Action taken to contain, recover, clean up, and dispose of spilled contaminant
- Name, address and phone number of person reporting the spill
- Name of owner or person in charge, management or control of contaminants at the time of the spill

In addition to reporting to the 24-hour Emergency Spill Report Line, an Indian and Northern Affairs (INAC) Water Resources Inspector must be notified of a spill immediately after occurrence. The INAC Water Resources Inspector should be contacted at (867) 975-4298. A copy of the completed Nunavut Spill Report Form should be forwarded to them.

6 ACTION PLANS

The most likely spill possibilities during construction and operation of the Access Road and Borrow Sources would be leakage or line failure from heavy equipment or other vehicles, spilling during fuel transfer, or vehicular accident. The likelihood of a major spill is negligible as no contaminants will be stored at construction sites along the Access Road route. All contaminants will be stored at a designated storage facility (e.g., Hamlet Garage, Naujaat Co-Op Fuel Centre). Further, a spill response kit will be kept at all construction sites.

The risk of spills will be further reduced through regular inspection and maintenance of all heavy equipment and vehicles associated with construction and operation activities along the Access Road and at Borrow Sources, as well as routine activities. These activities may include, but not be limited to:

- routine checks of fuel transfer hoses and equipment;
- inspection of fuel and oil lines on all equipment;
- completing on-site fuel transfer over spill pads and a minimum of 100 m from the high water mark of any waterbody;
- monitoring of tank volume during fuel transfer;
- cleaning up drips and minor spills immediately; and,
- ensuring quick repair of any identified deficiencies on heavy equipment or other vehicles.

6.1 Spill Response

The following steps outline the general spill response procedures for initial actions to be taken to contain and clean up a contaminant spill, as well as disposing of contaminated materials. Three procedures have been developed for handling contaminant spills, depending on where the spill has occurred (i.e., land, water or snow/ice).

6.1.1 Spills on Land

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, antifreeze, etc) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright

container), or contain the spill (e.g., place a container or tarp with built up edges under the spill source to contain the spill).

5. If the spill is too large to be controlled with the spill materials at hand, contact the SAO or Hamlet Foreman and report the spill immediately (see Section 3 for contact information).
6. If the spill is small enough to be controlled with the spill response materials at hand, prevent spilled contaminants from spreading or entering waterways by using sorbent (oil-absorbing) materials or a soil dyke down slope from the spill. This is especially the case with liquid contaminants (e.g., gasoline, diesel).

   If some contaminant has entered a waterway, follow procedures in the next section (***Spills in Water***) to contain and clean-up the contaminant in the water.
7. Once the spill has been controlled and further spreading prevented, contact the SAO or Hamlet Foreman and report the spill (see Section 3 for contact information). The SAO or Hamlet Foreman is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
8. If possible with spill response materials at hand, clean up the remaining spilled contaminant and store contaminated materials in a secure container for proper disposal. Do not flush the affected area with water.
9. If possible, remove any contained liquid by pumping into secure drums.

6.1.2 Spills in Water

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, antifreeze, etc) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container).
5. If the spill is too large to be controlled with the spill materials at hand, contact the SAO or Hamlet Foreman and report the spill immediately (see Section 3 for contact information).
6. If the spill is small enough to be controlled with the spill response materials at hand, use sorbent booms to contain the spill for recovery. Place sorbent sheets on the water within the boomed area to help contain the contaminant. For narrow waterways such as streams, place one or more sorbent booms across the waterway, downstream of the spill location, and anchor the booms on the each bank.

7. Once the spill has been controlled and further spreading prevented, contact the SAO or Hamlet Foreman and report the spill (see Section 3 for contact information). The SAO or Hamlet Foreman is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
8. If possible with the spill response materials at hand, clean up the remaining spilled contaminant within the boomed area. Store contaminated materials in a secure container for proper disposal.

