Construction
Of
Indian Head Salmon Hatchery
Stephenville, NL

PROJECT DESCRIPTION AND REGISTRATION

This document is being prepared for the Newfoundland and Labrador Department of Environment and Conservation (Project Registration), pursuant to the Newfoundland and Labrador Environmental Protection Act, and the Canadian Environmental Assessment Agency (Project Description), pursuant to the Canadian Environmental Assessment Act

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PREFACE

This document was prepared by Silk Stevens Ltd., (SSL) of St. George, NB on behalf of Northern Harvest Sea Farms Newfoundland Ltd., (NHSF/NL) with the assistance of various Northern Harvest Sea Farms (NHSF) staff in New Brunswick, Newfoundland and Chile, Barry Coates, Town Manager for the Town of Stephenville and Joline Keys, BSc.

To ensure that required technical support is provided for the duration of the project NHSF, has assembled a team of engineering and environmental experts which includes the following:

Company	Responsibilities
Silk Stevens Limited	Provide project management and engineering services for construction of hatchery buildings, land surveying / acquisitions / permitting, and site development plans.
Carter Management Services	Provide general engineering support services for the duration of the project.
Stantec	Project hydro geologist responsible for all groundwater supply.
Barry Coates – Town Manager for the Town of Stephenville	Contributed selected components of this Project Description and Registration Report.
Joline Keys, BSc. (Zoologist)	Contributed selected components of this Project Description and Registration Report.
Fracflow Consultants Inc.	Completed Factual Report on Well Drilling and Aquifer Testing at Exploratory Test Well PW1.

Construction work is scheduled to begin in the fall of 2010 and will proceed to completion following approval of the environmental regulatory process and receipt of all necessary permits and authorizations. Site construction for the first phase of the work (Smolt Buildings No. 1 and No. 2) is scheduled to be completed by June 2011.

Since 1985, NHSF has successfully operated salmon farming in New Brunswick and Chile and currently operates farm sites in New Brunswick and Newfoundland. The Newfoundland sites are located in Fortune Bay, Harbour Breton Bay, Great Bay de L'eau and Hermitage Bay. In addition, NHSF/NL currently processes its fish at the Barry Plant in St. Alban's, NL. It is important to note that NHSF operates with modern techniques and advanced processes, all controlled by an Environmental Management System utilizing compliant standard operating procedures and manuals.

EXECUTIVE SUMMARY

This document is being prepared for the Newfoundland and Labrador Department of Environment and Conservation (Project Registration), pursuant to the Newfoundland and Labrador Environmental Protection Act, and the Canadian Environmental Assessment Agency (Project Description), pursuant to the Canadian Environmental Assessment Act, for the construction of a modern *recirc* salmon hatchery.

This document intends to provide a detailed description of the various components associated with the operation of a modern *recirc* salmon hatchery, which may be summarized as follows:

- Fresh water resources;
- Internal hatchery processes;
- Infrastructure integration;
- Waste management;
- Human resources

NHSF plans to construct a 7000m² hatchery on an 11 hectare site situated at 15 Connecticut Drive in Stephenville. The proposed site is within the Planning Area Boundary for the Town of Stephenville and is zoned as "Industrial General" (IG). Hatchery water requirements, estimated at 200m³ per day, will be supplied to the facility through a new well. Potable water for the offices will be provided by connection to existing infrastructure, operated by the town. Hydro will be provided by connection to an existing three phase distribution system, adjacent to the site. Trash and solid waste will go to an approved landfill. Water discharged from the facility will be treated to remove solids and released into a treatment pond system. Sludge will be collected in holding tanks and disposed of at an approved waste management site.

NHSF have consulted all pertinent levels of government while developing the operational plan of this undertaking. They further plan to conduct a public meeting before the end of 2010 in the Town of Stephenville to present their plans in relation to the hatchery.

NHSF plans to complete the required regulatory processes, obtain secure title to the Indian Head site, complete engineering design and commence construction during the fall of 2010.

It is anticipated that Smolt Building No.1 and No. 2 will be fully operational by mid June 2011 with an initial production of 3.5 million smolts per year, representing about 60% of NHSF's smolt production in Atlantic Canada. The Fry Building will be operational by the fall of 2010. 4.5 million smolts will be produced in year two and going forward.

