REMEDIATION OF THE OLD TOWN SITE, CLYDE RIVER, NUNAVUT

Environmental Screening

FINAL

Prepared for:

Department of Community & Government Services
Government of Nunavut

Prepared by:

Nunami Stantec
P.O Box 188
Rankin Inlet, NU X0C 0G0
Tel: (867) 645-2805 Fax: (867) 645-2063

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EXECUTIVE SUMMARY

Nunami Stantec Ltd., on behalf of the Government of Nunavut Department of Community and Government Services, is submitting regulatory applications for permitting to complete remediation activities at the Old Town Site of the Hamlet of Clyde River, Nunavut (the Project).

The Hamlet of Clyde River (the Hamlet) was originally established approximately 5 km southeast of the present day community, on the east side of Patricia Bay. Known locally as “Old Town”, the original settlement was occupied from 1923 until 1970 when the new community was established. The Old Town Site currently consists of several building foundations, four bulk fuel aboveground storage tanks (ASTs) and several dump sites containing hazardous and non-hazardous wastes.

Several environmental investigations have been completed at the Old Town Site since the mid-1990s and remediation activities are now proposed to remove waste debris and remediate contaminated soils and water. Project activities include the following:

- Construction, operation and decommissioning of a 2.6 km access road from an existing municipal road to the Old Town Site;
- Development and operation of eight existing borrow sources, including the Hamlet’s existing quarry;
- Construction, operation and closure of a landfarm at the Old Town Site, to treat contaminated soils;
- Construction, operation and closure of a staging area at the Old Town Site;
- Construction, operation and closure of a landfill containment cell at the Hamlet’s solid waste facility;
- Excavation of buried waste debris, including hazardous and non-hazardous wastes, with appropriate segregation, containerization, transportation and disposal;
- Excavation of contaminated soils with appropriate treatment or disposal;
- Collection and treatment of contaminated water; and,
- Monitoring following closure.

This Environmental Screening document contains information regarding planned remediation activities at the Old Town Site. It has been developed to fulfill the Project Specific Information Requirements of the Nunavut Impact Review Board and the General Water Works and Landfarm Supplemental Information Guidelines of the Nunavut Water Board. Based on these, Nunami has compiled information about the Project and Clyde River area into the following sections:

- General Project Information: provides an overview of Project information including the need for the Project, alternatives to the Project, Project schedule, equipment, water use, solid waste and wastewater information, fuel and chemical use, and public involvement/traditional knowledge.

- Project Specific Information: provides specific details on Project components including volume, extent and characteristics of waste debris and contaminated soil and water; remedial methods, including construction/operation of the staging area, landfarm, and landfill containment cell; construction/operation of the access road; development of the borrow sources; excavation volumes (granular materials and contaminated soils); and, safety and environmental considerations.
- Existing Environment: provides a description of the existing physical, biological and socioeconomic environment of the Project and Clyde River areas.
- Environmental Assessment: provides an assessment of the potential environmental effects of the Project on identified physical, biological and socioeconomic Valued Environmental Components (VECs).
- Cumulative Effects: provides an assessment of the interaction between any residual environmental effects of the Project and any past, present or reasonably foreseeable future projects.

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ABBREVIATIONS

µg/L ..... micrograms per litre
ha ..... hectare
km^2 ..... square kilometres
L ..... litre
m^2 ..... square metres
m^3/s ..... cubic metres per second
mg/kg ..... milligrams per kilograms
AANDC ..... Aboriginal Affairs and Northern Development Canada
ACMs ..... asbestos containing materials
AST ..... aboveground storage tank
ATV ..... all-terrain vehicle
DFO ..... Department of Fisheries and Oceans Canada
DMP ..... Dust Management Plan
ESA ..... Environmental Site Assessment
FMA ..... FMA Heritage Incorporated
GN-CGS ..... Government of Nunavut Department of Community and Government Services
GN-CLEY ..... Government of Nunavut Department of Culture, Language, Elders and Youth
Hamlet ..... Hamlet of Clyde River
HHERA ..... Human Health and Ecological Risk Assessment
HRIA ..... Heritage Resource Impact Assessment
HTO ..... Hunters and Trappers Organization
NBRLUP ..... North Baffin Regional Land Use Plan
NIRB ..... Nunavut Impact Review Board
NLCA ..... Nunavut Land Claims Agreement
NPC ..... Nunavut Planning Commission
Nunami ..... Nunami Stantec Ltd.
NWB ..... Nunavut Water Board

PCB.....polychlorinated biphenyls

PHC ..... petroleum hydrocarbons

PPE.....personal protective equipment

Project.....Remediation of the Old Town Site, Clyde River, Nunavut

OS..... Operational Statement

RAP.....Remedial Action Plan

SARA ..... *Species at Risk Act*

TDGA ..... *Transportation of Dangerous Goods Act*

VECs.....Valued Ecosystem Components

1 INTRODUCTION

Nunami Stantec Ltd. (Nunami), on behalf of the Government of Nunavut Department of Community and Government Services (GN-CGS) is submitting regulatory applications for permitting to complete remediation activities at the Old Town Site of the Hamlet of Clyde River, Nunavut (the Project) (Figure 1 in **Appendix A**).

This Environmental Screening document contains information regarding planned remediation activities. It has been developed to fulfill the Project Specific Information Requirements of the Nunavut Impact Review Board (NIRB) and the General Water Works and Landfarm Supplemental Information Guidelines of the Nunavut Water Board (NWB).

1.1 Background

The Hamlet of Clyde River (the Hamlet) was originally established approximately 5 km southeast of the present day community, on the east side of Patricia Bay. Known locally as “Old Town”, the original settlement was occupied from 1923 until 1970 when the new community was established. The Old Town Site currently consists of several building foundations, four bulk fuel aboveground storage tanks (ASTs) and several dump sites containing hazardous and non-hazardous wastes. The Old Town Site is currently unoccupied, except in the summer months when residents of Clyde River erect summer recreational camps. While residing in the Old Town Site area, residents hunt and fish and collect drinking water from steams.

Several environmental investigations have been completed at the Old Town Site. These include studies completed by the Environmental Sciences Group of the Royal Military College (1997), Jacques Whitford Limited (2004a and 2004b), Nunami Jacques Whitford Ltd. (2009), and Nunami Stantec Ltd. (2011a, 2011b and 2011c). A Human Health and Ecological Risk Assessment (HHERA) was also completed as part of the environmental investigation by Nunami (2011d).

Based on the information collected during the environmental investigations, several waste streams are present at the Old Town Site; these include:

- Non hazardous waste – construction materials (e.g., wood, concrete, piping, roofing products, machine and equipment parts), miscellaneous metal debris and residential wastes (e.g., cans, wiring, appliances).
- Hazardous waste - several drums of waste oil, potentially containing ethylene glycol, and several capacitors and transformers, potentially containing polychlorinated biphenyls (PCBs).
- Aluminum waste – in the form of a white powdery substance. This substance is a hydrogen generation by-product, is alkaline and characterized by high concentrations of aluminum (maximum of 340,000 mg/kg).
- Waste petroleum product – drums of petroleum product waste and four 6,000 L ASTs.

- Special wastes – asbestos containing materials (ACMs), including tiles, shingles and insulation,, lead contaminated waste (lead-based paint constituents), some types of electrical equipment (e.g., batteries, wiring), and sanitary wastes.
- Petroleum hydrocarbon (PHC) and metal contaminated soil.
- PHC and metal contaminated water.

A Remedial Action Plan (RAP) was finalized for the Old Town Site in 2011 (Nunami 2011b). The remedial methods selected for each waste stream are presented in Table 1-1.

Table 1-1 Remedial methodology for each waste stream at the Old Town Site, Clyde River, NU

Environmental Issue	Quantity of Waste	Remedial Option Selected
Non-Hazardous Waste	1,254 m^3	All non-hazardous waste will be collected and disposed at the new containment cell at the Clyde River Solid Waste Facility. Combustible non-hazardous waste will be incinerated at the Old Town Site.
Hazardous Waste	17 m^3	All hazardous waste will be containerized in accordance with the applicable regulations and disposed at a licensed hazardous waste disposal facility in southern Canada.
Aluminum Waste Footprint	1,438 m^3 [a]	The top 0.3 m of the aluminum waste footprint will be excavated and disposed at the new containment cell at the Clyde River Solid Waste Facility.
Waste Petroleum Product	1,854 L	Waste fuel products will be collected and incinerated in a waste fuel incinerator on-site. Drums and ASTs present on the Old Town Site will be rinsed on-site and any residual fluids will be collected and treated. Once rinsed, the drums and ASTs will be disposed as non-hazardous waste at the new containment cell at the Clyde River Solid Waste Facility. Drums potentially containing ethylene glycol will be sealed and disposed of at a licensed facility in southern Canada.
Special Wastes		
Asbestos Containing Materials	187 m^3	Asbestos-containing waste will be collected, placed in plastic sealed bags, and disposed of at the new containment cell at the Clyde River Solid Waste Facility.
Polychlorinated Biphenyls		Capacitors and transformers found intact will be treated as hazardous waste, containerized, and shipped to a licensed disposal facility in southern Canada.
Electrical Wastes		Broken and intact batteries will be collected and transported to a registered recycling facility in southern Canada. Capacitors / transformers that are broken and contain no liquids will be placed in the new containment cell at the Clyde River Solid Waste Facility.
Lead Impacted Wastes		These wastes will be disposed of in the new containment cell at the Clyde River Solid Waste Facility.
Sanitary Wastes		Any identified sanitary wastes will be collected and, depending on the nature of the waste, either treated at the new landfarm or transported to the new containment cell at the Clyde River Solid Waste Facility for disposal.
Petroleum Hydrocarbon Contaminated Soil	7,500 m^3 [a]	PHC contaminated soil will be excavated and bioremediated using a new landfarm facility at the Old Town Site.
Metal Contaminated Soil	827 m^3 [a]	Metal impacted soil will be excavated and disposed of in the new containment cell at the Clyde River Solid Waste Facility.
Petroleum Hydrocarbon and Metal Contaminated Water	1,000,000 L (estimate)	Any PHC and/or metal contaminated water will be transferred to an assembled waste water treatment system at the Old Town Site. Upon completion of treatment, water samples will be collected and analysed to confirm the treated water meets the applicable discharge criteria.

NOTE:

[a] The estimated volume of contaminated soil have been developed considering the Site Specific Threshold Levels (SSTLs) generated by the HHERA; a 15% bulking factor and 25% contingency have been applied.

Nunami also completed a geotechnical assessment in 2011 to confirm if adequate natural deposits of suitable granular material were present in the Clyde River area to complete the remedial activities (i.e., Nunami 2011c). A review of the information collected during the geotechnical assessment is provided in Section 3.2.1.

In the final RAP, Nunami recommended that a Heritage Resource Impact Assessment (HRIA) of the Project area be completed prior to the start of the remediation activities. The Government of Nunavut Department of Culture, Language, Elders and Youth (GN-CLEY) concurred with this recommendation and Nunami will complete the HRIA in the summer of 2012. The HRIA will include a desktop site file search and field inventory and assessment program.

The Project being applied for is located within the Hamlet, which is located at the northwestern portion of Patricia Bay (70º 28' N, 68º 35' W) in the Qikqiqtani region of Nunavut. The Project area incorporates the Old Town Site, including a proposed landfarm, eight existing borrow sources (including the Hamlet's existing quarry), and the Hamlet's solid waste facility, where a new landfill containment cell is proposed (Figures 1 and 3 in **Appendix A** and Drawing 02 in **Appendix B**).

1.2 Project Activities

The Project activities to be completed include:

- Construction of a 2.6 km temporary access road to the Old Town Site. The access road will be constructed of granular material and will measure approximately of 9.2 m wide at the base of the embankment, with additional width for increased shoulders in some areas. Culverts will be installed at several locations. In addition to the access road, several new and existing temporary trails on the Old Town Site will be utilized to facilitate on-site transportation between the access road, the staging area (waste handling facility), the landfarm and the rest of the Old Town Site. Access road construction will follow the typical fill method, utilizing granular materials from the Hamlet's existing granular source and additional granular deposits (borrow sources).
- Construction of a new landfill containment cell at the Clyde River Solid Waste Facility. The facility will be located east of the existing Solid Waste Facility and will measure approximately 67 m by 85 m in size. Groundwater monitoring wells will be installed surrounding the landfill facility.
- Construction of a temporary staging area at the Old Town Site for the purpose of handling of wastes requiring off-site disposal. The staging area will measure a maximum of 30 m by 50 m.
- Construction of a temporary landfarm facility at the Old Town Site to facilitate the bioremediation of hydrocarbon contaminated soils. The landfarm will measure a maximum of 124 m by 86 m in size. Groundwater monitoring wells will be installed surrounding the landfarm facility.

- Operation of borrow sources. A total of eight borrow sources will be used for construction of the access road, waste handling facility, landfarm facility, new landfill containment cell, and as backfill material.

Once the above mentioned facilities have been constructed, the following remedial activities will be completed:

- Collection, segregation, transportation and off-site disposal of non-hazardous debris and waste at the new landfill containment cell.
- Collection, segregation, and off-site disposal of lead painted waste at the new landfill containment cell.
- Excavation, containerization, transportation and disposal of hazardous waste materials to a designated off-site hazardous waste disposal/treatment facility.
- Excavation of PHC contaminated soil and placement and treatment in the newly constructed on-site landfarm.
- Excavation and disposal of the metal contaminated soil and the aluminum waste footprint at the new landfill containment cell.
- Collection, cleaning and disposal of barrels and contents, including the transfer of hazardous barrel contents.
- Backfilling of all the excavated areas.
- On-site incineration of non-hazardous combustible waste and petroleum hydrocarbon contents.
- Operation of a waste water treatment system to remediate the hydrocarbon and metal contaminated water encountered throughout the remedial program.
- Landfill cell closure and placement of final cover.
- Monitoring of the landfarm facility for two years; and,
- Decommissioning of the landfarm and final site grading.

2 PROJECT GENERAL DESCRIPTION

2.1 General Information

Need for Project

The purpose of the Project is to remediate the Old Town Site. This project will meet the remedial objectives identified by GN-CGS including;

1. To provide for long-term, cost-effective, technically defensible and environmentally acceptable remediation of the Site.
2. To remove all hazardous and non-hazardous waste from Site and restore the natural topography of the area.
3. To provide a remediation plan that will be acceptable to the community, regulators and project sponsors.
4. To restore the Old Town Site to a condition where community members may use the site for recreational / traditional purposes.

Alternatives to the Project and Alternative Methods

Alternatives to the Project, including both viable technical and economic alternatives for carrying out the Project, have been considered. The alternative to the Project is to not complete the remediation. This is not considered feasible due to the following:

- health and safety risks for residents of Clyde River;
- potential migration of contaminants off-site (Patricia Bay, a sensitive marine receptor, is located down-gradient of the Old Town Site); and,
- additional remedial costs if the Project is delayed.

Alternative means of carrying out the Project focused on alternative routing for the access road, alternative locations for the landfill containment cell and landfarm, and alternative technical methods for completing remedial activities. Alternative means to those proposed herein have been considered not feasible for the following reasons:

- An alternative route for the proposed access road is not considered feasible as the cost of locating and designing a new route would be prohibitive; the GN-CGS has already completed geotechnical investigations of the route and will be undertaking archaeological investigations this summer. Additionally, based on the geotechnical investigations, Nunami believes the most efficient and cost-effective routing has been selected.
- An alternative location for the proposed landfill containment cell is not considered feasible as the costs would be excessive to site, investigate and design a new landfill facility. Furthermore, an alternative location would likely require construction over natural ground, producing

additional environmental effects. The proposed location for the landfill containment cell minimizes cost and potential effects to the nearby environment as it is situated within the Hamlet's existing solid waste facility.

- An alternative location for the proposed landfarm is not considered feasible as it is ideal to have the landfarm in close proximity to the source of the contaminated soils; this will reduce the potential for additional environmental effects (i.e., potential accidents during transportation to an alternative landfarm location). The proposed landfarm is currently situated on the Old Town Site and requires very short transport times from the identified impacted locations. Constructing the landfarm in an alternate location would also require additional costs to investigate and design the new landfarm.
- All viable technical methods for completing remedial activities at the Old Town Site were evaluated during the development of the Remedial Action Plan. As a result, Nunami believes the best possible options have been proposed for the various waste streams at the Old Town Site.

Project Schedule

Pending successful permitting through the regulatory review process, the proposed schedule for the Project is as follows:

- Contract tendering (January 2013)
- Contract award (February 2013)
- Mobilization (July 2013)
- Year 1 (July to September 2013): Construction Activities (includes development of the borrow sources and construction of the access road, the landfill containment cell and on-site staging area and landfarm)
- Year 2 (June to September 2014): Remedial Activities (includes excavation of contaminated soil and waste debris, operation/closure of the landfill containment cell, operation of the landfarm, etc.,)
- Soil treatment at the landfarm (2014 to 2016)
- Demobilization (Fall 2014)
- Closure of the site and landfarm (2016)
- Long term monitoring (2015 to 2018)

Legislation

Several federal and territorial acts, regulations and guidelines affect the Project. Throughout all project phases, project personnel will work in cooperation with regulatory authorities to ensure compliance with each. The relevant acts, regulations and guidelines pertaining to this project are presented below:

Federal

- *Arctic Waters Pollution Prevention Act* and Regulations
- *Canadian Environmental Protection Act*
- Canadian Environmental Quality Criteria for Contaminated Sites (CCME)
- Canada Labour Code
- Controlled Products Regulations
- Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products
- *Fisheries Act*
- Nunavut Land Claims Agreement
- *Nunavut Waters and Surface Rights Tribunal Act*
- Ozone Depleting Substances Regulations
- *Transportation of Dangerous Goods Act* and Regulations

Territorial

- *Commissioners Lands Act*
- Environmental Guidelines for Industrial Discharges
- *Labour Standards Act*
- Nunavut Archaeological and Paleontological Site Regulations
- *Nunavut Environmental Protection Act*
    - Contingency Planning and Spill Reporting
    - Guidelines for Dust Suppression
    - Guidelines for the Management of Waste Asbestos
    - Guidelines for the Management of Waste Paint
    - Guidelines for the Management of Waste Antifreeze
    - Guidelines for the Management of Waste Solvents
    - Guidelines for the Management of Waste Batteries
    - Guidelines for the General Management of Hazardous Waste in Nunavut
- Nunavut Environmental Guidelines for Contaminated Sites Remediation
- *Nunavut Fire Prevention Act* and Regulations
- *Safety Act*: Occupational Health Regulations
- Spill Contingency Planning and Reporting Guidelines

- Workplace Hazardous Materials Information System Regulations

Required Authorizations / Permits / Licenses

The lands affected by the Project are municipal lands located inside of the municipal boundary of the Hamlet of Clyde River. Table 2-1 summarizes the authorizations required for completion of the Project.

Table 2-1 Required authorizations / permits / licenses for remediation of the Old Town Site, Clyde River, NU

Approval / Permit / License	Issuing Agency	Authorization Details
Land Use Permit	GN-CGS Lands Administration Division	A land use permit will be required for the construction of the access road, completion of on-site remedial activities and associated infrastructure, and development of the borrow sources in accordance with the *Commissioner's Lands Act*. Note: As the Project area is within the municipal boundaries of Clyde River, authorizations from Aboriginal Affairs and Northern Development Canada are not required.
Quarry Permit	GN-CGS Lands Administration Division	A quarry permit will be required for the development of borrow sources in accordance with the *Commissioner's Lands Act* and regulations.
Water License	Nunavut Water Board	A water license will be required for use of water and deposition of waste under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act.*
Class 1 Permit	GN-CLEY	Investigation of archaeological sites in the Project area issued to Nunami for the HRIA
DFO Letter of Advice	Department of Fisheries and Oceans	A letter of advice will be required for works or undertakings potentially affecting fish habitat; these include the installation of culverts at four on-site drainage channels (for the access road), and remedial excavations within 30 m of the high water mark of Patricia Bay.
Permits for transportation of dangerous goods	Transport Canada	Shipping of hazardous waste materials during Project operation Note: Waste manifest documents are required for hazardous waste movements; the permits will be issued to the contractor and waste hauler.

2.1.1 Nunavut Planning Commission

As per Article 1 in the Nunavut Land Claims Agreement (NLCA), the Project must conform to the requirements outlined in the regional land use plan. The Project is located within the North Baffin Region; as such, the North Baffin Regional Land Use Plan (NBRLUP) is applicable. Table 2-3 identifies the conformity requirements that are applicable to the Project.