6.1.3 Spills on Snow/Ice

1. Once a spill is identified, all sources of ignition should be turned off (e.g., no smoking, shut off engines).
2. The spilled material (e.g., gasoline, diesel, antifreeze, etc) should be identified, if possible.
3. The affected area should be secured, ensuring the area is safe for entry and does not represent a threat to human health and safety of the spill responders. Public access of the area should be restricted.
4. If possible, identify where the spill is coming from (the source). Determine if the spill is still occurring (i.e., still leaking) or if the spillage has stopped. If the spill has not stopped, determine if it is safe to stop or control the spill (e.g., plug hole, close valve, upright container).
5. If the spill is too large to be controlled with the spill materials at hand, contact the SAO or Hamlet Foreman and report the spill immediately (see Section 3 above for contact information), particularly since a spill occurring on snow or ice presents the potential for immediate access of contaminants into waterways.
6. If the spill is small enough to be controlled with the spill response materials at hand, prevent spilled contaminants from spreading or entering waterways by using sorbent materials or a snow/soil dyke down slope from the spill. This is especially the case with liquid contaminants (e.g. gasoline, diesel).
7. Once the spill has been controlled and further spreading prevented, contact the SAO or Hamlet Foreman and report the spill (see Section 3 above for contact information). The SAO or Hamlet Foreman is responsible to report the spill to the 24-Hour Emergency Spill Report Line.
8. If possible with the spill response materials at hand, clean up the remaining spilled contaminant and store contaminated materials in a secure container for disposal. Impacted snow should also be stored in drums for proper disposal.

6.2 Additional Spill Delineation or Monitoring

In the event of a large spill or a spill in which not all of the spilled contaminant can be readily cleaned up with materials at hand (as described above), delineation of the affected area may be required. This would include subsurface investigation of the area (i.e., digging of test pits, soil sampling,

installation of monitoring wells) to determine how large and how deep the contaminant affected the subsurface soil and/or groundwater (horizontal and vertical extent of the spill). The delineation would result in the development of an appropriate remediation plan for the affected area. In this case, a qualified environmental consultant should be retained to provide advice on how to proceed with delineation and remediation of a large spill.

7 ENVIRONMENTAL MAPPING

As previously mentioned in Section 1 and indicated on Figures 1 to 3 in **Appendix A**, impacts from spills could occur all along the Project route as construction advances, and at all waterbodies adjacent to or crossed by the Access Road, or adjacent to Borrow Sources.

All six streams eventually flow into the marine environment of Repulse Bay and spills in water or on land adjacent to streams could impact this downstream environment. Additionally, some lakes along the Project route were confirmed to be fish-bearing while others are suspected. Spills in water or on land adjacent to these lakes could impact the fish and fish habitat.

Spill response equipment (e.g., spill kits) will be present at the construction site of the advancing road and at the excavation operations of the Borrow Sources. Spill response equipment is also kept in the Hamlet Garage and the Naujat Co-Op Bulk Fuel Storage Facility.

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8 RESOURCE INVENTORY

8.1 On-Site Resources

8.1.1 Personnel

All personnel hired to work on Access Road construction and/or borrow source development will be trained in on-site spill prevention, response and clean-up measures (see Section 9).

8.1.2 Equipment

The following is a list of equipment available to respond to possible spills.

- Two loaders
- Two haul/dump trucks
- One grader
- One pick-up truck (light vehicle)

8.1.3 Spill Kits

8.1.3.1 Spill Kit Locations

At least one spill kit should be clearly marked and present at each construction site along the Access Road route; this will include the along the advancing road front and at the borrow source excavation site(s). One spill kit should also be clearly marked and present at the Hamlet Garage or wherever equipment maintenance will be completed.

8.1.3.2 Spill Kit Contents

The following outlines the recommended minimum requirements for contents of spill kits to be used during construction of the Access Road. Each spill kit should be regularly inspected to ensure it always contains the following, at a minimum (in part from INAC [2007]):

- 1 – 205 L open top steel drum with lid, bolting ring and gasket (spill kit container)
- 10 disposable large 5 mil polyethylene bags (dimensions 65 cm x 100 cm) with ties
- 4 – 12.5 cm x 3 m (5 in. X 10 ft.) sorbent booms
- 10 kg bag of sorbent particulate
- 100 sheets (1 bail) of 50 cm x 50 cm sorbent sheets
- 2 large (5 m x 5 m) plastic tarps
- 1 roll duct tape
- 1 utility knife

- 1 field notebook and pencil
- 1 rake
- 1 pick-axe
- 3 spark-proof shovels
- 4 Tyvex® splash suits
- 4 pairs chemical resistant gloves
- 4 pairs of splash protective goggles
- Instruction binder, including Spill Contingency Plan.

The entire spill kit contents, with the exception of the spark-proof shovels, can be stored within the 205 L steel drum. The drum should be sealed securely to protect the spill kit contents though should always be accessible without the use of tools (i.e., finger tight bolt ring). The drum's bolt ring should be inspected regularly during facility inspections to ensure it turns freely and is lubricated.