The salmon hatchery will provide employment for approximately sixteen full-time/part-time employees with a range of skills. Assuming a direct-to-indirect labor ration of 1:2, this would imply that a total employment level of thirty-two jobs may be associated with this undertaking. NHSF is an equal opportunity employer with an anticipated fifty percent ratio between male and female employees in the hatchery environment.

1.0 INTRODUCTION

NHSF plans to construct and operate a modern *recirc* salmon hatchery in Stephenville, NL. Completion of the hatchery will provide the company with control of its smolt production and decrease biosecurity risks for the company and for the province's aquaculture industry overall. This project will see the construction of a 7,000m² facility on an 11 hectare site. It will utilize modern recirculation processes that reduce water use and it will have a maximum capacity to produce approximately 4.5 million smolts per year.

Section 2 of this document provides information on the proponent and presents rationale for the undertaking. Regulatory agencies and other stake holders impacted by the proposed undertaking are identified and ongoing efforts to consult with these groups is summarized to show the proponent's commitment to co-existing in harmony with other corporate entities, local citizens and with the environment.

A detailed description of the undertaking is presented in Section 3, with focus on such items as site parameters, operational scenarios, water consumption, waste management and quality standards.

Section 4 addresses Marine and Terrestrial Biological Environments associated with the undertaking. It provides a discussion of the various species found in the Stephenville area and presents any impacts that the proposed undertaking may have on the same.

Section 5 presents a description of the socio-economic environment in which the undertaking must exist. Historic and current demographics are elaborated on and any impacts that the hatchery may have on the traditional way of life in the Stephenville area are discussed. Public consultations, although not mandatory for an Environmental Registration document, are planned to be conducted in the town of Stephenville to describe the proposed hatchery and to address any concerns that the local citizens may have.

Land use issues are discussed in Section 6, with emphasis placed on zoning, surrounding land uses, land tenure and access to the proposed site.

The project schedule is presented in Section 7 of the document. It is based on an assumption that approvals will be issued following the review period by the Crown.

2.0 GENERAL INFORMATION

2.1 Proponent Contact Information

Name of the Corporate Body:

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2.2 Nature of the Undertaking

The project will involve the construction of a bio-secure recirc hatchery for sustained production of high quality smolt. The hatchery will produce 4.5 million smolt annually. Appendix A shows location and site plans of the hatchery, while Appendix B presents detailed floor plans, elevations and sections of the proposed Smolt Buildings No. 1 and No. 2 (Phase I of the hatchery).

2.3 Purpose / Rationale for the Hatchery

Newfoundland's marine environment offers many opportunities for salmon producers. However, the salmon farming industry in Newfoundland is presently reliant upon smolt importations from outside of the province for production. This approach poses significant risk to biosecurity and impacts competitiveness. To realize the potential of these opportunities, manage risks and be globally competitive, investment in hatchery capacity and a breeding program is critical.

This project will construct a modern, bio-secure recirc hatchery for land based production of smolt, broodstock, eggs, and a breeding program. The hatchery is an innovative application and combination of technologies merged with production techniques and management to meet these needs while achieving sustainable superior environmental performance and reduced production costs.

The hatchery will provide stock for NHSF's expanding ocean grow-out operations in Newfoundland and New Brunswick.

2.4 Authorizations Required / Approval of Undertaking

NHSF/NL will require approval in order to operate the hatchery. Following the environmental process, all applicable permits and licenses will be secured. These permits and licenses will include Department of the Environment and Conservation approval of the water works, municipal development approvals and other forms of authorizations as required.

The proposed location of the hatchery is situated within the Planning Area Boundary of the Town of Stephenville and any development must abide by municipal regulations and bylaws established by the town.

2.5 Public Consultations

NHSF recognizes that public consultation, while not mandatory, is desirable; and experience has shown that having all stakeholders, including the general public, consistently informed about Company plans leads to more successful on-going relationships. NHSF has met with the Town Council of Stephenville on several occasions and has involved them in meetings with regulatory agencies. In addition, NHSF plans to conduct a public meeting before the end of 2010 in the Town of Stephenville to present their plans in relation to the hatchery. During this meeting NHSF will provide an overview of the project, discuss employment requirements, solicit input into the project and receive feedback from the public.