Table 2-3 Nunavut Planning Commission project conformity review

Conformity Number	Confirmatory Requirement	How the Project proposal adheres to the NBRLUP
3.13.1	All users of the land should follow the *Code of Good Conduct* in Appendix H of the NBRLUP to ensure no new waste sites are created.	Project personnel will be required to adhere to the code during the project activities.
3.13.3	When identification is not possible, the government agency (or its successor) that had regulatory responsibility for the site at the time it was active shall be responsible for site cleanup and restoration.	The GN-CGS is responsible for the Project activities.
3.13.4 (b)	Community residents in particular, and all land users in general, shall be actively involved in planning and conducting cleanup operations, whenever possible and practicable.	During the preparation of the remedial plans, the GN-CGS has consulted extensively with community members. Local residents will be used during the completion of the Project activities.
3.13.4 (c)	Refuse, such as fuel drums and scrap metal, shall be recycled where possible.	Where possible, GN-CGS will recycle waste materials.
3.13.4 (d)	Sites containing toxic materials shall be given priority for cleanup, and the location of these sites shall be widely publicized to warn residents.	The Old Town Site is known to contain contaminated material. During the Project, access to Project areas may be restricted. The restricted areas will be marked with signs.
3.13.4 (e)	Sites within or near caribou calving grounds, near water and near communities shall also be given priority for cleanup.	The Project will be completed between 2012 and 2015.
3.13.8	New occurrences of pollution, garbage and contamination caused by anyone shall be prevented. Land users shall ensure that all drums are safely recovered.	The Project will remove all contaminated materials and restore the land. Any contamination caused during the cleanup and reclamation, such as accidental oil spills of fuel or oil, shall be cleaned up in accordance with the Project specific Spill Contingency Plan.

2.1.2 DFO Operational Statement Conformity

The Department of Fisheries and Oceans Canada (DFO) operational statements (OS') that apply to the Project include:

- Nunavut In-water Construction Timing Windows for the Protection of Fish and Fish Habitat
- Culvert Maintenance

During the Project, the measures to protect fish and fish habitat detailed in the DFO OS' above will be met (see **Appendix C** for the signed statement of conformation).

A Letter of Advice may be required from the DFO for the installation of culverts along the proposed access road. Upon receipt of the Letter of Advice, the culvert installation methodology will be reviewed and modified (if required).

2.2 Transportation

The Old Town Site is currently accessible by all-terrain vehicle (ATV) or boat across Patricia Bay from the Hamlet. The existing ATV trails that lead from the community to the Old Town Site are in poor condition. The remaining portions of the Project area (including the borrow sources and solid waste facility) are accessible using existing municipal roads.

During the 2011 geotechnical assessment, Nunami evaluated the potential access road routes between the existing municipal quarry access road and the Old Town Site. Based on the topography, drainage and proximity to areas currently in use, Nunami has selected one route that meets the requirements of the remediation program. This route is outlined in Drawings 06-A to 06-C in **Appendix B**.

Several existing trails at the Old Town Site will be utilized during the Project to access areas requiring excavation; a few new trails may also need to be established to access these areas (i.e., landfarm). The on-site trails must be adequate for heavy equipment use and provide easy access to the inaccessible areas of the Old Town Site, the staging area and the landfarm.

Mobilization of equipment required for the Project to the hamlet is anticipated to be conducted via sealift, with the proposed barge landing area located at the existing wharf in Clyde River. Equipment will then be mobilized via the existing municipal roads and the new access road to the Old Town Site. Commercial aircraft will be used to re-supply the Project, and move personnel as required during the Project.

Waste materials requiring disposal at a southern facility will be transported out of the community via sealift.

2.3 Camp Site

A camp will not be set up during Project activities. All Project personnel will be local residents or be accommodated in existing facilities in the hamlet.

A temporary office trailer will be mobilized to the Old Town Site to facilitate the completion of the Project. Portable bathroom facilities will be also mobilized to the Old Town Site.

2.4 Equipment

Equipment required for the Project are listed below. Digital photos of the equipment are not available.

- Excavators, dozers, graders and loaders – for excavating, transporting, placing and compacting granular material and/or contaminated soils.
- Water trucks – for dust suppression

- Haul/dump trucks – for transporting loads of granular material for road construction. Also, haul/dump trucks required for the transport of contaminated soil and non-hazardous waste.
- Grader – for grading and contouring
- Pick-up truck, ATVs – for crew transportation
- Incinerator – for burning combustible waste, waste fuel and used oil.
- Water treatment system, pumps etc. – for waste water treatment.
- Corrugated steel pipe (CSP) – for culvert material; to be installed at stream crossing and as general drainage culverts.
- Geotextile material with the following minimum requirements:
    - 3.0 m wide by 50 m long, 2.0 mm thick and weight of 200 g/m^2
    - Grab tensile strength of 1000 N and elongation of 15%
    - Puncture resistance (CBR Punc.) of 3500 N
    - Permitivity of 0.05 sec^{-1} and apparent opening size of 400 µm
- Geomembrane material with the following minimum requirements:
    - Grab tensile strength of 450 N and elongation of 12%
    - Nominal thickness of 1.5 mm
    - Tear resistance to 160 N and burst strength to 20 kN/m

2.5 Water

Potable Water

To service the office trailer, potable water will be brought to the Old Town Site from the hamlet. Water will not be withdrawn from waterbodies proximate to the Old Town Site for potable water use during the Project.

Culvert Installation

The proposed Project activities cross several watercourses; these include the previously constructed crossings at the Clyde River and streams within the hamlet, as well as new crossings constructed over four drainage channels located at the Old Town Site (Figure 2, **Appendix A**).

Stream flow is expected to be negligible in three of the four drainage channels (Drainage Channels #2 to #4) during in-stream construction (culvert installation); low water flow may be present in Drainage Channel #1 (see Figure 2 in **Appendix A**). If water is present at the time of installation, temporary cofferdams will be installed up and downstream of the crossing site to enable culvert installation in-the-dry. A water pump around system may be installed to transfer the natural stream flow directly downstream of the work site. The rate of pumping will correspond to the stream flow. An appropriately sized fish screen will be placed on the pump intake to prevent fish entrapment. The downstream pump outlet will also be stabilized, if necessary, to prevent unnecessary scouring and erosion. The proper

installation of temporary cofferdams, silt curtains and silt fences are intended to prevent any potential increases in suspended sediments of waters downstream of the Project.

Dust Suppression

Water used for dust suppression will be sourced from Patricia Bay, as outlined in the Dust Management Plan (**Appendix F**). The water will be pumped from the bay into a water truck equipped with a spray bar for road watering. An estimated 180 m^3 (180,000 L) of water will be withdrawn from Patricia Bay annually during Project activities; this equates to approximately 1.8 m^3 (1,800 L) of water per day during remedial work (100 days per year). Water will likely be withdrawn once per week during Project activities.

The intake location, fish screen size and intake flow rate will be determined by the Contractor based on desired intake flow (L/s). The features of the marine intake will be based on Fedorenko (1991) to minimize entrainment and impingement of marine fish and aquatic organisms.

Excavation Water

Some remedial activities (including the removal of surface waste and excavation) will be completed within 30 m of the high water mark of Patricia Bay and the drainage channels (Drawings 03-A and 03-B in **Appendix B**). During some of these excavations, water intrusion into remedial excavations is expected. When water intrusion occurs, excavation water will be pumped into temporary storage tanks and treated in the on-site wastewater treatment system (see Section 2.6).

Landfarm and Rinse Water

Water used for landfarm watering and cleaning/rinsing on-site equipment and debris (e.g., flushing pipelines and cleaning/rinsing drums and ASTs) will be sourced from the Clyde River. The water will be pumped from the river into a water truck, likely once per week, and brought to the Old Town Site; water will be stored in clean water tanks on site. Water will be treated as described in Section 2.6 before reuse or discharge to the environment. Wherever possible, treated water will be reused for cleaning/rinsing and landfarm watering.

An estimated 20 m^3 (20,000 L) of water will be withdrawn from the Clyde River annually during Project activities; this equates to approximately 0.2 m^3 (200 L) of water per day during remedial work (100 days per year). The intake location, fish screen size and intake flow rate will be determined by the Contractor based on desired intake flow (L/s). The features of the freshwater intake will be based on DFO (1995 and 2003) to minimize entrainment and impingement of freshwater fish.

2.6 Wastewater and Solid Waste

Waste generated during the Project may include, but not be limited to:

- Sewage from the portable bathroom facilities at the Old Town Site;
- Domestic waste from workers daily activities;
- Waste oil;

- Potential contaminated soil;
- Overburden and excavated material from culvert installation; and,
- PHC and metal contaminated surface and groundwater (wastewater).

Sewage generated from the use of portable bathroom facilities will be disposed of at the Clyde River Sewage Lagoon (see Drawing 02 in **Appendix B**).

During the Project, all domestic waste generated during the Project will be transported to Clyde River daily and disposed of at the Solid Waste Facility. Any waste which is left on-site (i.e., before daily removal), will be stored in animal proof containers situated at least 100 m from the high water mark of any waterbody.

Waste oil generated during the Project will be shipped to an approved disposal facility (see also **Appendix D** for the Spill Contingency Plan). Contaminated soil generated during the Project will either be disposed of at the Old Town Site landfarm or at new landfill containment cell, depending on the contaminant type.

Overburden and material excavated during culvert installation will be stockpiled. The piles will be situated a minimum 100 m from the high water mark of any waterbody to prevent material from entering the waterbody. The piles will also be sloped a minimum 2:1 horizontal to vertical ratio to prevent wind and water erosion.

Wastewater arising from the cleaning of fuel tanks and pipelines, dewatering of contaminated soil areas (including water collected from the landfarm), and encountered during the excavation of contaminated areas, may contain several potential contaminants of concern. Wastewater generated during the remedial activities will be treated in the on-site wastewater treatment system. The remediation contractor will be required to provide a treatment system which meets the discharge criteria listed below; as such the specific treatment system cannot be confirmed until contract award.

Following treatment, the wastewater will be contained in suitable storage containers until such time that the analytical results confirm concentrations of contaminants are below applicable wastewater discharge criteria. Wastewater discharge criteria will be based on those outlined in the Project's water license, issued by the NWB. In the absence of criteria established by the NWB, the Government of Nunavut's *Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities* (2002) will be used, at a minimum, as wastewater discharge criteria for the Project. These criteria are presented in Table 2-4; the parameters selected are based on the types of contaminants found at the Old Town Site during the previous investigations.

Table 2-4 Nunavut Environmental Guidelines for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities (2002)

Parameter	Discharge Criteria
pH	6 to 10.5 pH units
Aluminum	1 mg/L
Arsenic	1 mg/L
Cadmium	0.1 mg/L
Chromium	0.1 mg/L
Copper	1 mg/L
Iron	1 mg/L
Lead	0.05 mg/L
Mercury	0.0006 mg/L
Nickel	1 mg/L
Phenolic Compounds	0.02 mg/L
Zinc	0.5 mg/L
Total Suspended Solids	15 mg/L
Oil and Grease	15 mg/L and no visible sheen or odors

The treated wastewater will be tested each time prior to discharge. Once it is confirmed that the treated wastewater meets the discharge criteria, the water will be released onto the ground at the Old Town Site, at least 100 m from the high water mark of any waterbody; the exact discharge point has yet to be determined.

2.7 Fuel

It is estimated approximately 100,000 L of diesel fuel and 10,000 L of gasoline will be required over the life of the Project. All fuel used will originate from the existing bulk fuel storage facility in the Hamlet. Fuel will be transported to the Old Town Site within the equipment's fuel tank, via pick-up truck equipped with tidy tanks, or via the approved community fuel truck.

Secondary containment is provided within the lined bermed storage area of the municipal tank farm which is expected to meet the CCME Code for Aboveground Fuel Storage Tanks. If fuel is required to be stored at the Old Town Site, the tanks will be placed within secondary containment within the lined and bermed Staging Area, as illustrated in Drawing 04-A in **Appendix B**.

Fuel will be transferred through the fuel transfer station at the bulk fuel facility for pick-up trucks, ATVs, and heavy equipment. Fuelling at the Old Town Site will likely be required for the heavy equipment; this will be performed via hand pump (wobble pump on drums) or electrical pump (on pick-up or fuel truck) over spill pads and minimum of 100 m from the high water mark of any waterbody.

A Spill Contingency Plan has been developed for the Project and is included in **Appendix D**.

2.8 Chemicals and Hazardous Materials

Chemicals and hazardous materials used during the Project primarily include oils and lubricants for equipment; it is estimated approximately 1,000 L will be required over the life of the Project. All oils and lubricants for the Project will be stored at an approved location within the existing bulk fuel storage facility in the Hamlet, and transported to the Old Town Site via pick-up truck, if required at site.

Secondary containment will include a lined and bermed storage area within the bulk fuel storage facility. No chemicals or hazardous materials will be stored at the Project sites.

Oils and lubricants will be transferred via a hand pump into equipment. This will occur within the garage during regular equipment maintenance or, if required, out at the Old Town Site over spill pads and minimum of 100 m from the high water mark of any waterbody.

A Spill Contingency Plan has been developed for the Project and is included in **Appendix D**.

2.9 Workforce and Human Resources/Socio-Economic Impacts

A qualified remedial contractor with expertise in completing northern remediation projects will be contracted to execute the Project. The Project will primarily be constructed using local labour and some local equipment. Local employment will include residents, knowledgeable in the use of required heavy equipment, wildlife monitors and general labourers. Where possible, training of local Inuit beneficiaries will occur. All site personnel will be adequately trained in site-specific health and safety requirements and the proper handling of contaminated soil and waste. Designated site personnel will be trained in operational procedures for the landfarm, landfill containment cell, on-site wastewater treatment system, monitoring programs and sampling.

The construction and operation phases of the Project work is expected to be completed over two summer construction periods (August/September 2012 and July to September 2013) and operate 12 hours a day, five days a week (Monday to Friday). The monitoring and decommissioning work associated with the Project is anticipated to occur during the summer months in 2014 and 2015; however, the amount and hours of work cannot be predicted at this time.

Workers will be transported from Clyde River to the Project areas via passenger vehicle and will be transported back to the hamlet at the end of each work day.

The GN, through the Nunavummi Nangminiqaqtunik Ikajuuti (NNI) Policy, has made the use of local, Nunavut and Inuit businesses in the supply of materials, equipment, labor and other goods a priority for this Project.

2.10 Public Involvement / Traditional Knowledge

Parties most affected by this Project include the Hamlet and the Namautaq Hunters and Trappers Organization (HTO).

Community Meeting #1 – June 23, 2009

A community visit was completed in Clyde River on June 23, 2009. The consultation occurred with two council members of the Hamlet, two representatives of GN-CGS (Moonie Kolola and Malli Auluk) and one representative of Nunami. Approximately 40 community members attended the meeting.

The meeting included a presentation by the Nunami representative. After the presentation, a question and answer period was completed. The following comments were provided by the meeting participants:

- Community members were pleased that they were being consulted and asked for their input prior to the remediation occurring.
- They further expressed their pleasure of the fact that action was going to occur and that the Old Town Site was going to be cleaned up. Concern was also expressed about remediation of the site that was occupied by the Americans (Cape Christian).
- Elders suggested that metal and non-hazardous materials can be shipped to local dump, and hazardous material should be shipped to the south. Other community members also expressed that they do not want to see contamination remaining at the Old Town Clyde River Site. There were different opinions as to whether the contaminated soil could be contained in Clyde River landfill or should be sent south for treatment.
- Community members inquired if some of the contaminated materials could be sent to Cape Christian, a site undergoing remediation in 2009/ 2010. At the time, Nunami indicated that this may be a possibility. Due to delays in the Project, this is no longer an option.
- Community members expressed concerns about the availability of heavy equipment to use for the cleanup.
- The preferred option by Elders is to have the contaminated soil removed and not have it buried. The community identified that the Old Town Site is used as a campground, with children accessing the Site. The community would like to see the Old Town Site restored to allow children to play in the area without any risk to their health.
- The community members confirmed that people used to dump garbage into the ocean.
- The community members expressed concern regarding the schedule of cleanup. Malli Auluk (GN-CGS) stressed that we were not able to make any commitment on schedule, since the GN-CGS still has to secure the funds to undertake this work.
- The community members asked if it would be cost effective to ship metal to the south for recycling.

A summary of the presentation, including a detailed list of the questions and answers are provided in **Appendix G**.

Site Assessment – August 2010

Local knowledge was informally collected by Nunami during their 2010 visit to Clyde River (Nunami 2011a). At that time, Nunami was accompanied by a local Elder (Mr. Noah Kautuq) during the environmental assessment and local knowledge of the Project area was obtained.

Information regarding wildlife and plant species, fish presence, and heritage sites were incorporated into the overall assessment and provided excellent background about the Project area.

Community Meeting #2 – March 28, 2012

A second community visit was completed in Clyde River on March 28, 2012. Consultation occurred with members of the Hamlet and approximately 35 community members.

The consultation included a presentation by a Nunami representative regarding the history of site; historical site investigations completed at the site; site investigations completed at the site in 2010; types and quantities of on-site contamination; clean-up methodology; construction facilities for remediation, including landfill, landfarm and temporary road for remediation; benefits to the community from the clean-up project; and, future steps. After the presentation, a question and answer period was completed. A summary of the presentation, including a detailed list of the questions and answers, are provided in **Appendix G**.

Traditional Knowledge

As mentioned, a local Elder accompanied Nunami during the 2010 ESA. No other sources of traditional knowledge were utilized during the preparation of this Project.

On-going Community Consultation

Prior to the commencement of each work season, community meetings will be held with the Hamlet, HTO and residents of Clyde River to update them on planned work activities for the year. Upon completion of the Project, a final community meeting will be held to provide a summary of work completed at the Old Town Site

3 PROJECT SPECIFIC INFORMATION

3.1 Site Cleanup / Remediation

3.1.1 Contaminated Areas

3.1.1.1 Surficial Waste

Wastes are distributed throughout the Old Town Site. Some wastes are located within dump areas however the majority of the wastes are scattered across the Old Town Site.

Existing Dumps

There are four existing dumps at the Old Town Site: the Site Dump, the Beach Dump, the Fuel Dump, and the Extreme South Beach Dump. None of these dumps are engineered facilities. Drawings 03-A and 03-B in **Appendix B** illustrate the location of these dumps at the Old Town Site while the area name (on Drawings 03-A and 03-B), areal extent, depth, volume and coordinates for each of the dump areas is provided in Table 3-1.

Table 3-1 Existing dump sites at the Old Town Site, Clyde River, NU

Dump Name	Remediation Area No.	Area (m^2)	Volume (m^3)	Approximate Depth (m)	Location	
					Latitude	Longitude
Site Dump	E9-A to E9-C	137	22	0.5	70º27'20" N	68º33'12" W
Beach Dump	D15-A	1,835	294	0.5	70º27'40" N	68º33'22" W
Fuel Dump	B9-A	46	7	0.5	70º26'18" N	68º33'46" W
Extreme South Beach Dump	B2-9	2,629	421	0.5	70º26'58" N	68º33'45" W

The remedial activities at the dumps will include the excavation of all waste materials. The depth of each dump excavation will extend to the depth where debris is no longer visible. Wastes encountered will be processed similar to the surface debris described below.

Surface Debris

Surface debris present at the Old Town Site includes areas of scattered visible debris on the existing ground surface, visible partially buried debris within 0.5 m of the existing ground surface, and debris located within 2 m depth of water.

In total, twenty-two areas of surface debris (containing approximately 1,458 m^3 of waste) were identified at the Old Town Site. These areas contained both hazardous and non-hazardous waste. The location of all surface debris is illustrated on Drawings 03-A and 03-B in **Appendix B**.

Prior to the removal of wastes from the Old Town Site, a temporary debris and waste sorting area (Staging Area) will be constructed (see Drawing 04-A in **Appendix B**). The staging area will be used to

sort, package, sample and process hazardous and non-hazardous waste. Hazardous wastes will be processed in a specific Hazardous Material Processing Area within the staging area.

Prior to removal, surficial debris will be visually assessed to determine the type and nature of the debris/waste. If wastes are considered to be hazardous or potentially hazardous, the suspected wastes will be stored in secure containers.

Surficial debris will be transported to the staging and sorting areas using dump trucks. The processing requirements for the waste streams are described below:

- Combustible, non-hazardous waste will be incinerated at the Old Town Site.
- Non-combustible, non-hazardous waste (including ash from on-site incineration) will be collected and transferred to the new containment cell at the Clyde River Solid Waste Facility.
- Building foundations (concrete) will be dismantled and disposed of at the new containment cell at the Clyde River Solid Waste Facility.
- ASTs and other drums/tanks will be drained and rinsed, and all pipelines will be flushed to remove all fuel residues from the tank system. The liquid contents of the tank system will be incinerated. Any ash generated will be disposed of at the landfill containment cell at the Clyde River Solid Waste Facility. Any rinsate will be sampled. If concentrations of contaminants of concern exceed the applicable discharge criteria (Section 2.6), the rinsate will be treated in the water treatment system or disposed off-site to a licensed disposal facility. If off-site shipment is required, the rinsate will be containerized in accordance to with *Transportation of Dangerous Goods Act* (TDGA) regulations prior to transport from the Old Town Site.
- Drums will be drained, rinsed, crushed and disposed at the new containment cell at the Clyde River Solid Waste Facility. Any rinsate will be sampled. If concentrations of contaminants of concern exceed the discharge criteria (Section 2.6), the rinsate will be treated in the water treatment system or disposed off-site to a licensed disposal facility. If off-site shipment is required, the rinsate will be containerized in accordance to with TDGA regulations prior to transport from the Old Town Site.
- Any hazardous wastes will be collected, placed in appropriate containers / drums and transported to the Hazardous Material Processing Area in the staging area. The wastes will then be inspected, tested, classified and packaged as necessary for transport (if necessary) and disposal at an approved disposal facility in southern Canada. Any hazardous waste requiring transport to a disposal facility in southern Canada will be stored in a secure temporary storage area in the hamlet prior to shipment; the location of this storage area has yet to be decided. Any lead paint materials will be collected, placed in containers and transported to the Staging Area. The lead paint materials in good condition (i.e., no flaking of paint) will be sorted, sampled, re-packaged and then transported to the landfill containment cell at the Clyde River Solid Waste Facility. Loose and flaking lead paint will be removed from all painted surfaces, and collected for off-site disposal.