Extra spill response materials should also be available for use, in addition to the spill kit contents. These include:

- 10 – 205 L open top steel drum with lid, bolting ring and gasket
- 2 spark-proof shovels
- 50 disposable large 5 mil polyethylene bags (dimensions 65 cm x 100 cm)
- 10 – 12.5 cm x 3 m (5 in. X 10 ft) sorbent booms
- 5 – 10 kg bags of sorbent particulate
- 500 sheets (5 bails) of 50 cm x 50 cm sorbent sheets
- 2 Tyvex® splash suits
- 2 pairs of chemical resistant gloves
- 2 pairs of splash protective goggles.

8.2 Off-Site Resources

The following agencies can be contacted for assistance in spill reporting, response and/or clean-up and remediation.

Table 8-1 Regulatory agency contact information for spill contingency planning.

Agency	Legislation	Contact Information
Nunavut Water Board	*Nunavut Waters and Surface Right Tribunal Act*	Phone: (867) 360-6338 Fax: (867) 360-6369
Nunavut Impact Review Board	*Nunavut Land Claims Agreement Act*	Phone: (867) 983-2593
Government of Nunavut Department of Environment	*Nunavut Environmental Protection Act*	Phone: (867) 975-7700 Fax: (867) 975-7740

Agency	Legislation	Contact Information
Environment Canada	*Canadian Environmental Protection Act,* 1999	Phone: (867) 975-4464 Fax: (867) 975-4645
Fisheries and Oceans Canada	*Fisheries Act*	Phone: (867) 979-8000 Fax: (867) 979-8039
Transport Canada (Coast Guard)	*Transportation of Dangerous Goods Act*	Phone: (867) 979-5269 Fax: (867) 979-4260

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9 TRAINING & EXERCISES

9.1 Outline

All individuals hired to work on Access Road construction and/or borrow source development should have their basic first aid and WHMIS (Workplace Hazardous Materials and Information System) training before working on site. A training session on spill prevention and response should also be held for all individuals prior to the start of Access Road construction or borrow source development. The training session should review this SCP and include information on:

- Individuals roles and responsibilities in regards to spill prevention, detection, response and clean-up;
- Location(s) of hard copies of the SCP, maps and spill kits;
- Equipment available for spill response;
- Content of spill kits;
- Initial actions and spill reporting procedures; and,
- Spill response and clean-up actions.

Training exercises, including mock spills and proper use of spill kits, should also be held prior to the start construction to provide hands-on training for individuals on spill response procedures and equipment. Training exercises can be held during the training session for all individuals or at another time for individuals directly involved with handling of hazardous materials.

9.2 Schedule

The training session and exercises should be held prior to the start of construction and borrow source excavation each year. This will ensure all returning individuals receive a refresher while any new individuals become familiar with on-site spill prevention and response measures.

The Hamlet will keep records of all individuals who attend the training session and exercises, as well as copies of their training certificates (e.g., first aid, WHMIS).

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10 REFERENCES

10.1 Literature Cited

Indian and Northern Affairs Canada (INAC). Guidelines for Spill Contingency Planning. Yellowknife, NT: Water Resources Division, INAC, 2007. Retrieved 7 February 2011: http://www.ainc-inac.gc.ca/ai/scr/nt/pdf/SCP-EUD-eng.pdf

Northwest Territories Water Board (NWTWB). Guidelines for Contingency Planning. Yellowknife, NT: NWTWB, 1987.

10.2 Personal Communications

McCuaig, S. Senior Terrain Scientist, Stantec Consulting Ltd. Conversations. 10 – 14 January 2011.

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APPENDIX A

Figures

Construction and Operation of an Access Road and Borrow Sources at Repulse Bay, NU

Repulse Bay Final Road Design

Acknowledgements: Original Drawing by Nunami Stantec; NTS Data: Sheet 046L09, 1:50,000 provided by Government of Canada, Natural Resources Canada, Centre for Topographic Information