3.0 DESCRIPTION OF THE UNDERTAKING

3.1 Geographical Location

3.1.1 Site Location

The site of the proposed aquaculture operation is located in the Town of Stephenville on the north shore of St. George's Bay, NL. Appendix A shows a general location map from a regional perspective. The hatchery will be constructed on the north shore of Port Harmon below an elevated bog/overburden plateau, west of the Indian Head mountain range. The land that was considered by NHSF to be most suited for the construction of the hatchery is located south of Connecticut Drive near the Stephenville Airport.

3.1.2 Site Description Including Boundaries

The site is located in the Port Harmon Complex Industrial Park, north of Rorstad Loop, near the Stephenville Airport and between the Stephenville Naval Air Museum and the former Abitibi Mill. The rectangular shaped, 11 hectare, site is relatively flat, sloping towards Port Harmon and is well suited to the construction of the hatchery facility. Appendix C includes a legal survey completed by R. Davis Surveys Ltd., which shows the exact site boundaries.

3.1.3 Current and Historical Land Use

Barry Coates, the Town Manager for the Town of Stephenville provided the following historical summary for the land that was purchased by Northern Harvest for the Indian Head Hatchery:

- Prior to 1941 the land was vacant or used as a pasture by local farmers;
- Oct. 20, 1940 – the land was selected as part of 8,159 acres to be used by the US Army Air Force Base (Stephenville Army Base) – the largest military air base to be constructed outside the continental USA.
  - At that time Stephenville had only 500 residents.
  - Stephenville grew from 500 to 7000 almost overnight.
  - The first contingent of US Army troops arrived in January 1941.
  - When the US declared war on Japan in December 1942, the site was not yet finished.
- 1942 – 100 mammoth tents were erected on the site of the proposed hatchery as 700 troops arrived and housing was not available.
- December 31, 1966 – The base officially closed and was turned over to the federal government. Many of the buildings still stand and are used by residents and businesses in the Town of Stephenville today.
  - The proposed hatchery site had not permanent structures.
- Feb. 1966 – The Harmon Corporation was formed in an attempt to boost the town's economy after the Americans left Stephenville. It had the right to buy, sell or lease property. The corporation received government support until 1976.
- Mid 1970s – A yacht club operated on the north end of the site. The Stephenville Search and Rescue Club used a natural point on the south end of the site for launching boats for training

purposes. Remnants of the wharf and boat launch still remain today.

- 1972-1977 - Newfoundland Liner Board Company stored logs on the site.
- 1977-1979 - The land was vacant.
- 1987 - The Harmon Corporation transferred land to the Town of Stephenville.
- 2000 - The remaining lands were transferred to the Town of Stephenville from the Newfoundland Housing Corporation.

3.2 Physical Features

3.2.1 Major Physical Features

The main physical features associated with this undertaking will be the construction of two identical smolt buildings with a footprint of approximately 2,322 m^2, an incubation fry building of approximately 2,500m^2, land for parking and access roads. Appendix A shows location and site plans for the hatchery.

3.3 Project Components and Activities

3.3.1 Fresh Water Supply

Appendix D presents water supply information including data from monitoring wells that were completed along a straight line from Noel's Pond to the shore of Port Harmon. The data shows that the overburden aquifer extends to depths of 60m or more and consists of sands and gravels. The data indicates that the aquifer is unconfined. Over most of this zone, the aquifer is covered by a layer of bog/peat, followed by an unsaturated zone below the peat and in some areas; a second layer of decayed peat is present. An exploratory test well was drilled to check the depth of the overburden at the borehole location, the type of sediments present and whether the groundwater chemistry varied with depth or pumping. The client's biologist, Mario Puga, has confirmed that that the water chemistry for the samples analyzed is suitable for the proposed hatchery.

3.3.2 Marine Infrastructure and Transportation

No construction of marine infrastructure in the form of wharves or other marine installations is planned for the hatchery. NHSF/NL intends to utilize existing local marine installations in the area for the delivery of juvenile salmon from the hatchery site to well-boats at the local wharf that will transport them to cold water grow-out cages. A wharf already exists at the former Abitibi Mill site, a short distance from the hatchery site, and wharf facilities for commercial fishing enterprises exist at the entrance to Port Harmon.