Salvageable Equipment

Based on the condition of the wastes present at the Old Town Site, there is no salvageable equipment, infrastructure or supplies present.

3.1.1.2 Contaminated Soil

It is estimated that approximately 9,765 m^3 of contaminated soils have been identified at the Old Town Site. Table 3-2 summarizes the contaminants of concern exceeding the applicable regulatory criteria in soil at the Old Town Site and presents the maximum concentration for each contaminant (Nunami 2011a).

Table 3-2 Maximum concentrations of contaminants of concern in soil samples from the Old Town Site, Clyde River, NU (Nunami 2011a)

Contaminant	Maximum Surface Soil Concentration (mg/kg)[1]
Aluminum	340,000[b]
Chromium	160[a]
Hexavalent Chromium	0.5[b]
Copper	12,000[a]
Lead	1,300[b]
Nickel	500[a]
Selenium	2.7[b]
Silver	36[b]
Zinc	1,500[b]
Naphtalene	3.9[a]
Benzene	0.1[b]
Toluene	0.46[b]
Ethylbenzene	2.2[b]
Xylenes	17[b]
PHC F1 (C6-C10)	1,400[b]
PHC F2 (>C10-C16)	18,000[b]
PHC F3 (>C16-C34)	73,000 [a]
PHC F4 (>C34)	120,000 [a]

NOTES:
[1] Concentrations reported as milligrams per kilogram (mg/kg)

The contaminated soil has been subdivided into three types each having its own remedial methodology.

- *Petroleum Hydrocarbon Contaminated Soil* – will be excavated and transported to the landfarm facility at the Old Town Site for bioremediation.
- *Metal Contaminated Soil* – will be excavated and transported to the new containment cell at the Clyde River Solid Waste Facility for disposal.

- *Aluminum Waste Footprint* – will be excavated and transported to the new containment cell at the Clyde River Solid Waste Facility for disposal.

The remedial criteria for each type of contaminated soil, accompanied by the estimated soil volumes, are presented in Table 3-3.

Table 3-3 Summary of contaminated soil remedial criteria and estimated contaminated soil volumes at the Old Town Site, Clyde River, NU (Nunami 2011a)

Contaminant Type	Criteria	Soil Volume (m^3)[1]
Petroleum Hydrocarbon Contaminated Soil	Soils containing concentrations of any or all of the contaminants listed as follows: Benzene - 31 mg/kg Toluene - 75 mg/kg Ethylbenzene - 55 mg/kg Xylenes - 95 mg/kg PHC Fraction F1 - 240 mg/kg PHC Fraction F2 - 3,700 mg/kg PHC Fraction F3 - 1,800 mg/kg PHC Fraction F4 - 2,800 mg/kg	7,500
Metal Contaminated Soil	Soils containing concentrations of any or all of the contaminants listed as follows: Aluminum - 158,000 mg/kg Lead - 474 mg/kg Copper - 939 mg/kg Nickel - 258 mg/kg Hexavalent Chromium - 0.4 mg/kg Silver - 20 mg/kg Selenium - 1 mg/kg Zinc - 200 mg/kg	827
Aluminum Waste Footprint	Soils containing concentrations of aluminum greater than 158,000 mg/kg; and concentrations of any or all of the contaminants listed as follows: Benzene - 31 mg/kg Toluene - 75 mg/kg Ethylbenzene - 55 mg/kg Xylenes - 95 mg/kg PHC Fraction F1 - 240 mg/kg PHC Fraction F2 - 3,700 mg/kg PHC Fraction F3 - 1,800 mg/kg PHC Fraction F4 - 2,800 mg/kg	1,438

NOTES:
[1] A 15% bulking factor and 25% contingency are added to the soil volumes for the three contaminant types

3.1.1.3 Water

Petroleum hydrocarbon and metal contaminated water was encountered in several areas during the previous investigations.

Surface Water

Table 3-4 summarizes the contaminants of concern exceeding the applicable regulatory criteria in surface water at the Old Town Site and presents the maximum concentration for each contaminant (Nunami 2011a).

Table 3-4 Maximum concentrations of contaminants of concern in surface water at the Old Town Site, Clyde River, NU (Nunami 2011a)

Contaminant	Maximum Concentration (µg/L)[1]
Aluminum	27,000
Antimony	27
Arsenic	28
Copper	420
Iron	53,000
Lead	830
Manganese	560
Nickel	65
Thallium	1.1
Uranium	26
Zinc	96

NOTES:
[1] Maximum concentrations are total metal concentrations; reported in micrograms per litre (µg/L)

The areas exhibiting concentrations exceeding the applicable criteria for water are in the vicinity of areas requiring excavation of metal and/or petroleum hydrocarbon impacted soil.

Groundwater

Table 3-5 summarizes the contaminants of concern in groundwater exceeding the applicable regulatory criteria at the Old Town Site and presents the maximum concentration for each contaminant (Nunami 2011a).

Table 3-5 Maximum concentrations of contaminants of concern in groundwater at the Old Town Site, Clyde River, NU (Nunami 2011a)

Contaminant	Maximum Concentration (µg/L)[1]
Benzene	2.6
Toluene	25
Ethylbenzene	9.5
PHC Fraction F1	2.9
PHC Fraction F2	93
PHC Fraction F3	59
PHC Fraction F4	7.3
Aluminum	190
Antimony	0.01
Arsenic	0.13
Beryllium	0.006
Cadmium	1.5
Chromium	0.44
Cobalt	0.17
Copper	0.85
Iron	340
Lead	0.41
Nickel	0.27
Selenium	0.02
Thallium	0.0067
Uranium	0.049
Vanadium	1.6
Zinc	1.1

NOTES:
[1] Maximum concentrations are total metal or PHC fraction concentrations, reported in micrograms per litre (µg/L)

It is estimated that approximately 1,000 m^3 (1,000,000 L) of surface water and groundwater may need to be managed during the remediation activities. This is inclusive of water collected from dewatering activities, including potentially contaminated contact water from the landfill, landfarm and contaminated soil excavations, as well as ponded surface water runoff. Contact water will be analysed prior to collection to determine if it meets applicable discharge criteria. If contact water meets discharge criteria, it will be discharged without treatment; if it does not meet criteria, contact water will collected and treated through the on-site water treatment system (see Section 2.6).

Upon completion of the remedial activities, groundwater quality will be reassessed to establish post remediation contaminant concentrations. Groundwater quality will also be monitored following remediation activities, during the operation of the landfarm facility (i.e., up to 2015).

3.1.1.4 Sediment

Sediment samples collected within the nearshore area of Patricia Bay during the previous investigations did not identify any contaminants of concern exceeding the applicable regulatory criteria (Nunami 2011a). Accordingly there will be no remediation activity for sediments.

3.1.2 Remedial Methods

3.1.2.1 Landfill Containment Cell

The landfill containment cell will be constructed at the Clyde River Solid Waste Facility to dispose of lead impacted waste, asbestos waste, metal contaminated soil and aluminum waste. The perimeter of the cell will measure approximately 67.4 m x 85.4 m while the inside will measure 50 m by 32 m. The landfill containment cell will be located approximately 17 m east of the existing municipal facility and be constructed greater than 100 m from any waterbody, in an area free of ponded water. Four groundwater wells will be installed around the perimeter of the facility to enable groundwater monitoring during operations through to post-closure. The engineered design for the new containment cell is provided on Drawing 05-B in **Appendix B**.

Prior to the construction of the cell, a Landfill Containment Cell Construction Plan will be submitted by the contractor. Construction of the landfill containment cell will include ground preparation (e.g., removal of boulders, all vegetation, loose soil, ice and snow [if present]), installation of geotextile liner directly on the ground surface, and preparation of a sand layer (0.6 m cell pad) on top of the liner. A geomembrane liner will be placed on top of the sand layer followed by a minimum 150 mm sand layer. The exterior berms will then be constructed (see Drawing 05-B in **Appendix B**).

During construction, the facility will be inspected by the on-site Project Engineer. Construction inspection will include visual inspection as well as geotechnical sampling (i.e., gradation, compaction and moisture condition tests) as construction progresses. A Senior Project Engineer will also visit the Project site a minimum of four times during facility construction to conduct design specification inspections and ensure construction quality. Constructed structures/facilities will also be inspected weekly during operations and after any precipitation event.

On-site, all vegetation, loose soil, ice and snow from the landfill footprint will be removed before placement of granular materials. In order to protect the structural integrity of the containment cell, no heavy equipment will be permitted to work within the landfill until a 500 m base of waste material is present within the cell.

During operation of the landfill containment cell, metal impacted soil and aluminum waste will be deposited into the cell in 0.5 m lifts. To ensure contaminated soil volumes do not exceed capacity of landfill containment cell, a 15% bulking factor and 25% contingency have been added to the contaminated soil volumes. Lead based painted materials will be deposited on top of impacted soil inside of the cells. Bagged asbestos-containing materials will be consolidated into one location and covered with enough soil so that none of the bags are exposed.

The cell will be monitored for water accumulation during remedial activities; if water is present within the cell, dewatering of the cell will be conducted. The waste water collected will be treated in the water treatment system to meet the discharge criteria in Section 2.6.

Upon closure of the landfill containment cell, a geomembrane liner will be placed on top of the landfilled wastes and covered with a 0.4 to 0.5 m sand cap (as illustrated in Drawing 05-B in **Appendix B**). The granular material will then be compacted to 95% maximum dry density and graded (2 to 4%) to promote surface water runoff.

3.1.2.2 Staging Area

As discussed in Section 3.1.1.1, a debris and waste sorting area (Staging Area) will be constructed at the Old Town Site, immediately west of the landfarm (see Drawing 04-A in **Appendix B**). The Staging Area will be used to sort, package, sample, and process hazardous and non-hazardous waste. The Staging Area will be constructed greater than 100 m from any waterbody, in an area free of ponded water.

3.1.2.3 Landfarm

A landfarm will be constructed for the biotreatment of hydrocarbon contaminated soils; it will be situated 200 m east of Patricia Bay on the Old Town Site (see Drawing 04-A in **Appendix B**) and be constructed greater than 100 m from any waterbody, in an area free of ponded water. The perimeter of the landfarm will measure 124 m by 85.4 m while the inside will measure 113 m by 74.4 m. Four groundwater wells will be installed around the perimeter of the facility to enable groundwater monitoring during operations through to post-closure. The engineered design for the new containment cell is provided on Drawing 04-B in **Appendix B**.

Development, operation, and closure of the landfarm will involve the following tasks:

- Construction and maintenance of trails required to support the landfarm.
- Ground preparation, including the removal of boulders, installation of geotextile liner directly on ground surface, and preparation of a sand layer (0.5 m landfarm pad) on top of the liner. A geomembrane liner will be placed on top of the sand layer followed by a minimum 150 mm sand layer.
- Construction of exterior berms and interior drainage swales (approximate 0.4 m deep by 1.0 m wide) to collect potential runoff.
- Inspection of facility by on-site Project Engineer throughout construction:
    - Construction inspection will include visual inspection as well as geotechnical sampling (i.e., gradation, compaction and moisture condition tests) as construction progresses
    - A Senior Project Engineer will also visit the site during facility construction to conduct design specification inspections and ensure construction quality
    - Constructed structures/facilities will also be inspected weekly during operations and after any precipitation event.

- Placement of PHC contaminated soil inside of the landfarm. Approximate capacity of the landfill is 8,407 m^3; the contaminated soil stockpile not to exceed 1.0 m in height.
- Specific activities for landfarming operations including aeration, tilling, moisture conditioning and sampling; these will occur as proposed in the Hydrocarbon Contaminated Soils Treatment Plan, or as follows:
    - Aeration of the full thickness of the contaminated soil will occur August through September with the use of an excavator.
    - Moisture will be maintained to approximately 15% and tested weekly
    - Any oversize materials (i.e., boulders) encountered in remedial excavations will be washed and left on site

At the conclusion of the final treatment system, the following tasks will be completed to close out the landfarm:

- Confirmatory sampling with testing of the soils to ensure that the remedial objectives for the soil (Table 3-3) have been met.
- Consolidation of treated soil within the landfarm to a maximum height of 1 m.
- Removal of the geomembrane liner, and its disposal at the landfill containment cell.
- Placement of 300 mm of granular material from the perimeter berms over the landfarm area.
- Grading of the surface of the landfarm area (2 to 4%) to promote surface water runoff.

A Hydrocarbon Contaminated Soils Treatment Plan will be developed prior to construction of the landfarm. This plan will provide information regarding the following:

- The methodology for treatment of the hydrocarbon contaminated soils;
- The sampling and analytical program to monitor the treatment progress; and,
- The methodology for the handling and storage of the material, equipment and supplied related to the soil treatment process.

Development of this treatment plan is anticipated in July 2012, following contract award. The treatment plan will be provided to the required regulatory agencies for review and comment prior to construction of the facility.

3.1.3 Erosion Control

During the Project, erosion control measures will be implemented to protect native soils from erosion and permafrost degradation. These measures include:

- Use of sediment control structures including fences, ditches, geotextiles, drains, berms, terracing, temporary drainage piping, sedimentation basin dikes, and any other control structures, to prevent erosion and migration of silt, mud, sediment and other debris. The

sediment control measures will be used for the duration of the construction phase of the Project.

- Construction activities will prevent encroachment of equipment into waterbodies or drainage ditch banks.
- The use of erosive surface silts and clays will be avoided during the construction activities.
- Existing embankments or embankment protection will not be disturbed during the Project.
- Earthwork structures, including the new containment cell at the Clyde River Solid Waste Facility, the landfarm, staging area, etc., will be inspected weekly during remedial activities for evidence of erosion or sedimentation. If evidence of erosion or sedimentation is found, corrective measures will be completed promptly.
- Erosion control measures will be maintained throughout the duration of the Project.
- Use of silt fencing and other silt mitigation measures to prevent waterway sedimentation.
- Upon completion of the Project, all installed erosion control measures will be removed.

Dust Management

A Dust Management Plan (DMP) has been developed for the Project (see **Appendix F**) to reduce the potential for fugitive dust emissions from use of the access road, development of the borrow sources, and excavation and placement of granular materials.

Contouring

Contouring activities to be completed during the Project include:

- Granular fill will not be based on snow or surface ice to maintain natural drainage patterns.
- Depressions on the access road and site trails will be filled to prevent any ponding of water adjacent to the embankment
- Fill materials are to be placed in an unfrozen state to minimize slumping.

Re-vegetation

No re-vegetation of disturbed areas will occur upon completion of the Project; the site will be allowed to re-vegetate naturally.

3.2 Roads/ Trails

3.2.1 Project Information

Field Investigations

Nunami completed a geotechnical assessment to identify the proposed access road route and complete a preliminary road design (Nunami 2011c). The geotechnical assessment is provided in **Appendix G**.

An HRIA will be completed during the summer of 2012 to identify any sensitive cultural and heritage sites along the access road route and suggest any mitigative actions required. Once the HRIA is completed, the routing of the road will be altered, if necessary, to avoid specific cultural and heritage sites.

The preliminary road route is illustrated in Drawings 06-A to 06-C in **Appendix B** while the typical road cross section is presented in Drawing 06-D in **Appendix B**.

Type of Traffic, Access and Maintenance

The proposed access road is being constructed to facilitate the remediation of the Old Town Site. Following completion of the remedial activities, the access road will be decommissioned to prevent community use and protect against human health and public safety risks. During the remediation, trucks and equipment will travel the access road. The remediation activities will occur during summer and fall months (July to September) only. For public safety reasons, community use of the access road during Project activities will be discouraged through communication of potential safety hazards (i.e., posting public notices, radio broadcasts, on-going community consultation) and stopping residential traffic when possible. Only Project-related traffic will be approved for travel on the access road.

Maintenance of the road will occur during July to September, when the remediation activities are being completed. The road will not be maintained or ploughed in the winter. The access road and culvert installations will also be inspected weekly during operations. Where required, culvert maintenance will be completed as per the DFO OS' for culvert maintenance.

3.2.2 All Weather Road / Access Trail

Road Design for Permafrost

Nunami has designed the road for construction in a permafrost area and road use over two seasons (i.e., not permanent). The road cross-section (Drawing 06-D **Appendix B**) is typical permafrost region design, ensuring permafrost degradation is prevented or kept to a minimum. Design features include a minimum 1.2 m embankment fill with to help insulate the underlying soil and assist in the development of a solid road base, and a sloped shoulder with a 2:1 horizontal to vertical ratio to minimize erosion of the shoulder and prevent cracking.

As cutting of native soil will expose the underlying frozen soils that may be susceptible to thaw, the roadway will be constructed entirely of fill and will not include any cutting as a means of balancing fill volumes.

Construction Materials

The road bed will be constructed with general granular material (see Drawing 06-D in **Appendix B**)provided from the Hamlet's existing granular source (quarry) and utilization of seven additional borrow sources (Deposits 1 to 7; see Figure 3 in **Appendix A**).

Prior to construction of the road, the route will be uniformly graded with aggregate fill materials. Approximately 1.2 m of embankment fill will be placed over the existing soils to prevent seasonal thaw. The embankment fill will be placed in 150 mm lifts and compacted. In wet areas, the material will be worked with heavy equipment (blading) to obtain the optimal moisture content.

A 100 mm to 150 mm gravel layer will be placed above the embankment fill. The finished road top will measure 4.0 m wide and be crowned (3%) to aid drainage on the road surface. Each shoulder will have a minimum 2:1 slope, providing the minimum 9.2 m wide footprint.

The acid rock drainage potential or metal leaching characteristics are not known for the borrow sources in Clyde River.

Construction Techniques

As stated previously, the road will be constructed following the standard fill method. No cutting and/or balancing of fills will be permitted. Construction will occur during the summer months (July to September).

The road is designed for one way traffic and turnouts have been provided at least every 500 m, at crests of hills, or in areas with limited sight lines, to allow oncoming traffic to pull over to accommodate passing of vehicles. Where they occur, the turnout areas add an additional 4.0 m of width to the road footprint.

During construction, the access road and culvert installations will be inspected by the on-site Project Engineer. Construction inspection will include visual inspection as well as geotechnical sampling (i.e., gradation, compaction and moisture condition tests) as construction progresses. A Senior Project Engineer will also visit the Project site a minimum of four times during the construction phase to conduct design specification inspections and ensure construction quality.

Fuelling Facilities

As discussed previously, if fuel is required to be stored on-site, the tanks will be placed within secondary containment within the lined and bermed Staging Area (see Drawing 04-A in **Appendix B**).

Traffic Speed & Dust Management

Road speed will likely be set at 30 km per hour, similar to other municipal roads. The access road and road speed will be regulated in accordance with local bylaws and territorial legislation.

A DMP has been developed and is included in **Appendix F**. The DMP will be implemented during construction and operation of the access road and borrow sources.

3.2.2.1 Culvert Design and Construction

General Culvert Information

Water crossings and culvert locations are illustrated on Drawings 06-A to 06-C in **Appendix B**; typical culvert detail is presented in Drawing 06-D in **Appendix B**. A total of eight (8) culverts will be installed along the proposed access road; this includes four general drainage culverts and four water crossings. Culvert locations and Project water crossing names are provided in Table 3-6.

Table 3-6 Culvert locations and water crossings along the proposed access road, Clyde River, NU

Culvert No.	Waterbody	Location		
		Kilometre	Latitude	Longitude
1	-	0+800	70º28'7" N	68º32'55" W
2	-	1+460	70º27'49" N	68º33'15" W
3	-	1+880	70º27'36" N	68º33'26" W
4	-	2+175	70º27'27" N	68º33'32" W
5	Drainage Channel #4	2+240	70º27'25" N	68º33'35" W
6	Drainage Channel #1	2+390	70º27'22" N	68º33'44" W
7	Drainage Channel #2	2+460	70º27'19" N	68º33'46" W
8	Drainage Channel #3	2+560	70º27'16" N	68º33'44" W

Culvert Installation

The proposed start date for all construction activities is mid-August, 2012. Access road construction is expected to take place over two months and the predicted completion date is October 2012. Construction will begin and will move successively southward along the proposed route.

Stream flow and water depth is expected to be minimal (i.e., less than 100 mm water depth) at all four drainage channels during culvert installation. Corrugated steel pipe (CSP) culverts, with a minimum diameter of 300 mm and minimum length of 10 m, will be installed as per manufacturer's specifications. The minimum culvert diameter of 300 mm was determined based on previous site observations and the temporary nature of the access road and culvert installations. Using an inlet control nomograph (CSPI 2007) and a standard headwater to diameter ratio of 1.5, the design flow for these culverts is estimated at 0.07 m^3/s. Where required, multiple culverts (i.e., two) will be installed at a water crossing to ensure adequate flow through the road. Final culvert sizes at water crossings will be verified with the Contractor prior to construction.