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NUNAMI STANTEC

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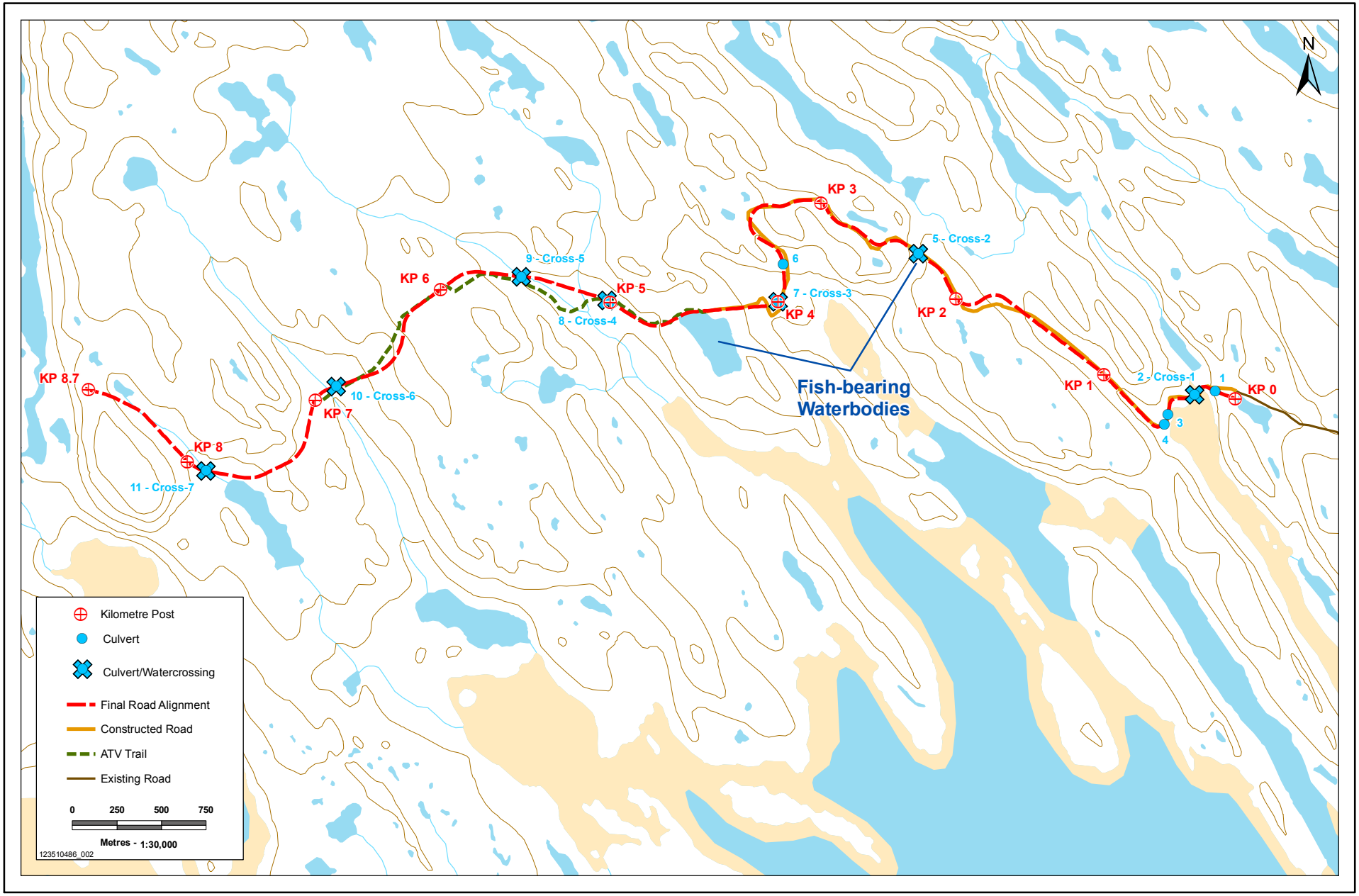
FIGURE NO.
1

Last Modified: March 8, 2011 by pselmo



Construction and Operation of an Access Road and Borrow Sources at Repulse Bay, NU

Repulse Bay Final Road Design and Watercrossings

Acknowledgements: Original Drawing by Nunami Stantec; NTS Data: Sheet 046L09, 1:50,000 provided by Government of Canada, Natural Resources Canada, Centre for Topographic Information