The hatchery will have company trucks for the transportation of materials required for operation of the hatchery and for the transportation of juvenile salmon from the hatchery to local wharves. As well, local delivery trucks will periodically visit the hatchery.

3.3.3 Related Municipal Infrastructure

3.3.3.1 Municipal Water System

The town of Stephenville is supplied by one of the best groundwater supply systems in Newfoundland. A potable water pipeline connected to this system runs along the south side of the paved road that is located along the northern edge of the proposed hatchery site. This will be used for site drinking water and fire protection.

3.3.3.2 Municipal Road System

The site is connected to the main road network for the town of Stephenville and the local highway system by a paved, two-lane road. No additional road upgrading is necessary for this development.

3.3.4 Electrical Services

The proponent proposes to connect to the existing power distribution system installed in the town of Stephenville by Newfoundland Power. In order to accomplish this, the proponent will run a three phase line from the new hatchery to the existing three phase line from the new hatchery to the existing three phase service on Connecticut Drive. This line of Newfoundland Power on Connecticut Drive is approximately 130 meters from the hatchery site which lies in a southwest direction from the Newfoundland Power lines. The new pole line will run along an access road which runs parallel to the proponent's property line and located approximately 30 meters inside the proponent's line. Poles will most likely be used to hold area lighting as well as the three phase lines. There will also be an emergency back-up generator on site.

3.3.5 Area to Be Affected By the Hatchery

The area to be affected by the hatchery is a site located in the Port Harmon Complex Industrial Park, north of Rorstad Loop, near the Stephenville Airport and between the Stephenville Naval Air Museum and the former Abitibi Mill site. The rectangular shaped 11 hectare site, is relatively flat, sloping towards Port Harmon and is well suited to the construction of the hatchery facility. The site is currently accessible by two gravel roads from the east, extending from an unnamed paved road from Rorstad Loop.

3.3.6 Environmental Protection During Construction

NHSF requires that all its employees and contractors comply with applicable environmental regulatory requirements related to the construction and operation of its facilities. As a result, NHSF is committed to minimizing environmental impact during the construction of the hatchery. As applicable, Environmental Guidelines issued by the DOEC will be followed.

Land clearing around the hatchery site will be controlled so that, where possible, activities will be kept to a minimum. Inspections of the site will be conducted on a regular basis as the project progresses and mitigation measures will be adjusted based on observations and scheduled activities.

3.3.6.1 Construction Duration and Period

The details of the construction duration and period of the undertaking are presented in Section 7. Construction of the Smolt Buildings will begin in the fall of 2010 and construction of the Fry Building will begin in the spring of 2011. Site construction should be completed by the fall of 2011 with inside finishes, furnishings, equipment and controls, substantially complete by January 2012.

3.3.6.2 Potential Sources of Pollutants during Construction

It is anticipated that the potential sources of pollutants arising from the construction of the hatchery will be fairly short-lived. Construction activities that will potentially generate sources of pollutants will include any on-site activities preparatory or related to the building, alteration or improvement of the property including, but not limited to the following activities; excavation, infrastructure development, vehicular travel and loading / unloading construction materials.

3.3.6.3 Air Emissions

Construction activities such as land clearing and the operation of heavy equipment can potentially contribute to air pollution. Dust emissions, known as particulate matter (PM) that can be generated during construction include dirt, dust, soot and smoke.

Vehicles equipped with diesel engines create air emissions such as carbon monoxide, carbon dioxide, nitrogen oxides and hydrocarbons. Air emissions can also be generated from paints, glues, oils, thinners, and cleaners that may be used during construction.

Intrusive noise can also be generated from construction activities and equipment. Due to the location of the site, however, it is not anticipated that noise will be a concern, as there are no other buildings or residents in the immediate vicinity. Construction activities will be managed to prevent or control sources of pollutants associated with air emissions.