The installation site will be dug out to three times the width of the culvert and will follow the natural slope and course of the ground or drainage channel; excavation of the drainage channel beds will occur at inlet and outlets to construct aprons (maximum of 300 mm). The culvert will be placed directly on the ground or drainage channel bed and be backfilled with clean rock (minimum 300 mm diameter) to the

height of the culvert. The culvert will then be covered with clean rock (minimum 200 mm diameter) to match road grade; the thickness of this layer will be a minimum of 0.4 m or half the culvert's diameter, whichever is greater. See Drawing 06-D in **Appendix B** for an illustration of a typical culvert installation.

The proposed maintenance methodology adheres to the specifications outlined in DFOs Culvert Maintenance Operational Statement for Nunavut (DFO 2007b). Additional site specific details will be provided upon tendering of the contract and submission of the appropriate logistical plan to the GN-CGS.

Culvert Maintenance

Culverts will be maintained in accordance with the DFO Nunavut Operational Statement for Culvert Maintenance (DFO 2007b). During the lifespan of the access road, culverts will be inspected annually for indications of scour degradation, culvert blockage, diversion of stream flow, bank erosion and flooding.

Culverts may eventually need to be cleaned of debris (e.g., vegetation debris, garbage, ice build-up) to enable unobstructed water passage. If it appears the culvert needs to be cleaned, any materials inside or lodged at the inlet of the culvert will be removed and disposed of away from the stream channel. If sediment accumulation becomes large (i.e., culvert greater than 50% full of sediment), some sediment will be cleared out. Sediment clearing will occur during the low flow period and, if required, sediment control measures (e.g., silt fences) will be installed prior to any sediment clearing in non-ephemeral streams.

3.3 Pits and Quarries

Borrow Source Activities and Material to be Extracted

Material from the borrow sources will be used to supply granular material for the construction of the access road, construction of a new containment cell at the Clyde River Solid Waste Facility, construction of a Staging Area and landfarm at the Old Town Site, and backfilling. Each of the borrow sources will be accessed using existing municipal roads.

Field Investigations

In 2011, Nunami completed a geotechnical assessment to identify potential construction borrow sources to be used during the Project. Eight borrow sources were selected and identified as being either currently active or previously active (by the Hamlet). Based on the findings of the assessment, approximately 29,300 to 36,800 m^3 of sand and 7,100 to 9,000 m^3 of natural sand and gravel were sourced for the Project from these eight existing sources.

Based on the Project's preliminary design, it is anticipated that there may be a shortfall of borrow materials. To address the anticipated shortfall, three of the existing borrow sources (Deposits 4, 5 and 6) can be combined into one large borrow source (total area of approximately 100,000 m^2) to provide an additional 30,000 to 50,000 m^3 of sand (Figure 3 in **Appendix A** and Drawing 02 in **Appendix B**).

However prior to the development of this combined source, other existing borrow sources will be exhausted first.

Table 3-7 outlines the activities that may take place at the specific borrow sources, as well as the description of the available materials, the total area, volume and dimensions of the existing source.

Table 3-7 Activities, descriptions, volumes and dimensions of existing borrow sources for Project use, Clyde River, NU

Deposit No.[1]	Activities	Description	Volume of Material		Area (m^2)	Depth (m)
			Sand (m^3)	Sand and Gravel (m^3)		
Existing Hamlet Quarry (TP017)	Overburden removal (if any), pitting, quarrying (e.g. cutting, digging, blasting), crushing and stockpiling	Existing quarry. Rip rap sized rock readily available in existing stockpiles or by blasting	3,000 to 4,000	1,500 to 2,500	15,000 to20, 000	0.2
1 (TP045)	Overburden removal (if any), pitting and stockpiling	Sand and gravel at surface to 0.5 m below grade (mbg).	500 to 1,500	0	1,000 to 1,500	0.5
2 (TP046)	Overburden removal (if any), pitting and stockpiling	Fine grained sand at surface to depth of 1.0 mbg.	1,000 to 2,000	0	1,000 to 2,000	1.0
3 (TP047)	Overburden removal (if any), pitting and stockpiling	Poorly graded to gap graded sand and gravel. Underlain by permafrost.	9,800 to 11,200	4,200 to 4,800	14,000 to 16, 000	0.7
4 (TP048)	Overburden removal (if any), pitting and stockpiling	Poorly graded to gap graded sand and gravel. Underlain by permafrost.	4,200 to 5,200	800 to 1,000	8,000 to 10,000	0.65
5 (TP049)	Overburden removal (if any), pitting and stockpiling	Sand and gravel with trace silt at surface to 0.45 mbg.	5,400 to 6,300	0	12,000 to 14, 000	0.55
6 (TP050)	Overburden removal (if any), pitting and stockpiling	Sand and gravel with trace silt at surface to 0.60 mbg. Stockpile of 25 mm crush gravel present at the source during the geotechnical assessment.	2,400 to 3,000	600 to 700	4,000 to 5,000	0.6
7 (TP051)	Overburden removal (if any), pitting and stockpiling	Well graded 25 mm minus gravel	3,000 to 3,600	0	5,000 to 6,000	0.6

NOTES:
[1] Deposit number with 'TP' is referenced on Drawing 02 in **Appendix B**

Carving Stone Deposits

No carving stone deposits were identified during the geotechnical assessment. Surficial geology analyses of the area did not identify sources of serpentinite, argillite or soapstone in the area (Smith et. al. 2012).

Thermokarst and Slumping Potential

Surficial geology and permafrost mapping completed in the Clyde River area identified widespread thermokarst depressions atop thick terraced raised marine and glaciomarine sandy sediments containing saline permafrost (Smith et. al. 2012). Upon review of the surficial mapping, ice wedges were observed in five of the borrow sources (Deposits 3 to 7) (Smith et. al. 2012) while thermokarst depressions were identified on the southern boundaries of borrow sources Deposits 3 and 6 (Smith *et. al.* 2012).

The Clyde River area is also characterized by the presence of other permafrost related landforms (e.g., patterned ground, ice wedges) and is subject to processes such as weathering (e.g., frost shattering) and mass movement (e.g., gelifluction, frost creep). Large ice wedge furrows have been observed east of the airport (Smith *et. al.* 2012).

The reported depths of the identified borrow sources are between 0.2 m and 1.0 m (Nunami 2011c). The depth to permafrost in the area has been reported between 0.2 m to 1.2 m, depending on the terrain and landform (Nunami 2011c). Therefore, it is likely that permafrost will be encountered during excavation particularly at the deeper borrow sources. Based on the specifics of this project, some melt back of the upper permafrost is likely to occur following excavation. In addition, excavation of material at the identified borrow sources will expose underlying permafrost to warming and may cause permafrost thaw and slumping.

Mitigation measures will be established to protect the underlying permafrost of borrow sources to prevent excessive thaw and subsequent slumping; the mitigation measures are presented in Table 5-2 in Section 5.1.

Flood Potential

The identified borrow sources are situated on raised landforms. With the implementation of permafrost mitigation measures described in Table 5-2 (Section 5.1), the potential for flooding at the borrow sources will be reduced. The establishment of a minimum of 30 m undisturbed buffer between the borrow source and the high water mark of any waterbody will further mitigate against flooding potential.

If flooding does become an issue at one or more borrow sources, drainage ditches / channels will be constructed to promote drainage away from the pit. Silt fences will be installed downstream of any drainage to permit reduction of suspended solids and any downstream impacts to surface water quality and fish habitat.

Erosion & Sedimentation Potential

To reduce the potential for wind and water erosion of the pit face, floor and stockpiles, all excavated slopes and piles will have a minimum horizontal to vertical ratio of 2:1. Silt fences will be installed to reduce the presence of suspended solids (sedimentation) in run-off and prevent impacts to surface water quality and fish habitat.

Ground Moisture

Based on the information collected during the geotechnical assessment, the moisture content in sand at the borrow sources ranged from 5.9 % to 14.2 % (Nunami 2011c).

Blasting Methods / Explosive Use

With the exception of the existing quarry, blasting will not be required to access the granular resources. As such, no explosives will be used during the Project.

Metal Leaching / Acid Rock Drainage

Studies for acid-generating and metal leaching potential of granular materials in the borrow sources have not been completed.

Safety Measures

Applying the appropriate health and safety measures at the active borrow sources is important for ensuring the health and safety of the workers and the public. All active borrow sources will be identified with stakes and flagging and access barriers will be installed. The community will be informed of the location of the active borrow sources via the local radio and posting of notices. Information shared will include the location of activities, scheduled times of activities, and equipment transportation paths.

All staff working within the borrow source areas will be required to carry handheld radios, wear appropriate personal protective equipment (PPE) (i.e., hard hats, steel-toe boots, reflective vests and appropriate clothing), and work with a buddy system (not alone). Tailgate safety meetings will be held with all borrow sources staff prior to the day's activities; these meetings will serve to inform the staff of the day's tasks, potential hazards, mitigation measures, required PPE and emergency procedures.

3.4 Excavation

Methodology

Contaminated soils identified at the Old Town Site will be excavated mechanically.

Extent of Excavation

The extent of each excavation has been determined considering the site-specific target levels (SSTLs) developed during the HHERA, and the other applicable regulatory criteria. Table 3-8 identifies the approximate extent of impacts for each type of contaminated soil.

Table 3-8 Excavation extents for metal and petroleum hydrocarbon contaminated soil at the Old Town Site, Clyde River, NU

Name of Area	Impacted Area (m^2)	Depth (m)	Estimated Soil Volume (m^3)
Metal Contaminated Soil			
C8-A	189.4	0.2	41
C11-A	112.6	0.8	132
D7-A	231.2	0.3	97
D7-B	87	0.8	102
D9-B	281.2	0.7	276
D10-D	102.3	0.9	130
E9-D	164	0.2	48
Aluminum Waste Footprint			
B9-A	624.3	0.5	476
C10-B	275.4	0.5	208
C10-D	231.2	0.5	175
C10-D	144	0.5	109
D10-B	524.2	0.5	396
Petroleum Hydrocarbon Contaminated Soil			
B8-A	582.3	1.2	984
C10-A	1481	1.7	3,545
C10-C	573.3	1.1	885
D10-C	828.5	0.9	1,052
D9-A	149.8	1.1	238
D10-A	290.3	1.1	430
E9-D	116.2	1.5	246
E9-A	92	0.9	121

Location

The areas of contaminated soil requiring excavation are illustrated on Drawings 03-A and 03-B in **Appendix B**.

Metal Leaching / Acid Rock Drainage

Studies for acid-generating and metal leaching potential of the contaminated soil have not been completed.

4 EXISTING ENVIRONMENT

4.1 Physical Environment

4.1.1 Terrain

The Old Town of Clyde River is located on the east side of Patricia Bay, on the eastern coast of Baffin Island. The area lies within the Baffin Island Coastal Lowlands ecoregion of the Arctic Cordillera ecozone.

The Baffin Island Coastal ecoregion is characterized by gently warped, old erosion surfaces with discontinuous, ridged and terraced surficial deposits (ESWG 1995). Regionally, the bedrock geology in central and northern Baffin Island is composed of the Archean-aged Mary River Group underlain by Archean-aged basement orthogneiss units of the Rae Craton (Nunami 2011d). The Clyde River area is situated within the zone of continuous permafrost, which tends to be saline (Smith *et. al.* 2012). The area also contains significant amounts of ground ice with widespread thermokarst depressions atop thick terraced raised marine and glaciomarine sandy sediments (Smith *et. al.* 2012).

The Old Town Site is situated on a gentle east-west slope bounded by large hills (maximum elevation approximately 110 m above mean sea level [EMR 1989]) to the east and Patricia Bay to the west; due to this, drainage on site is to the west, towards Patricia Bay. On-site surficial deposits primarily include raised marine beach ridges of sand and gravel on the west side, closest to Patricia Bay, while colluvial aprons of scree and blocky bedrock debris occur on the east side, further upslope; the large hills east of the Site are covered by till blankets greater than 2 m thick (Smith *et. al.* 2012).

Soils in the Clyde River area are classified as turbic cryosols; this mineral soil type typically has permafrost within 2 m of the surface and generally show marked evidence of cryoturbation (i.e., patterned ground) (SCWG 1998). The soils are well to moderately well drained (ECSS 1983). In the Clyde River area, some soils show thaw-sensitive characteristics, which if affected, may result in thaw settlement[1] or thaw weakening[2] (Smith *et. al.* 2012).

4.1.2 Climate

The climate in Clyde River features short, cold summers and long winters. Average monthly and annual weather data has been measured at the Clyde River weather station and is summarized in Table 4-1.

[1] Thaw settlement is caused by a loss of ice volume due to the changes in the thermal regime. Activities such as ground disturbances and changes to drainage patterns can cause thaw settlement.
[2] Thaw weakening is caused by a loss of soil strength. Use of equipment on these areas may cause significant rutting and erosion.

Table 4-1: Meteorology, precipitation and temperature profiles at Clyde River, NU[1]

Month	Daily Maximum (ºC)	Daily Minimum (ºC)	Daily Mean (ºC)	Extreme Maximum (ºC)	Extreme Minimum (ºC)	Rainfall (mm)	Snowfall (cm)	Snow at Month end (cm)
January	-24.2	-31.9	-28.1	3.3	-50.2	0	9.5	47
February	-25.6	-33.4	-29.6	3.3	-50.1	0	7.4	49
March	-22.7	-31.5	-27.2	-1	-47.8	0	8.3	52
April	-14.1	-23.9	-19	11.7	-41.1	0	17.4	59
May	-4.3	-12.7	-8.5	8.9	-31.1	0.4	19.4	53
June	3.6	-2.3	0.7	17.8	-17.2	3.6	13.5	10
July	8.2	0.6	4.4	22.2	-6.8	16.1	6.2	0
August	7.1	0.6	3.9	20	-5.6	24.8	7	0
September	2.4	-2.4	0	14.6	-16.1	7.3	29.4	6
October	-4.5	-10.6	-7.6	10.3	-28.7	0.3	43.9	25
November	-13.8	-21	-17.5	6.7	-39.5	0	25.9	35
December	-21	-28.5	-24.8	2.8	-45	0	15.1	42

NOTES:
[1] Environment Canada Canadian Climate Normals 1971-2000. Data collected at the Clyde River Airport. Latitude: 70º29'10" N, 68º31'00" W. Elevation 26.5 m.

4.1.3 Hydrology

The Project is situated wholly within the Davis Strait / Baffin Bay region of the Arctic Ocean watershed. In the Clyde River area, surface waters include small freshwater ponds, ephemeral watercourses, larger streams, the Clyde River, and the marine waters of Patricia Bay (refer to site photographs in **Appendix E**).

Project activities will extend throughout a wide area including the hamlet of Clyde River on the western shore of Patricia Bay and the Old Town Site, located on the eastern shore of Patricia Bay. Several waterbodies are located near or in areas of proposed Project activity; these waterbodies are shown in Figure 2 in **Appendix A** and described below:

- Clyde River – this will be crossed during the Project activities using an existing municipal road and Bailey bridge (Photographs #1 and #2, **Appendix E**).
- Drainage Channels #1 to #4 - draining through the Old Town Site and into Patricia Bay (see Photographs 4 to 15, **Appendix E**). These are crossed by the Project's proposed access road (see Figure 2 in **Appendix A** and Drawings 03-A and 03-B, **Appendix B**) and are currently crossed by an ATV trail. Minor improvements have been installed at three of the ATV trail crossing sites (Drainage Channels #2 to #4) and are typically hand-excavated channels covered with plywood. In Drainage Channel #1, no improvements have been installed and the effects to streambeds from ATV use have caused eroded streambanks.
- Three unnamed watercourses – drain the small ponds north of borrow source Deposits 3 to 7 into the Clyde River (see Figure 2 and 3 in **Appendix A** and Photographs 16 to 18 in

Appendix E). These watercourses are already crossed by existing municipal roads and, upstream of the crossings, are located adjacent to a number of the proposed and previously active borrow sources.

- One ponded area of surface water – situated at the Site Dump of the Old Town Site (Drawing 03-B in **Appendix B** and Photograph 20 in **Appendix E**). During the 2010 ESA, the ponded water was observed to be shallow (less than 1 m in depth) with there are no apparent surface drainage channels.
- The nearshore area of Patricia Bay – several remedial excavations of the Old Town Site are situated within 30 m of the high water mark of Patricia Bay (Photograph 19, **Appendix E**).

Stream flow measurements were not completed during the site assessments however stream flow conditions of Drainage Channels #1 to #4 were observed during site visits in 2008, 2010 and 2011; the three unnamed watercourses were observed in July 2011 only. In July 2011, the new watercourse crossings of Drainage Channels #1 to #4 had observed water depths ranging from 200 to 300 mm; the three unnamed watercourses had water depths less than 300 mm. During the site assessments in August of 2008 and 2010, the drainage channels had minimal water (less than 100 mm).

Given the historical climate in Clyde River, the timing of snow melt is likely to occur in the months of June and July (Environment Canada 2012). Therefore ephemeral drainages within the Project area (Drainage Channels #1 to #4 and the three unnamed watercourses) may be expected to flow through July with a decline in discharge through August when flow is expected to be negligible. No instrumented hydrologic stations (i.e., Water Survey of Canada) are present in the Clyde River area. Flow estimates have not been generated as Project activities are not expected to alter surface drainage.

Based on the encountered flow, the water depth and inferred drainage information available from the topographic maps, the watercourses present within the Project area are expected to be ephemeral and flow during the freshet or significant precipitation events only.

4.2 Biological Environment

4.2.1 Vegetation

Generally the Baffin Island Costal Lowlands ecoregion is characterised by a sparse cover of tundra vegetation; dominant species include moss, purple saxifrage (*Saxifraga oppositifolia*), avens species (*Dryas* spp.), sedges (including *Kobresia*) and arctic poppy (*Papaver radicatum*) (ESWG 1995). Wetter areas of this ecoregion can exhibit up to 60% vegetative cover with species including rush, and saxifrage (*Saxifraga* spp.), and a continuous cover of mosses.

An assessment of vegetation types within the Project area was completed as part of the vegetation sampling for the environmental assessment at the Old Town Site in 1995 (ESG 1997). One plant species on the Old Town Site, mountain sorrel (*Oxyria dignya*), was identified as edible during Nunami's HHERA (Nunami 2011d). No other vegetation assessments have been completed at the Old Town Site. Vegetation species that identified during the 1995 and 2010 assessments are provided in

Table 4-2. It is noted that the vegetation surveys conducted during the 1995 and 2010 assessments were not exhaustive and additional species may be present on the Old Town Site.

Table 4-2: Vegetation species observed at the Old Town Site, Clyde River, NU, during previous assessments in 1995 and 2010 (ESG 1997 and Nunami 2011d)

Common Name	Latin Name	Territorial Ranking[1]
Arctic lousewort	*Pedicularis arctica*	-
Arctic poppy	*Papaver radicatum*	Undetermined
Arctic tumbleweed lichen	*Masonhalea richardsonii*	Secure
Arctic white heather	*Cassiope tetragona*	Secure
Arctic willow	*Salix arctica*	Secure
Cotton grass	*Eriophorum augustifolium*	Secure
Fireweed	*Epilobium angustifolium*	Secure
Grass spp.	*Poa spp.*	-
Mountain sorrel	*Oxyria digyna*	Secure
Northern Buttercup	*Ranunculus pedatifidus*	Secure
Vahl's alkali grass	*Puccinellia vahliana*	Secure

NOTES:
[1] Territorial ranking data from CESCC (2011)

4.2.1.1 Rare Plant Species

A rare plant can be defined as a species that, because of its biological characteristics or because it occurs at the edge of its main range, exists in low numbers or in very restricted areas (Lucas and Synge 1978). McJannet *et. al.* (1995) list approximately 30 plant species identified as rare in Nunavut (the Inuit Settlement Region of the Northwest Territories at the time of publication); Table 4-3 lists these species and the habitat where they have been known to occur.

It is noted that accurate locations of the following rare plant species within Nunavut could not be determined due to the limited accuracy within the source documents and inherent in the original and historical records. Original sightings of several species occurred prior to the development of accurate positioning systems (e.g., GPS), therefore have resulted in a larger possible area for that species location today. Vascular plant species are also likely under recorded in the region due to the limited vegetation surveys completed and the likelihood that completed surveys did not thoroughly document species location. The following information in Table 4-3 then indicates which species are known or expected to occur in Nunavut, based on nearest known location and/or habitat required. Due to the paucity of data available for rare plants in Nunavut, a list specific to the Clyde River area could not be developed. Rare plant species included in Table 4-3 were not observed during the previous assessments completed in 1995 and 2010.