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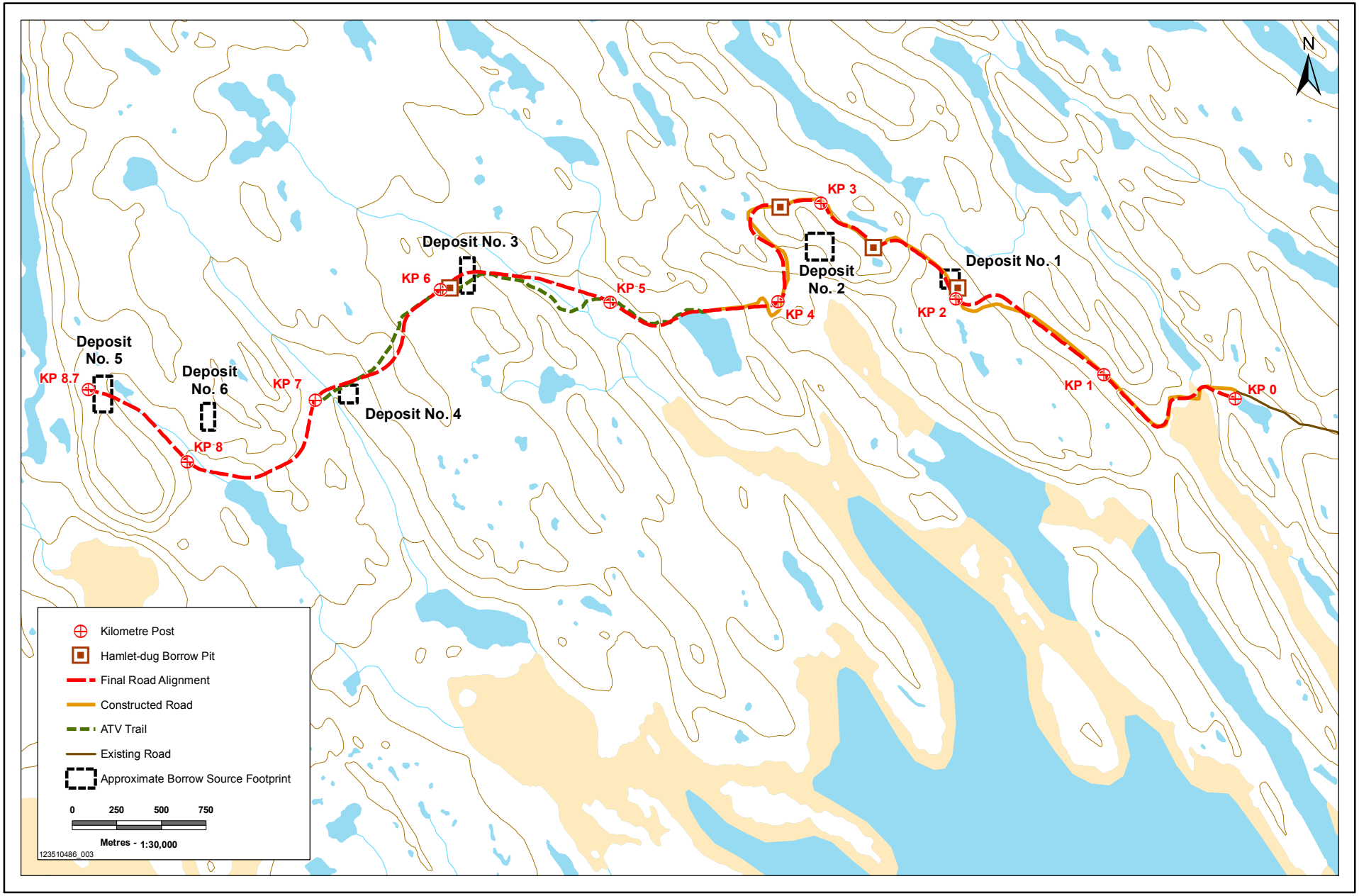
FIGURE NO. **2**

Last Modified: March 8, 2011 by pselmo



Construction and Operation of an Access Road and Borrow Sources at Repulse Bay, NU

Repulse Bay Final Road Design and Borrow Source Locations

Acknowledgements: Original Drawing by Nunami Stantec; NTS Data: Sheet 046L09, 1:50,000 provided by Government of Canada, Natural Resources Canada, Centre for Topographic Information

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FIGURE NO.
3

Last Modified: March 8, 2011 by pselmo

APPENDIX B

Nunavut Spill Report Form

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND OTHER HAZARDOUS MATERIALS

NT-NU 24-HOUR SPILL REPORT LINE
TEL: (867) 920-8130
FAX: (867) 873-6924
EMAIL: spills@gov.nt.ca