3.3.6.4 Liquid Effluents

Construction activities such as land clearing can potentially contribute to liquid effluents. Land clearing causes soil erosion which can lead to silt-bearing run-off and sediment pollution. Surface water run-off also has the potential to carry pollutants from the site. If not managed properly, contaminated surface run-off can pollute waterways, groundwater or soil. Construction activities will be managed to prevent and control sources of pollutants associated with surface run-off.

3.3.6.5 Solid Waste Materials

It is important to minimize construction waste leaving the site for landfill disposal. This waste includes building materials such as insulation, steel, concrete, and wood. Construction activities will be managed to prevent or control sources of pollutants associated with solid waste materials.

3.3.6.6 Equipment Operation and Dust Control

Contractors will implement best management practices and methods as described below:

- Vehicles and equipment will be clean and in good repair, free of oil and harmful substances;
- Vehicles will not be refueled or serviced on site and heavy equipment will be refueled only in designated areas;
- Traffic will be restricted to project related access routes and existing roads will be used whenever possible;
- Vehicles transporting loads to and from the construction site will have loads covered to minimize dust;
- Gravel will be applied to cover, regularly travelled, unpaved surfaces and water will be applied, as necessary, to limit the amount of dust;
- Any piles of soil / aggregate that could generate dust will be covered or watered down;
- Idling of vehicles and equipment will be kept to a minimum.

3.3.6.7 Sediment/Erosion Control and Natural Drainage

Contractors will implement best management practices and methods to protect natural drainage and minimize soil erosion:

- Alterations to existing drainage patterns will be avoided, if possible;
- Land disturbance will be kept to a minimum;
- Ditches will be constructed to intercept surface water that would enter the site;
- Ditches will be constructed from lower to high elevations to avoid water ponding;
- Culverts will be installed to prevent ponding, as necessary;
- Surplus soil will be removed and properly disposed of;
- Vegetation will be retained along ditches to reduce potential erosion.

3.3.6.8 Waste Management

Waste management during the construction of the Undertaking can be categorized into non-hazardous and hazardous waste management practices.

The practices that will be followed to minimize environmental impacts caused by non-hazardous waste are listed below:

- The site will be kept tidy at all times;
- Construction waste and sewage will be collected for proper disposal;
- Garbage will be collected and stored in covered containers and disposed of regularly at an

approved landfill;

- Surplus construction materials will be removed from the site.

The practices that will be followed to minimize environmental impacts caused by hazardous waste are listed below:

- Laws, regulations and standards for safe use, handling, storage, and disposal of hazardous waste will be followed;
- An inventory of controlled products including hazardous waste will be maintained on site and updated;
- WHMIS requirements will be followed;
- All regulatory requirements for hazardous waste, including spill containment, will be followed;
- Storage sites for petroleum products will be secured and comply with all regulatory requirements;
- Non-hazardous products will be used in place of hazardous products, if possible;

3.3.7 Potential Causes of Resource Conflicts

No potential causes of resource conflicts have been identified for the construction of the hatchery.

3.3.8 Operation

3.3.8.1 Description of Operation

The hatchery will be owned and operated by NHSF, the principal contact person being Aaron Craig. The facility will be a modern recirc salmon hatchery and the Atlantic Salmon (Salmo salar) produced will be used at the company's own sites. All smolt from the hatchery will be used by NHSF in their own cold water sea cage grow-out system; no smolt will be for sale.

The hatchery will be located in Stephenville, NL. The nearest aquaculture site is a blue mussel aquaculture site operating at Piccadilly Bay (located 120-140 km away on the Port-au-Port Peninsula). The proposed hatchery site size will be approximately 11 hectares.

Stocking and culture of Atlantic salmon is based on life stage and separation of year classes. The incubation timeline for eggs and fry before first feeding is October – February; for parr the first feeding to 30-40 g salmon is March to December; and the smolt timeline for 30-40 g to 100 g salmon is from January to May.

Growth and feed projections are as follows: a stocking ratio for 1 g fish will be 25 kg/m^3 with a feed rate per day of 6-7% and an expected mortality of 5% at a temperature range of 14-16°C rising to a stocking ratio of 60 kg/m^3 for 100 g fish with a feed rate of 2% per day and an expected mortality of 1% at a temperature of 12°C.