Table 4-3 Rare plant species known or expected to occur within Nunavut

Common Name	Latin Name	Habitat	Nearest Location[1]	SARA Listing
Alpine Bartsia	*Bartsia alpina*	Moderately well drained areas with high organic content; sunny, grassy slopes[2]	Near Iqaluit & Kimmirut, NU	-
Mackenzie's sedge	Carex mackenziei	Littoral species of brackish marshes[2]	West coast of Hudsons Bay (near Arviat), NU	-
Snowbed sedge	*Carex rufina*	Wet stony places, often by the edge of ponds or on snow beds[2]	Near Arviat, NU	-
Mountain chickweed	*Cerastium cerastioides*	Marshy tundra[3]	Baffin Island, NU	-
Tufted hair grass	*Deschampsia alpina (Deschampsia cespitosa* ssp. *alpina)*	Calcareous rocks and gravel (decomposed schist, granite and limestone); with low organic content[2]	Baffin Island, NU	-
Norwegian Whitlow-grass	*Draba norvegica*	Imperfectly drained moist areas, river terraces; calcareous rocks, gravel with low organic content[2]	Southhampton Island, Baffin Island and west of Arviat	-
Alpine fleabane	*Erigeron alpiniformis*	Dry tundra[3]	Baffin Island, NU	-
Northern fescue	*Festuca vivipara* ssp. *Glabra*	Imperfectly drained moist areas; tundra turf, gravel, and moist herb mats[2]	Near Alert, NU	-
Moor rush	*Juncus stygius* spp. *Americanus*	Wet margins of bogs and marly seepages[3]	At Hudson Bay, near Nunavut / Manitoba border	-
Highland Rush	*Juncus trifidus*	Seepage slopes, or dry, gravel, sand. On Baffin Island occurs on springy or sandy slopes, or sheltered sandy sites, often in iron-rich sands on the Beekman Peninsula[2]	Baffin Island (3 locations)	-
Northern Mudwort	*Limosella aquatica*	Wet, muddy, or sandy pond margins[3]	Near Chesterfield Inlet, NU	-
Alpine Catchfly	*Lychnis alpina*	Sandy gravelly slopes[3]	Baffin Island, NU	-
Drummond Bluebell	*Mertensia drummondii*	Substrates: ridges; dry; gravel, sand[2]	Victoria Island and Coronation Gulf area	-
Porsild's Bryum	*Mielichhoferia macrocarpa*	Sites constantly moist during growing season with complete desiccation during the winter season; grows in cracks and cliffs of calcareous rock, limestone, basalt, sandstone, and shale[4]	One location on Ellesmere Island	Threatened – Schedule 1

Common Name	Latin Name	Habitat	Nearest Location[1]	SARA Listing
Gray's Point-vetch	*Oxytropis podocarpa*	Imperfectly drained, or moderately well drained hummocks and tundra; acidic, or calcareous; gravel, sand[2]	Southampton Island and Baffin Island	-
Muskeg Lousewort	*Pedicularis parviflora (syn P. parviflora var macrodonta)*	Bogs and marshes[3]	Near Arviat, NU	-
Fowler Knotweed	*Polygonum fowleri* spp. *hudsonianum* (*Polygonum caurianum* spp. *hudsonianum*)	Gravelly pond margins and lake shores[3]	Near Arviat, NU	-
Blunt-leaf Pondweed	*Potamogeton obtusifolius*	Shallow lakes and ponds[3]	Near Baker Lake, NU	-
Dwarf Alkali Grass	*Puccinellia pumila (Puccinellia kurilensis)*	Imperfectly drained moist areas; halophytic; sand, silt; in poorly drained sand or on wet mud at the seashore[2]	Southampton Island, Baffin Island and near Chesterfield Inlet	-
Arctic Alkali Grass	*Puccinellia arctica* (includes *Puccinellia borealis ?, Puccinellia poaceae, Puccinellia agrostidea*)	Alkaline, salt or carbonate encrusted soil, may be the dominant grass in the immediate vicinity; hummocks, stream banks, river terraces, lake shores, slopes, seashore; dry, moderately well drained; sand, silt, clay (of flood plains)[2]	Ellesmere Island	-
Allen Buttercup	*Ranunculus allenii*	Wet tundra[3]	Baffin Island, NU (3 locations)	-
Felt-leaf willow	*Salix silicicola*	Near Athabasca occurs on large, open, active sand dunes, and as scattered individuals or small patches on shallow shifting sands of gravel flats; sometimes on the broad sandy beaches and beach terraces of Lake Athabasca. Nothing known about habitat at Pelly Lake, NU.[4]	Pelly Lake, NU	Special Concern, Schedule 1
Cushion Saxifrage	*Saxifraga eschscholtzii*	Calcareous rocks, particularly gravel, in crevices, and on rocky ledges[2]	Near Resolute, NU	-
Leafsystem Saxifrage	*Saxifraga foliolosa (also known as Saxifranga stellaris)*	Mossy and springy places, often located on the edges of ponds, brooks, lakes or in wet tundra [2]	Baffin Island, NU	

Common Name	Latin Name	Habitat	Nearest Location[1]	SARA Listing
Roseroot Stonecrop	*Rhodiola rosea (Sedum rosea)*	Dry tundra, slopes, talus ridges, moist cliffs; imperfectly drained moist areas, or on seepage slopes; rocks, gravel, till; with low organic content; typically occur in crevices or among mats of moss, often near shores, and sometimes in rather rich substrates[2]	Baffin Island (3 locations)	-
Eelgrass spp.	*Zostera marina*	Sheltered tidal flats[3]	Near Arviat, NU	-

NOTES:
[1] Nearest location information from Porsild and Cody (1980), McJannet et. al. (1995), and/or SARA Registry (2012)
[2] Habitat information from Porsild and Cody (1980)
[3] Habitat information from McJannet et. al. (1995)
[4] Habitat information from SARA Registry (2012)

4.2.2 Wildlife

The following sections identify wildlife species that are known or expected to occur in the Clyde River area. If a species is known or expected to occur in the Clyde River area, it is assumed they may also occur within the Project area. Each species status under territorial conservation ranking is provided, as well as any rankings by the COSEWIC and SARA.

4.2.2.1 Terrestrial Mammals

There are an estimated 36 terrestrial mammalian species known or expected to occur in Nunavut (Wild Species 2010) but only 11 of them can be found on Baffin Island including the Clyde River area. These species are listed in Table 4-4.

Table 4-4: Terrestrial mammal species known or expected to occur in the Clyde River area

Common Name	Latin Name	Migration Habit	Ranking[1]		
			Territorial	COSEWIC	SARA
Arctic fox	*Alopex lagopus*	Resident	Secure	-	-
Arctic grey wolf	*Canis lupus arctos*	Resident	-	Data Deficient	-
Northern grey wolf	*Canis lupus occidentalis*	Resident	Sensitive	Not at Risk	-
Northern (or Peary Land) collared lemming	*Dicrostonyx groenlandicus*	Resident	Undetermined[2]	-	-
Victoria collared lemming	*Dicrostonyx kilangmiutak*	Resident	Secure	-	-
Wolverine (Western Population)	*Gulo gulo*	Resident	Sensitive	Special Concern	-
Brown lemming	*Lemmus trimucronatus*	Resident	Secure[2]	-	-
Arctic hare	*Lepus arcticus*	Resident	Secure	-	-
Barren-ground caribou	*Rangifer tarandus groenlandicus*	Migratory / Resident	Sensitive	Special Concern	Schedule1-Special

Common Name	Latin Name	Migration Habit	Ranking[1]		
			Territorial	COSEWIC	SARA
					Concern
Red fox	*Vulpes vulpes*	Resident	Secure	-	-

NOTE:

[1] Known or expected to occur data and rankings from Canadian Endangered Species Conservation Council (CESCC 2011), the General Status of Species in Canada (Wild Species 2010) and IUCN Red List of Threatened Species (IUCN 2011).

[2] Government of Nunavut, Environmental Department, Wildlife Management Division: Terrestrial Mammals Fact Sheets from Nunavut Wild Species Report 2000.

Two terrestrial mammal species occurring in the Clyde River area are listed under SARA, including, the barren-ground caribou (*Rangifer tarandus groenlandicus*) and polar bear (*Ursus maritimus*). These two species, along with the wolverine (*Gulo gulo*), are nationally ranked as Special Concern by COSEWIC. These species, as well as the Northern grey wolf (*Canis lupus occidentalis)* are also territorially ranked as Sensitive (CESCC 2011).

Wolverine

The wolverines from western population found throughout Nunavut (compared to the eastern population in Quebec and Labrador with endangered status) have a low population density on the arctic islands and eastern Nunavut. Wolverines utilize a variety of habitats though have specific denning habitats, including boulders, under deadfall, or in snow tunnels on the tundra (COSEWIC 2003). Wolverines may be especially vulnerable on the arctic tundra, where visibility and snowmobile access are good.

Caribou

Caribou encountered in the northern portion of Baffin Island are generally divided into three categories: the south Baffin Island population, resident north Baffin Island individuals, and Barren-ground caribou originating from the mainland. Little to no information is available on the migratory activity of populations in this area; as intermittent surveys have been completed in this area since 1989. The range of the south Baffin Island population is generally restricted to the southern half of Baffin Island; extending between the Foxe Peninsula and the Meta Incognita Peninsula (Ferguson *et al*. 2001). Barren-ground caribou originating from the mainland were generally restricted to the Foxe Basin area.

Population of north Baffin Island caribou have ranged significantly overtime from approximately 30,000 individuals in 1985 (Williams and Heard 1986); to 50,000 to 150,000 individuals in 1991 (Ferguson and Gauthier 1992). As the population boundaries are not well understood, estimates are interrelated as the three population groups overlap. Communities in the range of the north Baffin Island population have reported general declines in the population. Harvest data shows a small amount of caribou harvesting near Clyde River, NU, with significant harvesting occurring near the Barnes Ice Cap located southwest of the community.

4.2.2.2 Marine mammals

Baffin Bay and Davis Strait are two large basins between Nunavut's Baffin Island and Greenland that connect the Arctic Ocean with the Atlantic. Stretching over 1.1 million square kilometres (425,000

square miles), the region includes the North Water Polynya, one of the Arctic's largest open-water areas and one of the most biologically productive volumes of water in any polar region (Pew 2012). The icy habitat of Baffin Bay and Davis Strait is an ideal home for globally important populations of bowhead whales, narwhals, fish, seabirds and cold water corals (Pew, 2010).

Marine mammals known or expected to occur in the marine areas off the coast of the Clyde River area include seven species (SARA 2012, COSEWIC 2012). These species are listed in Table 4-5 below.

Table 4-5: Marine mammal species known or expected to occur in the Clyde River area

Common Name	Latin Name	Ranking[1,2]		
		Territorial EAO[3]	COSEWIC	SARA
Bowhead Whale	*Balaena mysticetus*	Sensitive	Special Concern	-
Hooded Seal	*Cystophora cristata*	Secure	Not at Risk	
Bearded Seal	*Erignathus barbatus*	Secure	Data Deficient	-
Narwhal	*Monodon monoceros*	Sensitive	Special Concern	-
Atlantic Walrus	*Odobenus rosmarus rosmarus*	Sensitive	Special Concern	No schedule, No Status
Killer Whale (Northwest Atlantic / Eastern Arctic population)	*Orcinus orca*	Undetermined	Special Concern	-
Harp Seal	*Pagophilus groenlandica*	Secure	-	-
Harbour Seal (Atlantic and Eastern Arctic subspecies)	*Phoca vitulina concolor*	Undetermined	Not at Risk	-
Ringed Seal	*Pusa hispida*	Secure	Not at Risk	
Polar bear	*Ursus maritimus*	Sensitive	Special Concern	Schedule1- Special Concern

NOTE:

[1] Known or expected to occur data and rankings from Canadian Endangered Species Conservation Council (CESCC 2006), the General Status of Species in Canada (Wild Species 2005) and IUCN Red List of Threatened Species (IUCN 2011); downloaded on March24, 2012.

[2] Known to occur data from PEW (2012).

[3] EAO = Eastern Arctic Ocean

Range information for killer whale and Atlantic walrus includes the western coast of Baffin Island and encompasses Patricia Bay, although potential timing or frequency of use of the marine habitats off Clyde River and the Old Town Site by these species is not well documented. For other marine mammal species included in Table 4-5, species occurrence is derived from harvest records and community studies; as an example, ringed seal and narwhal are both included in Wenzel's (1995) list of the five most important wild food resources in Clyde River.

Bowhead Whale

During the 2010 ESA, one bowhead whale was observed in Patricia Bay. Bowhead whale are known to use the Davis Strait – Baffin Bay area, summering in the inshore waters and fiords of northern Baffin

Island and along the northeastern coast of Baffin Island (May through August) (NWMB 2000). Isabella Bay, 100 km southeast of Clyde River, contains important summer habitat for Bowhead Whales and is protected as Niginganiq National Wildlife Area (Environment Canada 2010). Presently, Project activities are not anticipated within the marine environment.

Polar Bear

Polar bears of the Baffin Bay subpopulation can be found within the Clyde River area; this subpopulation has been estimated at 2,074 bears in 1998 but Inuit have reported higher abundances of polar bears in recent years and safety and property risk concerns have grown (COSEWIC 2008). Their habitat is closely associated with that of ring seal and sea ice. Local observations of increased abundance of polar bears may be due to higher levels of bear activity in response to increased time spent on-shore in response to climate warming in the region. Movements inland during summer have apparently increased in and Inuit have reported that during the open-water season bears can be found much farther into Eclipse sound, up the fiords and inlets where they did not previously occur (COSEWIC 2008).

4.2.2.3 Avifauna

An estimated 30 avian species have ranges extending through the eastern coast of Baffin Island and may potentially occur at some point of the year within the Clyde River area; these species are listed in Table 4-6. Only eight species are recognized as non-migratory or resident to Nunavut while the remaining 22 species either breed or migrate through the Clyde River area in summer (Cornell 2008).

Table 4-6 Avifauna known or expected to occur in Clyde River area[1,2]

Common Name	Latin Name	Migration Habit	Ranking		
			Territorial[3]	COSEWIC	SARA
Known or Expected to Occur[2,3]					
American pipit	*Anthus rubescens*	Migratory	Secure	-	-
Snowy owl	*Bubo scandiacus*	Resident	Secure	Not at Risk	-
Lapland longspur	*Calcarius lapponicus*	Migratory	Secure	-	-
Baird's sandpiper	*Calidris bairdii*	Migratory	Secure	-	-
Semipalmated sandpiper	*Calidris pusilla*	Migratory	Sensitive	-	-
Common redpoll	*Carduelis flammea*	Migratory	Secure	-	-
Hoary redpoll	*Carduelis hornemanni*	Resident / Migratory	Secure	-	-
Black Guillemot	*Cepphus grylle*	Resident	Secure	-	-
Semipalmated plover	*Charadrius semipalmatus*	Migratory	Secure	-	-
Snow goose	*Chen caerulescens*	Migratory	Secure	-	-
Long-tailed duck	*Clangula hyemalis*	Migratory	Secure	-	-
Common Raven	*Corvus corax*	Resident	Secure	-	-
Horned Lark	*Eremophila alpestris*	Migratory	Secure	-	-
Peregrine falcon	*Falco peregrinus*	Migratory	Secure	Special	No Schedule,

Common Name	Latin Name	Migration Habit	Ranking		
			Territorial[3]	COSEWIC	SARA
	anatum/tundrius			Concern	No Status
Gyrfalcon	*Falco rusticolus*	Resident	Secure	Not at Risk	-
Northern Fulmar	*Fulmarus glacialis*	Resident	Secure	-	-
Common Loon	*Gavia immer*	Migratory	Secure	-	-
Pacific loon	*Gavia pacifica*	Migratory	Secure	-	-
Red-throated loon	*Gavia stellata*	Migratory	Secure	-	-
Sandhill crane	*Grus canadensis*	Migratory	Secure	-	-
Willow ptarmigan	*Lagopus lagopus*	Resident	Secure	-	-
Iceland gull / Thayer's gull	*Larus glaucoides* / *Larus thayeri*	Migratory	Secure	-	-
Glaucous gull	*Larus hyperboreus*	Migratory	Secure	-	-
Snow bunting	*Plectrophenax nivalis*	Migratory	Sensitive	-	-
Black-legged Kittiwakes	*Rissa tridactyla*	Resident / Migratory	-	-	-
Common eider	*Somateria mollissima*	Migratory	Sensitive	-	-
King eider	*Somateria spectabilis*	Migratory	Sensitive	-	-
Long-tailed jaeger	*Stercorarius longicaudus*	Migratory	Secure	-	-
Parasitic jaeger	*Stercorarius parasiticus*	Migratory	Secure	-	-
Snow Goose	*Chen caerulescens*	Migratory	Secure	-	-
Canada Goose	*Branta canadensis*	Migratory	Secure	-	-
Arctic tern	*Sterna paradisaea*	Migratory	Secure	-	-

NOTES:

[1] Known to occur data from CBIF (2005); data sources include the Canadian Museum of Nature Bird Collection and the Northwest Territories and Nunavut Bird Checklist

[2] Expected to occur data from habitat range information obtained from Cornell (2008)

[3] Territorial rankings obtained from CESCC (2006)

Peregrine Falcon

A single bird species potentially occurring within the Clyde River area is listed as Special Concern under COSEWIC (Table 4-6): the peregrine falcon (*Falco peregrinus anatum/tundrius*). Originally listed under two separate subspecies, *anatum/tundrius,* the peregrine falcon is now managed as a single species based on genetic evidence (ENR 2012). The species underwent a dramatic decline in population between the 1950s and 1970s, primarily resulting from increased egg mortality from the eggshell thinning effect of pesticides (e.g., DDT). Since the mid-1970s however, the number of nesting pairs has increased and COSEWIC down-listed the peregrine falcon from Threatened to Special Concern in early 2007 (COSEWIC 2007). At this time, the peregrine falcon was also taken off of the SARA registry and currently has no status under SARA.

COSEWIC identifies potential breeding range throughout Nunavut, with over 400 nest sites reported in Nunavut as a whole. Based on the range maps available, breeding occurs on Baffin Island (White *et al* 2002). Exact habitat use or requirements in the Clyde River area are unknown, however this type of

falcon has been reported to nest in south- or southwest-facing vertical coastal cliffs (Court *et al.* 1988a) or in rocky bluffs in inland tundra areas (Court *et al.* 1988b). High points of land that may provide similar potential nesting locations are limited within the Project area. Small mammals, including lemmings and juvenile Arctic ground squirrels, can make up an important portion of a peregrine falcon's diet though they have also been shown to consume ptarmigans, shorebirds and small songbirds in tundra areas (COSEWIC 2007).

4.2.3 Fisheries

Arctic aquatic environments offer protection from climate extremes, despite the severe and variable climatic conditions experienced on land. Arctic waters support 224 marine fish species and 42 freshwater fish species (Reist 1997), which represent nearly a quarter of Canada's fishes (Hardie 2003). Baffin Bay and Davis Strait, off the east coast of Baffin Island, provide habitat for 116 species of fish ranging from Arctic char (*Salvelinus alpinus*), an important food fish found in both freshwater and anadromous (sea-going) forms, to numerous marine fish including capelin (*Mallotus villosus*) and turbot (Pew 2010). Freshwater habitats also support anadromous fish species, such as chars (*Salvelinus* spp.), whitefishes (*Coregonus* spp.), and sticklebacks (Gasterosteidae) (Burridge and Mandrak 2012). Access to overwintering habitat is critical for Arctic species and in northern freshwater environments, can typically be limited in capacity as streams and shallow ponds may remain frozen for much of the year (Craig 1989).

4.2.3.1 Fish and Fish Habitat

Fish species potentially present within the aquatic habitats in the Clyde River area are predominantly marine species. Anadromous Arctic char are known to use the Clyde River and unnamed tributary streams connecting area ponds to the Clyde River. Limited fisheries inventory information is available for the Project area, although harvest records suggest habitats in the Clyde River and Patricia Bay may include the species provided in Table 4-7. Several fish species of conservation concern have general areas of occupancy that overlap the Project area; these have also been included in Table 4-7, although the likelihood of their occurrence in marine waters off the Project area is unknown.

Table 4-7: Fish known or expected to occur in the Clyde River and Patricia Bay area, including species of conservation concern with overlapping range and habitat[1]

Common Name		Latin Name	Habitat Use	Ranking		
				Territorial EAO[2]	COSEWIC	SARA
Char	Arctic Char	*Salvelinus alpinus*	Anadromous (marine, freshwater)	Sensitive	-	-
Capelin	Capelin	*Mallotus villosus*	Marine, nearshore	Not Assessed	-	-
Cod	Greenland cod	*Gadus ogac*	Marine			
	Arctic cod	*Boreogadus saida*	Marine			
	Atlantic cod	*Gadus morhua*	Marine	Sensitive	Special Concern	-

Common Name		Latin Name	Habitat Use	Ranking		
				Territorial EAO[2]	COSEWIC	SARA
Turbot	Atlantic Halibut	*Hippoglossus hippoglossus*	Marine, deepwater	Undetermined	Endangered	-
	Greenland Halibut	*Reinhardtius hippoglossoides*	Marine, deepwater	Secure	-	-
Sculpin	Fourhorn Sculpin	*Myoxocephalus quadricornis*	Marine, nearshore	Secure	Data Deficient	-

NOTE:

[1] Known or expected to occur data and rankings from Canadian Endangered Species Conservation Council (CESCC 2006), the General Status of Species in Canada (Wild Species 2005) and IUCN Red List of Threatened Species (IUCN 2011). Downloaded on 24 March 2012.

[2] EAO = Eastern Arctic Ocean

Anadromous Arctic char are known to use Clyde River and area waterbodies in August (NIRB 2010). They spawn in rivers and/or lakes that are deep enough to withstand freezing over winter as most rivers freeze completely (Balon 1980, Johnson 1980, Dempson and Green 1985, Cunjak et al. 1986). They make minimal use of rivers, mainly as migration routes, although some populations appear to spawn in larger rivers (Reist unpublished, Kristofferson 1988, and Macdonell 1996 and 1997).