REPORT LINE USE ONLY

A	REPORT DATE: MONTH – DAY – YEAR	REPORT TIME	☐ ORIGINAL SPILL REPORT, OR ☐ UPDATE # _____ TO THE ORIGINAL SPILL REPORT	REPORT NUMBER ____-_____
B	OCCURRENCE DATE: MONTH – DAY – YEAR	OCCURRENCE TIME		

C	LAND USE PERMIT NUMBER (IF APPLICABLE)	WATER LICENCE NUMBER (IF APPLICABLE)
D	GEOGRAPHIC PLACE NAME OR DISTANCE AND DIRECTION FROM NAMED LOCATION	REGION ☐ NWT ☐ NUNAVUT ☐ ADJACENT JURISDICTION OR OCEAN
E	LATITUDE DEGREES MINUTES SECONDS	LONGITUDE DEGREES MINUTES SECONDS

F	RESPONSIBLE PARTY OR VESSEL NAME	RESPONSIBLE PARTY ADDRESS OR OFFICE LOCATION	
G	ANY CONTRACTOR INVOLVED	CONTRACTOR ADDRESS OR OFFICE LOCATION	
H	PRODUCT SPILLED	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER
	SECOND PRODUCT SPILLED (IF APPLICABLE)	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER
I	SPILL SOURCE	SPILL CAUSE	AREA OF CONTAMINATION IN SQUARE METRES
J	FACTORS AFFECTING SPILL OR RECOVERY	DESCRIBE ANY ASSISTANCE REQUIRED	HAZARDS TO PERSONS, PROPERTY OR ENVIRONMENT
K	ADDITIONAL INFORMATION, COMMENTS, ACTIONS PROPOSED OR TAKEN TO CONTAIN, RECOVER OR DISPOSE OF SPILLED PRODUCT AND CONTAMINATED MATERIALS		

L	REPORTED TO SPILL LINE BY	POSITION	EMPLOYER	LOCATION CALLING FROM	TELEPHONE
M	ANY ALTERNATE CONTACT	POSITION	EMPLOYER	ALTERNATE CONTACT LOCATION	ALTERNATE TELEPHONE

REPORT LINE USE ONLY

N	RECEIVED AT SPILL LINE BY	POSITION STATION OPERATOR	EMPLOYER	LOCATION CALLED YELLOWKNIFE, NT	REPORT LINE NUMBER (867) 920-8130

LEAD AGENCY ☐ EC ☐ CCG ☐ GNWT ☐ GN ☐ ILA ☐ INAC ☐ NEB ☐ TC

SIGNIFICANCE ☐ MINOR ☐ MAJOR ☐ UNKNOWN

FILE STATUS ☐ OPEN ☐ CLOSED

AGENCY	CONTACT NAME	CONTACT TIME	REMARKS
LEAD AGENCY			
FIRST SUPPORT AGENCY			
SECOND SUPPORT AGENCY			
THIRD SUPPORT AGENCY			

FSC File: 2010-0880-41

10 February 2011

Stantec
5021 - 49th Street PO Box 1680
Yellowknife NT
X1A 2N4
Attn: Carey Sibbald, B.Sc., EPt

Re: <u>Repulse Bay Road - Response to Nunavut Water Board</u>

Dear Ms. Sibbald,

In your email of January 28th, 2011, you informed us that:

> Specifically, the NWB requests:
>
> *The design flood flow in cubic metres per second and its return period for the type of structure proposed.*
> *An explanation of the rationale for the selected design flow flood and its return period.*
>
> The NWB also requests technical specifications of any geotextile used (so under culverts); I know you may not have exact details but do you have any specifications for this based on your design? (NWB requests "*If geotextile is used or a similar material to prevent the transport of sediment into a watercourse, provide the technical specifications for the proposed material as well as the location, extent and placement method for the material.*")

We will attempt to provide adequate answers to these questions, and requests for information, following.

1.1 GENERAL

For this project, we found early in the design, that the available terrain information, both from the field survey program and from available mapping data was not sufficient to allow a fully detailed design of the drainage and stream crossing culverts.

We were forced to rely on past experience and judgment to size the culverts in such a way as to exceed probable design flows over a reasonable rate of return for the roadway.

We have determined to use wherever possible one of two possible culvert sizes due partially to construction logistics. 800 mm and 1600 mm for the project.