Fish utilization of aquatic habitat found within or potentially affected by the Project is largely dependent on the presence of permanent flow and access to deep-water overwintering habitat, which may be provided by marine waters of Patricia Bay or within deep lakes and ponds. Two types of aquatic features exist within the Project area: watercourses at crossing locations and the marine nearshore adjacent to remedial works.

4.2.3.2 Freshwater Waterbodies

Water will be withdrawn from the Clyde River for use during remedial works. The proposed access road crosses Drainage Channels #1 to #4 (Figure 2 in **Appendix A** and Drawing 06-C in **Appendix B**). Other watercourses, including the Clyde River and the three unnamed streams, are already crossed by existing municipal roads. The three unnamed streams are also located adjacent to borrow source deposits however potential adverse effects to these will be mitigated with appropriate measures (see Section 5).

Clyde River

The Clyde River appears to originate from the mountains situated north of the community. The river flows east and south into an unnamed freshwater lake situated east of Patricia Bay, and finally flows west into Patricia Bay (see Figure 1 in **Appendix A** and Drawing 02 in **Appendix B**). A bailey bridge has been installed by the Hamlet to cross the river to access the Hamlet's existing quarry; the municipal crossing spans approximately 50 m and is located approximately 1.6 km northeast of the river's outlet to Patricia Bay. During the 2010 ESA (Nunami 2011a), the Clyde River had a considerable volume of water at the crossing location (Photographs #1 and #2, **Appendix E**), however flow volume is unknown. River substrate at the bailey bridge location primarily consisted of boulders, with raised sand deposits.

Fish presence or movement in Clyde River was not verified during the ESA. However due to the connection to Patricia Bay and potential fish-bearing lake upstream of the bailey bridge, Clyde River may provide a migration route and have suitable fish habitat for spawning, rearing and food supply.

Drainage Channel #1

The crossing at Drainage Channel #1 is situated at km 2+390 of the proposed access road and is located in a shallow valley extending from hills to the east to the waters of Patricia Bay (Photographs 4 to 6 in **Appendix E**). During the 2010 ESA, an ATV trail crossing was present at the proposed access road crossing (Nunami 2011a). The stream channel was affected by trail use as ATVs crossed directly through the stream and the bed, bank and channel were altered.

The depth of water present during the 2010 ESA (August) was minimal however 200mm to 300 mm of water was noted during the 2011 geotechnical assessment (July). The substrate of the channel is dominated by boulders and the water was clear. Vegetation on the banks included grass and sedge

Drainage Channel #1 appears to provide drainage for the nearby hill slope (east of the crossing) and does not appear to be connected to any lakes or ponds, Therefore Drainage Channel #1 is expected to be ephemeral, flowing during the spring freshet or significant precipitation events only. However Drainage Channel #1 is deeper than the other drainage channels and anadromous fish from Patricia Bay may be able to use the channel during higher spring flows. However as the channel does not appear to be connected to any surface waterbodies and has minimal water throughout the rest of the year, it is unlikely to be used as a migration corridor.

The construction of the access road and installation of a properly sized culvert will remove direct ATV traffic on the channel bed and should not affect any fish habitat potential.

Drainage Channel #2

The crossing at Drainage Channel #2 is located at km 2+460 of the proposed access road (Photographs 7 to 9 in **Appendix E**). The water depth during the August 2010 ESA was minimal (less than 100 mm) however 200 to 300 mm of water was noted in the channel in July 2011.

Drainage Channel #2 appears to provide drainage for the hill slope to the east of the crossing into Patricia Bay; the crossing is located approximately 30 m west of Patricia Bay. During the August 2010 ESA, an ATV trail crossing was present at the proposed access road crossing location (Nunami 2011a). In this area, the channel appeared to be poorly defined with little vegetation. The substrate of the channel primarily consisted of fines with boulders distributed along the length of the channel; the water was clear. Various species of grasses and sedges were observed within the channel and on its banks.

Due to the lack of a defined channel up or downstream of the crossing, Drainage Channel #2 appears to provide overland shallow drainage only and is likely ephemeral, flowing during the spring freshet or significant precipitation events only.

Drainage Channel #3

The crossing at Drainage Channel #3 is located at km 2+560 of the proposed access road (Photographs 10 to 13 in **Appendix E**). An ATV trail crossing was observed at the proposed access road crossing location during the August 2010 ESA (Nunami 2011a). Water depth in the channel was minimal during August 2010 however 200 to 300 mm of water was noted during the geotechnical assessment in July 2011.

During August 2010, the access road crossing location on Drainage Channel #3 was vegetated however it lacked a defined channel and appeared to provide drainage for the hill slopes to the east during the spring freshet. The channel substrate at the crossing primarily consisted of fines. Vegetation on the channel's banks consisted of grasses and sedge and occurred) throughout the length of the channel. The water at the access road crossing was clear and drained through a sloped vegetated area into Patricia Bay, approximately 70 m west of the crossing.

Due to the lack of a defined channel up or downstream of the crossing, Drainage Channel #3 appears to provide overland shallow drainage only and is likely ephemeral, flowing during the spring freshet or significant precipitation events only.

Drainage Channel #4

The crossing at Drainage Channel #4 is located at km 2+240 of the proposed access road (Photographs 14 and 15 in **Appendix E**). Similar to all drainage channels, an ATV trail crossing was observed at the proposed access road crossing location during the 2010 ESA. Water depth in the channel was minimal during August 2010 however 200 to 300 mm of water was noted during the geotechnical assessment in July 2011.

Drainage Channel #4 has larger substrates than the other three drainage channels and primarily consists of cobbles with some boulders located along the length of the channel. Vegetation, including grasses and sedge, were observed at the crossing in August 2010. The channel appeared to provide drainage for the surrounding hills (to the east of the Old Town Site) during the spring freshet. The water at the crossing was clear and drained through a sloped vegetated area into Patricia Bay, approximately 70 m west of the crossing.

Due to the lack of a defined channel up or downstream of the crossing, Drainage Channel #4 appears to provide overland shallow drainage only and is likely ephemeral, flowing during the spring freshet or significant precipitation events only.

4.2.3.3 Nearshore Marine Habitat

The nearshore area of Patricia Bay, below the Old Town Site, likely provides some habitat to marine fish and invertebrates. At the Old Town Site, the shoreline of Patricia Bay is dominated by beaches consisting of fines, gravel and cobble with scattered boulders; rockweed (*Fucus* spp.) was also observed. Due to the presence of sea ice (bergs) throughout the year, the presence and diversity of marine species in the intertidal is expected to be relatively low as a result of potential scouring from the grounding of bergs.

Clams are harvested by residents of Clyde River for subsistence purposes from the nearshore area of the Old Town Sites, as well as other areas in Patricia Bay (Nunami 2011d). A sample of marine clams collected adjacent to the Old Town Site were shown to have significantly greater ($p < 0.05$) lead concentrations than a sample of clams collected from a reference location (Nunami 2011d). Additionally, some of the collected clams had lead concentrations greater than recommended alert or consumption guideline levels (Nunami 2011d). Additional sampling and analysis was recommended by Nunami (2011d) due to the limited dataset (only five clams collected from site) and insufficient data on clam consumption by residents.

4.3 Socioeconomic Environment

4.3.1 Local Economy and Traditional Land Use

The population in Clyde River was estimated at 934 in 2011, an increase of 13.9% from 2006 (StatsCan 2012). The unemployment rate was reported at 24.2% in 2006, up from 15.6% in 2001, with the sales and service sector being the primary occupation type providing approximately 12.2% of employment (StatsCan 2007). Occupations in the social sciences, education, government service and religion are the second greatest occupation retaining 7.3% of the labour force, while trades, transport and equipment operators make up 6.7%.

The economy of Clyde River is largely traditional and many residents engage in traditional hunting and fishing. Tourism opportunities in Clyde River include access to Sam Ford Fjord and Barnes Ice Cap, in the centre of Baffin Island, as well as the Iqalirtuuq National Wildlife Area, a protected bowhead whale sanctuary located in Clyde Inlet.

According to the 2004 harvest study, species typically harvested by residents include caribou, arctic fox, arctic hare, snow goose, Canadian goose, eider ducks and ptarmigan (NWMB 2004). Goose and seagull eggs are also an important component of the harvesting study; an average of 323 goose and 33 seagull eggs collected annually. Marine mammals, including narwhal, polar bear, ringed seal and bearded seal, are also harvested; ringed seals make up the largest component of the marine mammal harvest with an average annual harvest of 2,004. Arctic char, cod, sculpins, turbot and clams are also important subsistence species for the residents and some residents participate in the commercial Arctic char harvest (NWMB 2004).

Residents of Clyde River traditionally use the Old Town Site every year to establish summer camps. Many residents stay at their camps at or near the Old Town Site throughout the summer while hunting and fishing in the area. Some residents have also established semi-permanent structures (i.e., wood frames, shacks) at or near the site. During the 2010 ESA, one family was resident on the beach at the Old Town Site. The Old Town area is typically accessed by ATV on an existing trail or by boat across Patricia Bay.

4.3.2 Heritage Resources

Following the 2010 ESA, Nunami recommended a Heritage Resource Impact Assessment (HRIA) be completed prior to the commencement of Project activities. The HRIA will be completed during the summer of 2012 and will include a desktop file search and a field inventory / assessment program.

During the 2010 ESA, two areas with unmarked graves were recorded (see Drawing 03-A in **Appendix B**). These sites will be further investigated during the 2012 HRIA.

5 ENVIRONMENTAL ASSESSMENT

5.1 Overview

This environmental assessment has been completed using the standard corporate methodological framework developed by Nunami to meet the requirements of the *Nunavut Land Claims Act* and other environmental legislation. The environmental effects assessment method is based on a structured approach that:

- Considers mandatory and discretionary factors;
- Focuses on issues of greatest concern;
- Affords consideration of all federal and territorial regulatory requirements for the assessment of environmental effects;
- Considers all issues raised by the public, Inuit people and public stakeholders; and,
- Integrates engineering design and programs for mitigation and monitoring into a comprehensive environmental planning process.

The environmental assessment focuses on specific environmental components (called Valued Environmental Components [VECs]) that are of particular value or interest to regulators and other stakeholders. VECs for the biophysical environment typically represent major components or aspects of the physical and biological environment that might be altered by the Project, and are widely recognized as important for ecological reasons. VECs for the Socio-cultural and Economic Environment are aspects of the human environment that include such components as Economy, Employment, Land Use, Traditional Land and Resource Use, etc.

Interactions between Project activities and the environment were considered according to the potential for an activity to interact with one or more VECs of the biophysical or human environment. Project interactions with the environment were considered based on the following:

1. No interaction
2. Interaction occurs however based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation; or, interaction would not be significant due to the application of codified environmental protection practices that are known to effectively mitigate the predicted environmental effects
3. Interaction could result in an environmental effect of concern; the potential environmental effects are considered further in the environmental assessment

Based on this, the following VECs were identified for the Project, considering all phases (construction, operation and decommissioning):

Physical: Ground Stability and Permafrost, Hydrology and Water Quality, Soil and Sediment Quality, and Air Quality;

Biological: Vegetation, Wildlife and Avifauna, and Fish and Fish Habitat;

Social: Local Economy, Traditional Land Use, Human Health, and Heritage Resources.

Specific components of the Project in each phase are assessed for their interaction with the VECs and potential environmental effects are identified. Project components assessed include:

- the access road;
- the borrow sources;
- the landfill containment cell;
- the staging area;
- the landfarm; and,
- general remedial activities .

The assessment of each Project environmental effect begins with a description of the mechanisms whereby specific Project activities and actions could result in the environmental effect. Where possible, the temporal and spatial extent of these changes (i.e., where and when might the environmental effect occur) is also described. Mitigation measures that will help reduce or eliminate an environmental effect are then described, with an emphasis on how these measures will help alter the environmental effect.

Potential adverse effects of the Project on the identified VECs of the biophysical and human environments of the Project area are listed in Table 5-1. Proposed mitigation measures for the potential adverse effects are described in Sections 5.2 to 5.4 and summarized in Table 5-2.

Table 5-1: Identification of environmental effects arising from remediation of the Old Town Site, Clyde River, NU

		ENVIRONMENTAL COMPONENTS	PHYSICAL	designated environmental areas (ie. Parks, Wildlife Protected areas)	ground stability	permafrost	hydrology/ limnology	water quality	climate conditions	eskers and other unique or fragile landscapes	surface and bedrock geology	sediment and soil quality	tidal processes and bathymetry	air quality	noise levels	other VEC:	other VEC:	other VEC:	BIOLOGICAL	vegetation	wildlife, including habitat and migration patterns	birds, including habitat and migration patterns	aquatic species, incl. habitat and migration/spawning	wildlife protected areas	other VEC:	other VEC:	other VEC:	SOCIO-ECONOMIC	archaeological and cultural historic sites	employment (local economy)	community wellness	community infrastructure	human health	Traditional Land Use
PROJECT COMPONENTS/ACTIVITIES																																		
CONSTRUCTION	General Project Activities																				M	M							P				P	P
	Project-related transportation				M	M	M	M						M						M	M	M	M											
	Excavation and placement of materials				M	M	M	M												N			M					M						
	Culvert installation																						M											
OPERATION	General Project Activities																				M	M							P				P	P
	Operation of the Landfarm and Landfill Containment Cell						M	M				M																						
	Project-related transportation				M	M	M	M				M		M						M	M	M	M											
	Handling/Disposal of wastes													M																			M	
	Excavation and placement of materials																			N			M					M						
DECOMMISSIONING	General Project Activities						M	M													M	M							P				P	P
	Culvert removal							M															M											
	Excavation and placement of materials				M	M														P			M					M						
	Project-related transportation				M	M	M	P				M								M	M	M	M											
	Closure of the Landfarm and Landfill Containment Cell											M																						

Notes: Please indicate in the matrix cells whether the interaction causes an impact and whether the impact is:

P *Positive*

N *Negative and non-mitigatable*

M *Negative and mitigatable*

U *Unknown*

If no impact is expected then please leave the cell blank

Table 5-2: Mitgation and monitoring during remediation of the Old Town Site, Clyde River, NU

	PROPOSED MITIGATION MEASURE	IMPLEMENTATION SCHEDULE	RESIDUAL IMPACTS	PROPOSED MONITORING SCHEDULE	REPORTING SCHEDULE
EFFECTS (IDENTIFIED IN TABLE 5-1)					
Construction					
General Project Activities	• Restrict Project activities to non-critical wildlife periods (e.g., after early July) • Restrict Project activities to non-critical wildlife periods (e.g., after early July) • Prior to dismantling and removal of on-site debris (i.e., building foundations), area will be checked for nesting birds or signs of burrowing; if evidence is present, the area will be avoided until nesting/burrowing is complete • If avoidance is not possible, contact local Wildlife Officer to obtain advice/assistance on how to proceed • Halting of Project work activities if wildlife are in the vicinity and give wildlife right-of-way; report all wildlife presence to local Wildlife Officer • Establishment of a 100 m buffer if a Peregrine Falcon or other raptor nest is encountered on a Project site; inform local Wildlife Officer • Development and enforcement of site-specific Health and Safety Plan	• July - September 2013	None	None	
Excavation and placement of materials	• Avoid use of frozen granular materials • Control runoff by creating positive drainage or with the use of control structures • Use of geomembrane and geotextile liners to insulate underlying soils and increasing bearing capacity • Minimum 1.2 m embankment fill height on access road protect underlying soils from exposure to softening and seasonal thaw • Inspection of structures/facilities for structural integrity (weekly) • Short-term exposure for excavations • Restricting excavation to the active layer in shallow borrow sources • Establishing progressive reclamation procedures for borrow sources and potential temporary reclamation through winter and spring • Minimizing excavation footprints wherever possible and avoiding unneccesary vegetation removal • Ensuring no obstruction of natural drainage, no flooding or channel diversion • Where possible, establishing a minimum 30 m undisturbed buffer between a Project work site and the high water mark of a waterbody • Minimum 2:1 horizontal to vertical slope on all stockpiles and excavation/pit walls • Where necessary, installation of silt fences down-gradient of Project work areas • Development and implementation of Dust Management Plan to control fugitive dust - • Avoidance of identified heritage/archaeological sites with a minimum 20 m buffer (mark off sites)	• July - September 2013	None	None	
Project-related transportation	• Restriction of activities to designated work areas to minimize spatial extent of Project effects • Restriction of activities to built-up portions of the site and access road, and/or previously disturbed areas • End dump method of construction to minimize effects from heavy equipment during access road construction • Restriction of heavy equipment and vehicles to constructed portions of the access road until at least 0.6 m of compacted fill is placed • Discouragement of community use of the access road for public safety reasons • Restriction of Project-related vehicles from off-road travel • Development and implementation of Dust Management Plan to control fugitive dust - limiting traffic speeds on access road and on-site trails and road watering • Ensure all equipment is kept in good working order and not left running needlessly	• July - September 2013	None	None	
Culvert installation	• Restriction of in-water work to periods of low or no flow (July/August) and appropriate in-stream timing window (June 30 to September 1) • Ensuring work in-the-dry, if necessary • Restriction of equipment to constructed/built-up portions of the access road • Use of clean equipment and clean granular material • Where necessary, install silt fences or silt curtains downstream of installation site • Retention of vegetated banks • Emergency spill kits kept with all working equipment • Development and implementation of a Spill Contingency Plan • Where necessary, enable work in-the-dry by setting up temporary cofferdams with a water pump-around system; intake on pump-around will have appropriate fish screen and outflow will be stabilized to prevent erosion	• July - September 2013	None	None	

	PROPOSED MITIGATION MEASURE	IMPLEMENTATION SCHEDULE	RESIDUAL IMPACTS	PROPOSED MONITORING SCHEDULE	REPORTING SCHEDULE
EFFECTS (IDENTIFIED IN TABLE 5-1)					
Operation					
General Project Activities	• Implementation of a Dust Management Plan to control fugitive dust - limiting traffic speed on access road and on-site trails and road watering; minimum 2:1 slope on all piles; orienting pit faces with consideration to prevailing winds; closing borrow sources on high wind days; watering of the landfarm during soil rotation, if necessary; and, watering of borrow source pit floors, if necessary • Restrict Project activities to non-critical wildlife periods (e.g., after early July) • Prior to dismantling and removal of on-site debris (i.e., building foundations), area will be checked for nesting birds or signs of burrowing; if evidence is present, the area will be avoided until nesting/burrowing is complete • If avoidance is not possible, contact local Wildlife Officer to obtain advice/assistance on how to proceed • Halting of Project work activities if wildlife are in the vicinity and give wildlife right-of-way; report all wildlife presence to local Wildlife Officer • Establishment of a 100 m buffer if a Peregrine Falcon or other raptor nest is encountered on a Project site; inform local Wildlife Officer • Enforcement of site-specific Health and Safety Plan	• June - September 2014	None	None	
Operation of the Landfarm and Landfill Containment Cell	• Pump out, collection and treatment of all intrusive water • Installation of groundwater monitoring wells to monitor potential groundwater and leachate • To prevent against movement of contaminants off-site during operations, facility construction will be completed by a qualified contractor and inspected by an on-site Project Engineer • Design of facilities to prevent migration of contaminants - berms of sufficient height to contain wastes, use of geomembrane liner • Pump out, collection and treatment of all intrusive water • Inspection of Project structures/facilities for structural integrity (weekly) and prompt repairs, if required	• Operation of the Landfill Containment Cell in June - September 2014 • Operation of the Landfarm in June 2014 to Fall 2016	None	None	
Project-related transportation	• Discouragement of community use of the access road for public safety reasons • Restriction of Project-related vehicles from off-road travel • Implementation of a Dust Management Plan to control fugitive dust - limiting traffic speed on access road and on-site trails and road watering • Emergency spill kits kept with all working equipment • Implementation of a Spill Contingency Plan • Training of all on-site personnel in the proper handling procedures for all wastes, and in spill response procedures • Ensure all equipment is kept in good working order and not left running needlessly • Following DFO Operational Statement for Culvert Maintenance (if performing maintenance)	• June - September 2014	None	None	
Disposal of wastes	• Conduct waste incineration in accordance with Nunavut Environmental Guidelines for Burning and Incineration of Solid Waste • Restrict incineration to non-hazardous, combustible wastes and non-hazardous, petroleum product waste only • Containerization of all generated ash and disposal at landfill containment cell • Ensure all on-site personnel are trained in use of personal protective equipment, proper handling of hazardous materials, and proper procedures for working on construction and remediation sites	• June - September 2014	None	None	
Excavation and placement of materials	• Inspection of Project structures/facilities for structural integrity (weekly) and prompt repairs, if required • Short-term exposure for excavations • Restricting excavation to the active layer in shallow borrow sources • Establishing progressive reclamation procedures for borrow sources and potential temporary reclamation through winter and spring • Minimizing excavation footprints wherever possible and avoiding unneccesary vegetation removal • Ensuring no obstruction of natural drainage, no flooding or channel diversion • Where possible, establishing a minimum 30 m undisturbed buffer between a Project work site and the high water mark of a waterbody • Where this is not possible, construction of silt fences down-gradient of Project work sites • Pump out, collection and treatment of all intrusive water • Minimum 2:1 horizontal to vertical slope on all stockpiles and excavation/pit walls • Restriction of activities to built-up portions of the site and access road, and/or previously disturbed areas • Avoidance of identified heritage/archaeological sites with a minimum 20 m buffer (mark off sites)	• June - September 2014	None	None	