The culverts were sized to a minimum diameter of 800 mm, for general drainage culverts and areas of low flow runoff. This size allows some settlement with degradation of permafrost following installation (which is a common concern in roadways in this region) while still allowing adequate cross sectional area for light drainage and equalization purposes.

Culverts have a hydraulic capacity for water flow that depends upon several factors. These include diameter, slope, length, type of pipe, and type of pipe end treatment.

The capacity of any particular culvert also depends upon how much surcharge if any is at the inlet and outlet of the culvert. Depending on that surcharge the culvert will either be in what is called 'inlet control' or in what is called 'outlet control'. Design is based upon evaluation of both inlet and outlet control, and accepted the lower value as controlling the capacity of the culvert.

The design methodology for this project is based upon a method developed by the California Department of Highways and subsequently used around the world by most highway design agencies.

It states that the 1 in 10 year flood is to be designed to be passed with the installed culvert flowing without any inlet surcharge.

The 1 in 100 year flood is to be passed utilizing the available head above the culvert.

The geometric design basis for this particular roadway calls for a minimum of 400 mm of cover above the top of any culvert to the shoulder of the road.

In the culvert hydraulic calculations, we set the 1 in 100 year head to be the diameter plus 400 mm.

1.1.1 Inlet Control Design Capacity

Culverts can flow water either in 'Inlet Control' or in 'Outlet Control'. In general, inlet control applies to steep gradient culverts, and outlet control applies to 'flat' culverts.

Inlet control flow capacity is determined through the use of an 'Inlet Control Nomograph', taken from the 'Handbook of Steel Drainage and Highway Construction Products – Canadian Edition'.

Inlet control assumes that inlet losses are larger than the friction losses in the culvert, and thus that the inlet controls the overall flow capacity of the culvert.

The Inlet Control Nomograph gives us the following capacities for the three sizes noted, using the above noted surcharges.

	800 mm	1600 mm
1:10 Year	0.62 cu.m./s	4.20 cu.m./s
1:100 Year	0.85 cu.m./s	5.10 cu.m./s

For this project we will find that typically inlet control does NOT govern the culvert design.

1.1.2 Outlet Control Design Capacity

Outlet control assumes that the friction losses in the culvert are larger than inlet losses, and thus that the culvert geometry, controls the overall flow capacity of the culvert.

Outlet control considers the length, type of pipe, inlet losses, and slope of the culvert pipe. We have prepared design spreadsheets for outlet control each of the significant crossings. The results are presented in Section 4 and 5.

Under outlet control, for a single culvert we calculate these capacities.

Outlet Control	800 mm	1600 mm
1:10 Year	410.9 L/s	2,076.6 L/s
1:100 Year	1,208.4 L/s	4,122.6 L/s

Thus, outlet control governs these cases being lower than inlet control.

1.2 RATIONAL METHOD RUNOFF ANALYSIS

We have utilized the Rational Method of runoff analysis for determining the runoff flow rates for rainfall.

Using the Rational method:

- Q (Flow Rate) = C (Runoff Coefficient) * I (Intensity) *A (Area of Drainage Basin)
- T (Time of Concentration) = 0.0078 (L / S^0.5) ^ .77
- Where S (Slope) = H (Elevation Change) / L (Length of Drainage Basin)
- Rainfall intensity I varies with time.
- The Time of Concentration is the time that it takes the most remote area of the Drainage Basin to run to the outfall structure.

Given these parameters, each drainage structure has a calculated peak flow rate, for different design periods.

In the absence of site specific data for Repulse Bay, we have used the following criteria for design taken from a similar arctic coastal community:

- 10 Year return period: I=10^(LOG (10)+(-0.63)*LOG (T/60))
- 25 Year return period: I=10^(LOG (13.5)+(-0.63)*LOG (T/60))
- 100 Year return period: I=10^(LOG (16.21)+(-0.63)*LOG (T/60))

1.3 CULVERT RUNOFF AREAS AND DESIGN FLOWS

The chosen culvert sizes allow the following flows, and drainage areas, for the 100 Year return period.

- 800 mm A maximum design flow of 1.21 cu. m. per second. This equates to a runoff area of 225,000 sq. m, given a 5% slope.
- 1600 mm A maximum design flow of 4.06 cu. m. per second. This equates to a runoff area of 1,163,000 sq. m, given a 5% slope.