	PROPOSED MITIGATION MEASURE	IMPLEMENTATION SCHEDULE	RESIDUAL IMPACTS	PROPOSED MONITORING SCHEDULE	REPORTING SCHEDULE
EFFECTS (IDENTIFIED IN TABLE 5-1)					
Decommissioning					
General Project Activities	• Restriction of activities to built-up portions of the site and/or access road • Restrict Project activities to non-critical wildlife periods (e.g., after early July) • Prior to dismantling and removal of on-site debris (i.e., building foundations), area will be checked for nesting birds or signs of burrowing; if evidence is present, the area will be avoided until nesting/burrowing is complete • If avoidance is not possible, contact local Wildlife Officer to obtain advice/assistance on how to proceed • Halting of Project work activities if wildlife are in the vicinity and give wildlife right-of-way; report all wildlife presence to local Wildlife Officer • Establishment of a 100 m buffer if a Peregrine Falcon or other raptor nest is encountered on a Project site; inform local Wildlife Officer • Enforcement of site-specific Health and Safety Plan	• Fall 2014 (for majority of Project) • Fall 2016 (during landfarm closure)	• Completion of the Project is expected to have an overall positive residual effect on traditional land use through removal of contamination and waste debris • Completion of the Project is expected to have a positive residual effect on human health through removal of contamination and waste debris	None	
Culvert removal	• Restriction of in-water work to periods of low or no flow (August/September) and appropriate in-stream timing window (June 30 to September 1) • Ensuring work in-the-dry, if necessary • Restriction of equipment to constructed/built-up portions of the access road • Use of clean equipment and clean granular material • Where necessary, install silt fences or silt curtains downstream of installation site • Retention of vegetated banks • Emergency spill kits kept with all working equipment • Development and implementation of a Spill Contingency Plan • Where necessary, enable work in-the-dry by setting up temporary cofferdams with a water pump-around system; intake on pump-around will have appropriate fish screen and outflow will be stabilized to prevent erosion	• Fall 2014 (for majority of Project) • Fall 2016 (during landfarm closure)	None	None	
Excavation and placement of materials	• Ensuring landfill cover cap is appropriately compacted to reduce potential for sedimentation of runoff • Where this is not possible, construction of silt fences down-gradient of Project work sites • Pump out, collection and treatment of all intrusive water • Minimum 2:1 horizontal to vertical slope on all stockpiles and excavation/pit walls • Restriction of activities to built-up portions of the site and access road, and/or previously disturbed areas	• Fall 2014	None	None	
Project-related transportation	• Restriction of activities to built-up portions of the site and/or access road • Implementation of a Dust Management Plan to control fugitive dust - limiting traffic speed on access road and on-site trails and road watering • Emergency spill kits kept with all working equipment • Implementation of a Spill Contingency Plan • Ensure all equipment is kept in good working order and not left running needlessly	• Fall 2014 (for majority of Project) • Fall 2016 (during landfarm closure)	None	None	
Closure of the Landfarm and Landfill Containment Cell	• Grading of landfarm area to promote surface water runoff • Covering of landfill containment cell with geomembrane liner • Compaction and contouring of the landfill cover cap to promote surface water runoff and prevent water intrusion • Monitoring groundwater wells for potential groundwater and leachate	• Closure of the Landfill Containment Cell in Fall 2014 • Closure of the Landfarm in Fall 2016	None	• Annual monitoring for up to two years following closure to examine surface water runoff, facility integrity and groundwater quality	

Note: Residual impacts refers to those impacts that remain after mitigation has been implemented.

5.2 Physical VECs

5.2.1 Ground Stability and Permafrost

Potential adverse effects to ground stability and permafrost may potentially occur during all Project phases. These effects are associated with the following activities:

- Excavation and placement of materials; and,
- Project-related transportation (including the use of heavy equipment, earth moving activities, and on-site travel).

Excavation and Placement of Materials

The excavation and placement of materials includes all earthwork activities associated with the construction of Project structures/facilities (i.e., the access road, landfarm, staging area and landfill containment cell), development of the borrow sources, and remedial excavations.

Prior to the construction of the access road, landfill containment cell, staging area and landfarm, each area will be uniformly graded by placing and grading aggregate fill materials. No cuts will be made into the existing soil layer. Geotextile and geomembrane liners, with additional fill, will also be used in the construction of the landfill containment cell and landfarm to insulate the underlying soils and increase their bearing capacity. As discussed in Section 3.2.2, a minimum of 1.2 m of embankment fill will be placed along the road alignment to protect the underlying soils from softening and seasonal thaw. The use of frozen fill materials will be avoided to reduce the potential for excessive settlement, slope failures and surface water ponding. Runoff will also be controlled by creating positive drainage, or with the use of control structures, to prevent any water ponding and erosion which could further affect the thermal regime of the soil. During Project operations, the structural integrity all Project structures/facilities will be inspected weekly and monitored for cracks or any sign of failure. Any repairs will be completely as soon as possible to minimize further degradation, including water infiltration and potential ice wedge formation.

The remedial excavation of contaminated materials will cause a change in the terrain of the Old Town Site. However as the Old Town Site is not in a natural, undisturbed state, the effects of additional excavation are not considered. The remedial excavations, and development and operation of the borrow sources, may cause some warming and melt back of the permafrost however due to the removal of the active layer / exposure of permafrost. On-site depth to permafrost has been measured from 0.4 to 0.8 m below ground (mbg) and from 0.2 to 1.2 mbg at the borrow sources; actual depth to permafrost may be slightly deeper in some areas however as the geotechnical investigations were completed in July and the depth of seasonal thaw was likely not at its maximum. As reported depths of borrow sources range from 0.2 to 1.0 m and remedial excavations will be dug to a confining later (typically permafrost), encountering permafrost during excavations is likely,

On-site remedial excavations will be short-term in duration and backfilled as soon as possible following confirmatory sampling therefore any effects to permafrost will be temporary. However

mitigation measures will be established to protect the underlying permafrost of the borrow sources to prevent excessive thaw. These include restricting excavation to the active layer in shallow borrow sources, ensuring positive drainage away from the pit face, and establishing progressive reclamation of depleted sources. If it becomes known that pit faces or other areas may become unstable due to erosion and permafrost melt, additional mitigation may include temporary reclamation at seasonal borrow sources (i.e., those used each summer/fall during Project operations). At these sources, an organic layer will be placed over the excavated face(s) in the fall to provide insulation and protect face(s) from thaw and erosion during spring.

Upon Project decommissioning, the landfill containment cell and landfarm will be graded to a grade of 2 to 4% to promote surface water runoff; this will prevent water ponding, erosion of the granular caps, and infiltration of water into the capped material and potential generation of leachate.

The access road will be decommissioned once activities at the Old Town Site are complete. Some granular material used for access road construction will be re-used as either the sand cap at the landfill containment cell, as backfill at on-site remedial excavations, or for other municipal needs. Similar to access road construction, decommissioning activities will be restricted to the built-up portions of the road to minimize effects on the underlying terrain.

Project-related Transportation

Project-related transportation includes the use of heavy equipment at the borrow sources and Old Town Site, use of the access road by light and heavy vehicles, and on-site travel. As the Project area contains significant amounts of ground ice, widespread thermokarst depressions atop thick terraced raised marine and glaciomarine sandy sediments, saline permafrost, and thaw-sensitive soils, disturbances to the terrain from Project-related transportation and other activities will be minimized. All Project activities will be restricted to designated work areas only to reduce the spatial extent of Project effects on ground stability and permafrost. Wherever possible, sensitive landforms having evidence of thaw-sensitive soils, and/or wet areas with a thick organic layer, will be avoided.

The use of heavy equipment on the existing trails may alter natural drainage courses and establish areas where surface water may collect. In low-lying areas, on fine-grained and poorly drained soil, the existing ATV trails to and on the Old Town Site have already had an effect on the terrain as rutting and muddy conditions are present. The use of heavy equipment on the trails during the Project may exacerbate this effect and create a larger impact area as equipment is forced around muddy conditions. To mitigate this potential effect, the end dump method of construction will be applied for the access road and other infrastructure. Granular material will be dumped off the leading edge of the advancing road, eliminating the need for heavy equipment to travel on the terrain. Furthermore, trucks and other equipment will not be allowed to travel on the constructed road bed until at least 0.6 m of fill has been placed and compacted. Once completed, the access road will provide a stable driving surface and prevent direct effects to terrain while also reducing the required footprint as all site preparation and construction activities will be confined to the road alignment.

In the same way, on-site travel by ATVs and heavy equipment can also affect ground stability and permafrost. Here, on-site travel will be restricted to existing trail alignments, speeds will be reduced,

and movement of heavy equipment on these trails will be minimized. Where trails intersect low-lying, wet areas, trail crossings will be improved with the use of a temporary crossing (i.e., lay down wood boards), or alternate trail alignments over higher ground will be considered. Heavy equipment travel through low-lying trail segments will be restricted, or kept to a minimum if the travel is deemed necessary.

During operation of the access road, potential adverse effects can arise from the increased use of the road and surrounding area by residents. For public safety reasons, community use of the access road will be discouraged during Project activities however some use can be expected. Unrestricted travel off the access road may cause adverse effects to the surrounding environment as the vegetation and soil is disturbed by off-road travel. These potential problems cannot be prevented but can be minimized through strong discouragement and enforcement of access road use. Access road use by residents will be restricted as much as possible to protect public safety and the surrounding terrain and permafrost.

Overall, the removal of wastes and remediation of contaminated materials at the Old Town Site will restore a more natural terrain surface and improve site aesthetics. With applied mitigation, adverse environmental effects of the Project on ground stability and permafrost are considered mitigable and not significant (see Table 5-1). Residual effects are not expected.

5.2.2 Hydrology and Water Quality

During one or more phases of the Project, adverse effects to hydrology and water quality (surface and groundwater) may occur as a result of the following:

- Culvert installation and removal;
- Excavation and placement of materials;
- Operation of the landfarm and landfill containment cell; and,
- Project-related transportation (including the use of heavy equipment, earth moving activities, and on-site accessibility).

Potential adverse effects of water use (i.e., water withdrawal) on hydrology and water quality on the Clyde River and Patricia Bay are not expected and therefore have not been assessed. Assuming site activities seven days a week, up to 1.4 m^3 (1,400 L) of water will be withdrawn from the Clyde River weekly (using estimates of 0.2 m^3 [200 L] water per day). The estimated weekly water withdrawals are not expected to have an adverse effect on hydrology of the river. In the same way, Patricia Bay is a marine environment and weekly water withdrawal up to 12.6 m^3 (12,600 L) (using estimates of 1.8 m^3 [1,800 L] water per day) is not expected to have an adverse effect on the marine environment.

Culvert Installation & Removal

The installation of culverts at the four drainage channels could affect stream hydrology and water quality through alteration of stream hydrology, the release of and/or increase in downstream

sediments, and the deposition of a deleterious substance (e.g., fuel leaks/spills). The existing ATV trail on the Old Town Site has impacted all four drainage channels since ATV traffic traverses directly through the streams. Furthermore, impacts to water quality from existing waste at the Old Town Site have been detected in Drainage Channel #4, and to a lesser extent in Drainage Channels #2 and #3. Overall, the construction of the water crossings and remediation of the Old Town Site should result in a net environmental benefit as travel through the streams will be eliminated and the removal of wastes will improve on-site environmental conditions.

Potential effects to stream hydrology and water quality during in-stream work will be avoided by restricting any in-stream construction to periods of low or no flow (i.e., August/September), construction of temporary cofferdams to enable work in-the-dry (if necessary), and confining heavy equipment to the constructed portion(s) of the access road only. Permanent alteration of the stream channel is not required for the installation of any culverts and any effects to stream hydrology and downstream water quality will be temporary and short-term. The minimum culvert diameter of 300 mm was determined based on previous site observations and the temporary nature of the access road. The estimated design flow is 0.07 m^3/s and multiple culverts will be installed, where required, to ensure adequate flow through the road. Installation of culverts may result in a minor positive effect on channel hydrology as traffic will be expected to use the constructed stream crossings rather than travelling through the streambeds.

During in-stream work, adverse effects to water quality resulting from the potential release of a deleterious substance(s) (i.e., fuel leaks/spills, increase in suspended sediments) will be prevented. Clean equipment and clean granular materials will be used for work in or near any waterbody (see Table 5-2). Regular equipment inspection and maintenance, installation of silt fences and silt curtains, and retention of vegetated banks, will also prevent and mitigate any potential effects to water quality during in-stream work.

Emergency spill kits will be kept with working equipment through all phases of the Project (i.e., during construction of the access road, and during operations at the Old Town Site and borrow sources). In the event of spill, the Spill Contingency Plan (**Appendix D**) will be immediately initiated. Many of these mitigation strategies are also detailed in DFO's OS' for timing windows and culvert maintenance. These OS' will be adhered to for in-stream works to help mitigate any effect on hydrology and downstream water quality (see **Appendix C** for signed statements of confirmation).

Similar measures will be undertaken for culvert removal during decommissioning of the access road. Additionally, as the channel bed will not be dug up for culvert installation, minimal restoration will be required following removal. Minimal water flow and downstream silt curtains, with additional proposed techniques, will protect against effects to hydrology and water quality during culvert removal.

Excavation and Placement of Materials

The excavation and placement of granular materials at the borrow sources and/or waste debris (including contaminated soil) at the Old Town Site could have an effect on surface water hydrology by altering the natural surface drainage patterns on site through removal of natural vegetation and/or

contours; depending on the location of material excavation or placement, this may result in destabilisation of nearby banks or shores. These effects will be avoided by minimizing the Project footprint and necessary vegetation removal; ensuring there is no obstruction of natural drainage, no flooding or channel diversion; and, wherever possible, establishing a minimum of a 30 m undisturbed buffer between any Project work sites and the high water mark of a waterbody.

The excavation and placement of materials may affect runoff and surface water quality by causing an increase in turbidity/suspended solids, and potentially heavy metals and PHCs. Along with the aforementioned mitigation techniques, increased sediment in runoff will be reduced by decreasing the potential for erosion (i.e., minimum 2:1 horizontal to vertical slope on all stockpiles and excavation walls, ensuring landfill cover is appropriately compacted), and, where necessary, installation of silt fences down-gradient of any surface runoff at the borrow sources, landfill containment cell, or Old Town Site, including the landfarm.

On the Old Town Site, several areas of existing waste debris and contamination, which require excavation, are situated within 30 m of the high water mark of waterbodies (i.e., Patricia Bay and all drainage channels) (see Drawings 03, 03-A and 03-**B** in **Appendix B**) Here, it will not be possible to have a minimum 30 m undisturbed buffer to help prevent effects to down-gradient surface water hydrology and water quality. In these areas, silt fences will be constructed down-gradient of the work site to reduce potential sedimentation effects. Additionally, in all excavations, any instrusive water (i.e., water entering remedial excavations and potentially containing heavy metals and/or PHCs) will be pumped out and treated to applicable discharge criteria using the on-site water treatment system.

Operation of the Landfarm and Landfill Containment Cell

The removal of the contaminated soil and waste debris from the Old Town Site will, overall, eliminate uncontrolled contaminant migration into nearby waterbodies. However the operation of the landfarm and landfill containment cell could potentially affect surface water and groundwater quality during operations by increasing contaminants in surface runoff (i.e., heavy metals, PHCs) and through the generation of leachate.

Design specifications for the landfill and landfarm facilities (i.e., compacted berms of sufficient height to enclose materials, geomembrane liner) are such that potential migration of contaminants off-site will be minimized. To prevent leachate generation, any water which accumulates within the landfarm or landfill facilities will be pumped out and treated through the on-site water treatment system. Additionally, groundwater monitoring wells will be installed around the perimeter of both facilities to monitor groundwater for potential leachate contamination.

Upon closure of the landfill containment cell, a geomembrane liner will be placed on top of the landfilled wastes and covered with a 0.4 to 0.5 m sand cap. This granular material will be compacted and contoured to promote surface water runoff and protect the underlying landfill cell from water penetration.

Project-related Transportation

Project-related transportation, including use of the access road, earth moving activities, and on-site travel, may result in increased dust levels in the Project area. Increased dust can negatively affect runoff and nearby surface water quality by increasing turbidity/suspended solids and heavy metals. The potential for fugitive dust arising from Project-related transportation will be controlled by methods outlined in the DMP (**Appendix F**). For the access road and on-site trails, this includes limiting traffic speed and completing road watering during dry periods.

Therefore with applied mitigation, adverse environmental effects of the Project on hydrology and water quality are considered mitigable and not significant (see Table 5-1). Residual effects are not expected.

5.2.3 Soil and Sediment Quality

During the operation and decommissioning phases of the Project, adverse effects to soil and sediment quality may occur as a result of the following:

- Operation and closure of the landfarm and landfill containment cell; and,
- Project-related transportation (including the use of heavy equipment, earth moving activities, and on-site accessibility).

Operation and Closure of the Landfarm and Landfill Containment Cell

As discussed in Section 3.1, contaminated soil and waste debris is present throughout the Old Town Site, including areas within 30 m of a watercourse, as mentioned in Section 5.2.2. The excavation of these materials from the Old Town Site will remove the contaminated soil and waste debris from contact with the surrounding environment and improve overall soil quality on site. However improper construction of the landfarm or landfill containment cell could allow for the migration of contaminants outside of these facilities during operation. To ensure rigorous construction quality is monitored and maintained through the construction of these facilities, a qualified contractor will be retained to complete the work while inspections to ensure adherence to design specifications will be completed by an on-site Project Engineer throughout construction.

To further prevent migration of contaminants off-site (i.e., leachate) during facility operation, the facilities are designed to reduce potential for off-site migration of contamination (i.e., berms sufficient height to contain wastes, geomembrane liner). Additionally, all contact water which collects inside these facilities will be pumped out and treated in the on-site wastewater treatment system during facility operation. The facilities will also be inspected weekly to ensure structural integrity throughout facility operation. If, during the operation of either of the facilities, issues regarding the integrity of the structures are identified, corrective actions will be undertaken.

As stated in Section 5.2.2, upon closure of the landfill containment cell, the facility will be capped with a geomembrane liner and topped with a minimum of 0.4 m sand cap. This sand cap will be compacted and contoured to promote surface water runoff and prevent leachate generation. The closed facility will also be monitored annually for up to two years after closure to examine surface

water runoff, facility integrity, and the groundwater quality from the wells installed around the perimeter of the facility.

Once it is confirmed the contaminated soil in the landfarm has been remediated to site-specific criteria, an adverse effect from operation of the landfill no longer exists. The landfarm will be closed as outlined in Section 3.1.2.3.

Project-related Transportation

As a result of Project-related transportation and the potential for accidents or malfunctions, adverse effects on soil or sediment quality may arise from potential releases of hazardous materials, contaminated soil and/or fuels . To avoid these, mitigation measures will include ensuring the proper handling, storage and transportation of the materials, in accordance with the *TDGA* regulations. All workers will be trained in proper handling procedures for all wastes and in spill response activities. Emergency spill kits will be kept on-site with all working equipment and, in the event of spill, the Spill Contingency Plan (**Appendix D**) will be immediately initiated.

Therefore with applied mitigation, adverse environmental effects of the Project on soils and sediment quality are considered mitigable and not significant (see Table 5-1). Residual effects are not expected.

5.2.4 Air Quality

Adverse effects to air quality may occur during all phases of the Project as a result of the following:

- Disposal of wastes; and,
- General Project activities.

Disposal of Wastes

As a result of the landfarming of PHC contaminated soil, PHC vapours will be released during the remediation process. The volatilization of PHC vapours is necessary for soil treatment; however, the human health risk to on-site personnel and residents of Clyde River is expected to be negligible for PHCs (Nunami 2011d). Therefore, no mitigation measures are proposed.

Incineration of wastes at the Old Town Site could have an adverse impact on local air quality if incomplete or low temperature combustion occurs, or non-burnable wastes are attempted to be incinerated. To mitigate this potential effect, incineration will be conducted in accordance with the GN's *Environmental Guideline for Burning and Incineration of Solid Waste*. Furthermore, incineration will be restricted to non-hazardous, combustible wastes and non-hazardous petroleum product waste only. All ash generated will be containerized and disposed of at the landfill containment cell.

General Project Activities

Fugitive dust may be generated during all phases of the Project as a result of construction activities (i.e., access road, landfarm, landfill containment cell, staging area), and excavation and transport of borrow material, contaminated soil and waste debris.

A Dust Management Plan (DMP) has been developed for the Project activities (see **Appendix F**). Mitigation measures for dust management of the Project activities involve suppression, reduction and effect-minimizing activities, such as:

- Ensuring all material piles are sloped with a minimum 2:1 horizontal to vertical ratio to reduce wind erosion;
- Orienting borrow source pit faces with consideration to prevailing winds to direct any generated dust away from the community and other land uses (e.g., access road);
- Closing borrow source excavation on high-wind days;
- Watering of the landfarm to minimize dust during periods of soil rotation; and,
- Watering of the borrow source pit floor if the above mitigation measures prove inadequate to control dust generation from the borrow sources.

Project-related Transportation

Fugitive dust may be generated by Project-related transportation during all phases of the Project from use of the access road and existing on-site trails. To minimize these fugitive dust emissions, the access road and on-site trails (if required) will be watered during the summer period. Road watering will likely occur weekly, depending on weather conditions. Limiting speeds of heavy equipment, haul/dump trucks, light vehicles and ATVs travelling on the access road will also help reduce the fugitive dust emissions.

In addition to fugitive dust, the operation of light and heavy equipment through all Project phases may adversely affect air quality due to vehicle emissions. To help reduce this effect, all equipment will be kept in good working order and will not to be left running needlessly. Additionally, the Project will be short-term (two to three months over two years) and temporary (completed once) so any adverse effects to local air quality will be minimal.

Therefore with applied mitigation, adverse environmental effects of the Project on air quality are considered mitigable and not significant (see Table 5-1). Residual effects are not expected.

5.3 Biological VECs

5.3.1 Vegetation

During all phases of the Project, potential adverse effects to vegetation may occur as a result of the following:

- Excavation and placement of materials; and,
- Project-related transportation (including the use of heavy equipment, earth moving activities, and on-site accessibility).

Excavation and Placement of Materials

Approximately 7,080 m^2 (0.71 ha) of contaminated soil and waste debris will be excavated from the Old Town Site. The excavation of this material will reduce contaminant concentrations in the soil and improve overall site and vegetation quality. However the direct loss of vegetation within excavation footprints and under Project facilities is unavoidable.

Approximately 41,186 m^2 (4.12 ha) of land will be used for structures/facilities (i.e., footprints of the access road, landfill containment cell and landfarm) however 16,346 m^2 (1.63 ha) will be on previously disturbed land on the Old Town Site or at the Hamlet's Solid Waste Facility. Vegetation within the footprint of each of the constructed facilities will be covered by granular materials. The removal of the vegetation community will have an overall minor adverse effect on biodiversity and natural vegetation communities in the Project area, To minimize this loss, the area of disturbance during all Project phases will also be minimized. The mitigation measures described for ground stability and permafrost in the Section 5.2.1 (i.e., site preparation and construction confined to the constructed portions and previously disturbed areas, minimize number of vehicles required) will also minimize the area of native vegetation disturbed and therefore the loss of biodiversity. Following the decommissioning of Project structures/facilities (i.e., access road, landfarm) and backfilling of excavations, all areas will be allowed to re-vegetate naturally.

Development of the borrow sources will disturb approximately 74,500 m^2 (7.45 ha) of land. The area for borrow source development is currently or has been previously used for granular materials and little vegetation is present. However to mitigate against unnecessary disturbance, borrow source footprints will be minimized. Progressive reclamation following subsequent depletion of granular materials will also be completed (see Table 5-2). To facilitate progressive reclamation, any organics and overburden removed during borrow pit development will be properly salvaged and stored to enable use during reclamation.

Project-related Transportation

Project-related transportation can adversely affect the habitat quality and productivity of vegetation in the Project area as a result of increased fugitive dust or from further effects to vegetation from potential off-road travel by ATVs (see Table 5-1). Increased dust cover on vegetation can cause increased heat absorption and reduced transpiration while off-road travel can further disturb natural vegetation communities and biodiversity. Dust effects to vegetation will be mitigated with methods outlined in the DMP (**Appendix F**). Off-road travel by Project-related equipment will not be permitted.

Additional adverse effects to vegetation may result from the potential fuel leaks/spills. Emergency spill kits will be kept at each Project facility with working equipment and, in the event of spill, the Project-specific SCP (**Appendix D**) will be immediately initiated.

Therefore with applied mitigation, adverse environmental effects of Project activities on vegetation are considered mitigable and not significant (see Table 5-1). Residual effects are not expected

5.3.2 Wildlife

During all phases of the Project, potential adverse effects to wildlife may occur as a result of the following activities:

- General Project activities; and
- Project-related transportation.

General Project Activities

General Project activities include all construction, remedial operation and decommissioning activities in the Project area. Potential effects to wildlife from general Project activities include sensory disturbance, disruption of wildlife movement, habitat alteration, and direct / indirect wildlife mortality as a result of wildlife / human interactions.

Sensory disturbance effects on wildlife may include the temporary avoidance of the area by wildlife species, and potential changes in local movement patterns. The Project area has been subject to a moderate level of human use as a result of its proximity to the community, current use for traditional harvesting and camping, and previous use as the town site. However despite the area's use by the community residents, caribou, polar bear, arctic hare, foxes, ptarmigan, eider ducks, loons, sand pipers, songbirds and seagulls have been observed.

Sensory disturbance effects will be mitigated by restricting Project activities to non-critical periods (e.g., after early July for nesting avifauna). The construction and operation phases of the Project will occur over two summer and fall seasons while decommissioning will occur during one summer and fall season and will take place concurrently with Project operations in some areas. Therefore, though sensory disturbance effects may occur annually over the Project life, they would be temporary, short-term and very small on a geographic scale. As a result of Project activities, wildlife that may currently use the Project area may temporarily avoid the area, however similar habitat is available adjacent to the Project area.

Permanent avoidance of the area by some wildlife species may result from sensory disturbances over the life of the Project (e.g., increased vehicle traffic, equipment activity, and human activity). As mentioned, the area is and has been subject to a moderate level of human use and several wildlife species are known to occur despite this. Some wildlife avoidance of the area during the Project activities will be unavoidable, however the restriction of Project activities to non-critical periods and limiting of road use will mitigate against long-term wildlife avoidance.

The Project area does provide habitat for several migratory wildlife species, however due to the temporary nature of most structures/facilities and overall improvement of site quality, direct habitat loss due to Project activities is considered not significant. However, Project activities may affect habitat of species residing at the Old Town Site due to the removal of waste debris (including demolition of building foundations, etc) and the excavation of contaminated soils. The removal of these structures may affect existing avifauna nesting and small mammal burrow sites. Prior to disturbing building foundations and waste piles, the footprints of each area will be checked for the presence of nests or burrow. If evidence of nesting/burrowing is present, demolition or removal of

contaminated soil or waste debris proximate to these areas will be avoided until nesting is complete. In the event that the Project activities cannot be completed without disrupting nesting birds or small mammals, the local Wildlife Officer will be contacted to provide advice.

Direct effects to wildlife (avifauna and mammals) as a result of Project activities are expected to be minimal; most wildlife species are mobile and are not likely to suffer mortality or injury due to direct contact with construction equipment or materials during placement. However, if wildlife are encountered during Project activities, work will be halted until the animal(s) has moved away from the area. Wildlife will be given the right-of-way.

The presence of polar bears and/or caribou in the Project area is unlikely, though a possibility. Wolverine, foxes, wolves and ravens may also be attracted to the Project area as a result of odours and/or activity. Any wildlife encountered during the Project will not be harassed and all wildlife fatalities, if any, will be immediately reported to the local Wildlife Officer.

Peregrine falcon nests may be present in the Project area however interaction with these nests is not expected. Nests are typically located on rocky bluffs and cliffs and, with the exception of the existing Hamlet Quarry, the Project activities locations are not situated in these areas. If any active Peregrine falcon or other raptor nests are encountered during Project activities, a buffer of 100 m will be established around the nests; the nests will remain undisturbed and will be reported to the local Wildlife Officer.

Project-related Transportation

Project-related transportation may adversely affect wildlife mortality (i.e., increase mortality) due to the increased potential for vehicle-wildlife collisions, particularly with small mammals and avifauna (e.g., Arctic ground squirrels, birds). The Project area will be frequented by ATV, light vehicle and heavy equipment traffic. Road kills to larger mammals, such as caribou and wolves, will be prevented by reducing speed limits and giving wildlife the right of way.

During operations, the access road will provide the improved access to the Project area, potentially resulting in increased access to harvest wildlife. For public safety reasons, community use of the access road will be discouraged during Project activities. The access road will also be decommissioned to prevent community use and potential human health and public safety risks associated with the remediated Old Town Site. However, despite this, some community use of the access road is anticipated and it is expected that the HTO and residents will monitor resource harvesting activity and implement any controls, if/when necessary. To reduce the potential for wildlife road kills, these restrictions will need to be enforced during times of the year when evidence of caribou and other wildlife are present in and adjacent to the Project area.

Therefore with applied mitigation, adverse environmental effects of Project activities on wildlife are considered mitigable and not significant (see Table 5-1). Residual effects are not expected.

5.3.3 Fish and Fish Habitat

During all phases of the Project, potential adverse effects to fish and fish habitat may occur as a result of the following activities:

- Culvert installation and removal;
- Excavation and placement of materials; and,
- Project-related transportation.

Culvert Installation and Removal

As all drainage channels flow into fish habitat (Patricia Bay) and there is potential for fish presence in Drainage Channel #1 during high spring flows, in-stream construction will need to be restricted within a timing window to avoid sensitive life stages.

In the DFO Nunavut Operational Statement for In-Water Construction Timing Windows (DFO 2007a), the timing window recommended for spring and fall spawning fish, or unknown species, will be adopted for all in-stream construction activities at these crossing sites. The recommended window, when in-stream work is allowed, for waterbodies in the Clyde River area (Zone 1) is June 30th to September 1st, inclusive. This timing window has been applied as the presence of fall spawners (i.e., Arctic char, lake trout, and whitefish) was indicated. The June 30th to September 1st timing window is also ideal for in-stream construction at the non-fish bearing streams (i.e., Drainage Channels #2 to #4) as it occurs after the spring freshet and stream flow will be negligible in these streams.

As mentioned in Section 5.2.2, potential adverse effects to waterbodies and fish habitat may arise from increased sedimentation during structure/facility construction and other depositions of deleterious substances. The mitigation measures described in Section 5.2.2 (i.e., restriction to periods of low or no flow, work in-the-dry, clean equipment, etc) will mitigate effects to fish or other aquatic life and fish habitat in streams and adjacent waterbodies during construction (see Tables 5-2 and Table 5-3). The additional mitigation measures for in-stream work outlined in DFO's OS' for timing windows and culvert maintenance (e.g., in-water work) will also be followed to help mitigate any potential adverse effects on hydrology and downstream water quality (see **Appendix C** for signed statements of conformation).

Water flow is expected to be minimal in all four drainage channels during Project activities (after the freshet). However where necessary to enable work in-the-dry, temporary cofferdams will be set up upstream and downstream of the crossing sites and with a pump around system will be installed to prevent upstream flooding. An appropriately sized fish screen will be placed on the pump intake while the downstream pump outlet will be stabilized with riprap, if necessary, to prevent unnecessary scouring and erosion. Furthermore, where necessary, silt curtains can also be constructed downstream of the culvert installation site to protect the downstream fish habitat (Patricia Bay) from increased sediments.

Similar measures will be undertaken for culvert removal during decommissioning of the access road. Additionally, as the channel bed will not be dug up for culvert installation, minimum restoration is

expected following removal. Low water flow and downstream silt curtains will protect downstream fish habitat from adverse effects during culvert removal.

Excavation and Placement of Materials

As mentioned in Section 5.2.2, several areas of existing waste debris and contamination on the Old Town Site are situated within 30 m of the high water mark of waterbodies (i.e., Patricia Bay and all drainage channels). Here, silt fences will be constructed down-gradient of the work site to reduce potential sedimentation effects to fish habitat in waterbodies adjacent to and downgradient of these areas. Furthermore, effects to fish and fish habitat from potentially contaminated water (i.e., intrusive water in remedial excavations) will be prevented as all intrusive water will be pumped out and treated in the on-site water treatment system to applicable discharge criteria.

Also mentioned in Section 5.2.2, on-site remedial excavations and borrow source development may cause potential adverse effects to adjacent waterbodies and downstream fish habitat from the alteration of natural drainage patterns, increased sedimentation from runoff erosion or increased dust, and other depositions of deleterious substances (i.e., fuel spills, etc). Proposed mitigation measures, including a minimum 30 m natural buffer from the high water mark of any waterbody, minimum 2:1 slope ratio for excavations and piles, installation of down-gradient silt fences, collection of drainage water, if necessary, and the SCP (**Appendix D**), will protect against potential effects to fish and fish habitat (see Table 5-2).

Project-related Transportation

Fugitive dust arising from use of the access road, on-site travel and heavy equipment operation could adversely affect fish habitat in the Project area through increased sedimentation and reduced water quality. Culvert maintenance activities may also increase downstream sediment. These effects will be effectively mitigated with methods outlined in the DMP (**Appendix F**) and the compliance with the DFO OS' for Culvert Maintenance (DFO 2007b). With mitigation, adverse environmental effects from road operation on fisheries would then be considered not significant (see Table 5-1).

Residents currently utilize the Old Town Site for fishing and recreation. The access road will provide improved access to the Old Town Site and other fishing locations and this may result in increased use of the fisheries resource. During Project operations, community use of the access road will be discouraged for public safety reasons. Decommissioning of the access road will also further prevent community use to protect against human health and public safety risks from the remediated Old Town Site. However, despite this, some community use of the access road is anticipated and it is expected that local authorities will monitor fishing activity and implement controls to preserve populations, if necessary.

Therefore with applied mitigation, adverse environmental effects of Project activities on fish and fish habitat are considered mitigable and not significant (see Table 5-1). Residual effects are not expected.

5.4 Socioeconomic VECs

5.4.1 Local Economy

General Project activities will have a short-term positive effect on the Clyde River economy by providing opportunities for employment-focused training, seasonal employment, and procurement opportunities for individuals and businesses.

Project activities will be completed by a general contractor that is required to have a minimum Inuit employment content and minimum Inuit contracting content as established by the Government of Nunavut. Some of the possible employment opportunities for residents include equipment operators, labourers, wildlife monitors, environmental monitors, health and safety officers, etc.

In addition to the employment opportunities, the Project will create opportunities for local businesses to supply accommodations, domestic and fuel and industrial sales / service and supply.

5.4.2 Traditional Land Use

General Project activities, including the use of heavy equipment and increased noise, will likely have a temporary and short-term adverse effect on traditional land use in the area of the Old Town Site during all phases of the Project. As residents of Clyde River typically establish summer camps at and around the Old Town Site, the presence of remediation activities and associated noise levels, may interfere with traditional activities at and near the Old Town Site by potentially interrupting daily activities or contributing to wildlife avoidance of the area. These effects can be minimized by keeping regular work hours on-site (i.e., 7:00 am to 7:00 pm) and ensuring all equipment is kept in good condition to reduce Project-generated noise.

Overland access to the Old Town Site via the access road will also be discouraged and possibly restricted at times, due to public safety concerns (i.e., use of heavy equipment, hauling of wastes, etc). Residents of Clyde River have been made aware of Project activities and of possible restrictions in site accessibility during previous community consultations. Additional consultations are planned prior to Project mobilization each year to inform the Hamlet, HTO and interested residents of planned activities for the year and address any concerns about proposed activities.

However, the overall effect of Project activities on traditional land use is expected to be short term and positive but not significant as the removal of contaminated soil and waste debris from the Old Town Site will improve site quality. Hazards to human health and public safety will be minimized and potential sources of environmental contamination to traditionally harvested resources (i.e., marine clams) will be removed.

5.4.3 Human Health

As residents of Clyde River traditionally use the Old Town Site, completion of the Project is expected to have an overall positive effect on human health as contaminants and waste debris will be removed from the Old Town Site.

However during Project operations, remediation personnel could suffer potential adverse effects from the handling and disposal of waste; this could occur through improper handling of contaminated materials and hazardous waste, and improper use of personal protective equipment. These potential effects will be mitigated by ensuring all on-site personnel are adequately trained in the use of personal protective equipment, the handling of hazardous materials (i.e., WHMIS, site-specific procedures) and proper procedures for working on construction and remediation sites. An extensive site-specific health and safety plan will also be developed and enforced throughout Project activities; all on-site personnel will be familiar with this plan and made aware of site requirements (i.e., required PPE, waste handling and disposal procedures, decontamination procedures, working alone procedures, etc).

Therefore with applied mitigation, potential adverse effects of the Project on human health are considered mitigable and not significant (see Table 5-1). Long-term positive residual effects are expected through the removal of contaminants and waste debris from the Old Town Site.

5.4.4 Heritage Resources

During all phases of the Project, potential adverse effects to heritage resources may occur as a result of the excavation and placement of materials. These Project activities may potentially alter, disturb or destroy heritage sites along and/or within the structure/facility and excavation footprints.

Adverse effects to heritage resources (i.e., archaeological sites, including fossils, artefacts and/or archaeological remains), identified prior to the construction stage of development, can be significantly reduced or eliminated through avoidance or adequate study. Site avoidance can be achieved by the relocation of proposed Project structures/facilities or by restriction of Project activities within a development zone. Adequate study of archaeological sites generally involves scientific investigations which are designed to systematically explore and reconstruct the activities that are represented at the heritage site.

As discussed in Section 4.3.2, an HRIA will be completed in July / August 2012 to investigate the presence of heritage resources within, adjacent to, or near Project activity areas. Two grave sites have previously been identified at the Old Town Site. Until site-specific mitigation measures are recommended following the HRIA, the following mitigation measures are proposed for the two grave sites and any additional heritage resources sites identified within active Project areas:

1. The heritage site, with a minimum 20 m buffer zone, will be marked off and avoided during all Project activities.
2. If avoidance of the heritage site is not possible (e.g., it is located in the middle of a contaminated soil excavation footprint), a Project archaeologist will with work the GN-CLEY to determine the most appropriate option for the specific heritage site. This may include temporary or permanent excavation and removal of artefacts. A report of the discovery of the heritage site will be reported to GN Department of CLEY.

In addition to the above mentioned mitigative measures, off-road travel by Project-related vehicles will be restricted to prevent effects to identified or unidentified heritage sites. Though community use

of the access road during Project activities will be strongly discouraged, and the road will be decommissioned following Project completion, some use of the road route by residents is anticipated. In this instance, off-road travel by ATVs and snowmobiles will discouraged and/or limited by during and following completion of Project activities.

With proposed mitigation and anticipated mitigative recommendations following the HRIA, potential adverse effects of the Project on heritage resources are considered mitigable and not significant (see Table 5-1). Residual effects are not expected.

6 CUMULATIVE EFFECTS

From NIRB Guide #2, *Guide to Terminology and Definitions*, a cumulative effect is described as "... an impact on the biophysical and socio-economic environment that results from the incremental effects of a development when added to other past, present and reasonably foreseeable future developments, regardless of what agency or person undertakes such other developments. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time".

From this definition, cumulative effects from the Project activities have been assessed and the following key questions considered:

1. Are there residual Project-related adverse environmental effects?
2. Do identified residual Project-related adverse environmental effects overlap with (i.e., act in combination with) those of other existing projects and activities?
3. What is the contribution of the Project to those overlapping cumulative environmental effects of present projects, if any?
4. Do the combined Project and environmental effects of present projects or activities overlap with those of any approved or proposed projects that will be carried out?

These questions were considered for each VEC to the extent that they are applicable within the environmental effects investigation conducted in Section 5. Those VECs which may have cumulative effects from the Project activities, and known previous, current or reasonably foreseeable future developments are considered below.

6.1 Physical VECs

Residual effects were not identified for any phase of the Project for ground stability, permafrost, sediment / soil quality, hydrology and water quality, or air quality. Further, there are no known previous, current or reasonably foreseeable developments within or near the Project area which might affect the ground stability, permafrost, sediment / soil quality, hydrology and water quality, or air quality of the Project area.

6.2 Biological VECs

Residual effects were not identified for any phase of the Project for vegetation, wildlife, fish and fish habitat or aquatics. Further, there are no known previous, current or reasonably foreseeable developments within the Project area which might affect the vegetation, wildlife, fish and fish habitat or aquatics of the Project or Clyde River area.

6.3 Socioeconomic VECs

6.3.1 Local Economy, Traditional Land Use and Human Health

Positive residual effects were identified upon completion of the Project for traditional land use and human health. These positive residual effects result from the removal of contaminants and waste debris from the Old Town Site, an area which is used by residents of Clyde River for traditional activities, including harvesting. With the removal of contaminants and waste, the overall site aesthetics will be improved and human health and public safety risks reduced. Furthermore, the presumed source of contamination to marine clams (harvested by residents) will be removed which should improve their consumption quality.

However, no cumulative effects are expected as there are no known previous, current or reasonably foreseeable developments which might also affect the local economy, traditional land use or human health within the Project or Clyde River area and no cumulative effects are expected.

6.3.2 Heritage Resources

Residual effects were not identified for any phase of the Project for heritage resources. Further, there are no known previous, current or reasonably foreseeable developments within or near the Project area which might affect heritage resources of the Project or Clyde River area.

7 SUPPORTING DOCUMENTATION

Supporting documentation includes:

- Appendix A: Figures, including the Project Area (Figure 1), culvert and watercrossing locations (Figure 2) and borrow source locations (Figure 3).
- Appendix B: Nunami Stantec Clyde River Old Town Site Remediation 100 % Design Specifications
- Appendix C: DFO Statement of Conformation
- Appendix D: Spill Contingency Plan
- Appendix E: Photographs
- Appendix F: Dust Management Plan
- Appendix G: Community Consultation Meeting Minutes
- Appendix H: Supporting Documentation (Previous Reports) including:
    - Nunami Jacques Whitford Ltd. Supplemental Phase III Environmental Site Assessment (2011a);
    - Nunami Stantec Ltd. Remedial Action Plan (2011b);
    - Nunami Stantec Ltd. Geotechnical Assessment (2011c); and,
    - Nunami Stantec Ltd. Human Health and Ecological Risk Assessment (2011d).

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