1.4 GEOTEXTILE

The use of geotextile under the culverts is not to prevent sediment transport. It is used to slow the typical settlement of a culvert installed in permafrost, and so extend the useful life of the culvert.

For the record, we specify a mid-weight, non-woven geotextile of at least 250 g/m^2.

1.5 CONCLUSION

We trust the above meets your requirements, and that of the Nunavut Water Board. Please let us know if you require anything in addition.

Sincerely,
FSC ARCHITECTS & ENGINEERS

Walter Orr, P. Eng.
Principal Engineer

Cc: file

FSC File: 2010-0880-41

29 June 2011

Stantec
5021 - 49th Street PO Box 1680
Yellowknife NT
X1A 2N4
Attn: Carey Sibbald, B.Sc., EPt

Re: Repulse Bay Road - Response to Nunavut Water Board

Dear Ms. Sibbald,

In your email of June 20th , 2011, you informed us that:

> We recently received a request for additional information from the Nunavut Water Board regarding the access road construction in Repulse Bay, based on comments from INAC. We can provide some of the additional information however I would request your input on the questions regarding culverts. Please see the attached documents for specifics.
>
> INAC and the NWB are requesting additional details on:
>
> - Flow estimates and drainage areas, or barring better peak flow estimates, contingencies for upstream ponding, deeper melting of the frost line, and washouts of the culverts and road
> - Confirmation that the road will cross streams at right angles and any changes to stream alignments
> - More information on the general drainage culverts (specifically at 0+130, 0+470, 0+538 and 3+790)

We will attempt to provide adequate answers to these questions, and requests for information, following.

1.1 FLOW ESTIMATES AND CONTINGENCIES

As noted in our previous response, for this project, the available terrain information, both from the field survey program and from available mapping data was not sufficient to allow a fully detailed design of the drainage and stream crossing culverts.

Thus, we were not able to provide flow estimates and drainage areas as requested above. That has not changed.

The sizing of the culverts, were then set to larger than a 'normal' size for similar installations. Thus a portion of the contingency planning requested above is simply taken care of through over sizing of the culverts.

A normal culvert minimum size for similar roads with better known drainage would be 500 mm. An 800 mm culvert will handle more than 2 ½ times greater flow.

Should additional information be required to address the INAC and NWB issues raised above, either additional survey or remote sensing data would have to be acquired, and considerable time and expense.

1.2 UPSTREAM PONDING AND FROST MELTING

In the Canadian Arctic, it must be noted that in the great majority of cases, the rainfall peak runoff hydrograph has an extremely short period of not exceeding one days, and usually in less than 10 or so of hours.

Thus, the impact of ponding and resulting thaw, in the vulnerable summer season, is not anticipated to be a problem for this roadway as any ponding would be on the order of hours.

The snow melt hydrograph is typically lower in peak flows, but continues for a much longer duration, typically several days. When these flows happen, however, the ground is still frozen, and frost degradation is not a problem.

When culverts fail, it is normally from runoff of snow melt, combined with ice and/or run off debris plugging the culvert limiting the flows.

That type of failure can happen regardless of whether a culvert is properly sized for peak design flows or not.

In the event of a significantly larger flow event than the as designed culverts can handle, the culvert would initially back water up to the top of the road, raising the surcharge on the entrance, and thus the flow capacity of the culvert. If the water then overtops the road, then the road will typically wash out and have to be repaired, with the culvert having to be either reinstated or replaced.

1.3 CROSSING STREAMS AT RIGHT ANGLES AND ANY CHANGES TO STREAM ALIGNMENTS

The design intent of this work is to set all culverts at the lowest flow channel, and parallel to the flow direction, regardless of whether or not the roadway crosses the stream at right angles or not.

Due to the rolling nature of the terrain, in many cases, it was not possible to cross the streams with the road at right angles. That has been done wherever possible, however.

1.4 GENERAL DRAINAGE CULVERTS

General Drainage culverts have been placed at locations where ponding adjacent to the roadway is anticipated, but where there is no stream flow. As such, they have not been sized for a particular flow capacity, but exist strictly to prevent the entrapment of water, with subsequent degradation of the road embankment.

1.5 CONCLUSION

We trust the above meets your requirements, and that of the Nunavut Water Board. Please let us know if you require anything in addition.

Sincerely,
FSC ARCHITECTS & ENGINEERS

Walter Orr, P. Eng.
Principal Engineer

Cc: file