Egg incubation will be done on vertical trays or "Heath Incubators". This current technology is already in use in many hatcheries and has proven results. The Health Incubators require very little floor space and less water than other technologies. The Egg Room will need to be biosecure and completely independent in terms of systems and control from all other parts of the hatchery.

The Alevin Room is simply an extension of the Egg Room and also has to be biosecure and independently controlled with respect to temperature, water demand, etc.

The Fry Room will contain sixteen 5 m diameter x 1.2 m deep tanks. This Fry Room will be divided into two systems of eight tanks each, completely independent from each other including a physical barrier. There will also be two sorting tanks for each system.

The Juvenile Room will consist of fourteen 7 m diameter x 1.6 m deep tanks. This room will also be divided into two systems completely independent of each other with two sorting tanks for each system.

The Smolt Room will consist of sixteen 12.2 diameter x 2.3 m deep tanks. This will provide enough capacity for production of 4.5 million smolt annually with a target weight of 80 grams each at a density of 60 kg/m^3. The Smolt Room will be divided into four separate tank bays or systems of four tanks each.

Product transportation will involve delivery of juvenile salmon from the hatchery site to well boats at the local wharf that will transport them to cold water grow out cages.

3.3.8.2 Estimated Period of Operation

Following the construction phase, the facility will begin operation and assume full production capacity by January 2012. The hatchery will operate for an indeterminate period into the future.

3.3.8.3 Potential Sources of Pollutants during Operation

Sources of pollutants during the operation of the hatchery include wastewater, fish feces, dead eggs and fish, food waste, sludge, ammonia, any chemicals used at the facility, and any feed bags used to bring the fish food into the hatchery. Trace amounts of dissolved reactive phosphorous, nitrate, nitrite, copper, zinc, iron, and hydrogen sulphide are expected to be found at the hatchery during operation.

3.3.8.3.1 Hatchery Effluent

Hatchery effluent includes wastewater, fish feces, dead eggs and fish, food waste, sludge, ammonia, and any chemicals used at the facility. Solid waste, including food waste, fish feces and dead eggs and fish, would be for the most part removed by filters before waste water leaves the facility.

Filtration and disinfection will be as follows: water will go through u/v, drum filter, swirl separator, bio filter, bead filter, low head oxygenator (LHO) and degasser.

3.3.8.3.2 Waste Materials

Waste materials will include: wastewater, fish feces, dead eggs and fish, food waste, sludge, ammonia, any chemicals used at the facility and trace amounts of other elements.

A feed-fine recovery system will not be used. Feed will consist of micro pellets for the first feeding through to 3 mm diet for smolt. There will also be a need to have up to 10 mm diet for brood fish. Feed bags will be disposed of in a dumpster on-site. Solid waste (trash) generated at the hatchery site will be disposed of at an approved waste disposal site.

3.3.8.3.3 Noise Pollution

Noise pollution is not expected to be a significant problem at the hatchery facility. Sources of noise such as motors, engines, fans, etc are expected to generate little significant noise at the hatchery.

3.3.9 Hatchery Effluent Monitoring

All of the water that enters the hatchery will be treated with UV Sterilization in order to prevent contamination. A Water Quality Monitoring Program will be part of the Hatchery Quality Management Program. The water that comes in from groundwater supply wells has very little oxygen in it and so because of this, oxygenation will be required prior to the water entering the culture tanks. Degasification will also be required in order to maintain ideal oxygen levels. This will be done as part of the recirculation treatment system and no additional equipment will be required.

The main water supply will enter the hatchery directly into the water treatment room. From there, the water will be split into process water and non-process water. Water supply distribution pipes will pass through the centre of the main hatchery building and run down the centre of each tank bay. Water treatment and distribution is important in order to maintain optimal water quality for fish culture and to control operating costs. Water treatment for the hatchery will consist of: solids removal, biofiltration, degasification, oxygenation and sterilization.

3.3.10 Waste Management

Any waste water that is generated will be filtered, to remove solids before being discharged from the hatchery. Once discharged, the waste water will be sent to an Abydos Treatment System.

NHSF has a Waste Management Plan in place to reduce waste and effluents.

An effluent treatment system will be provided to meet local discharge requirements. The effluent treatment system will include:

1) Drum filters;
2) Radial flow clarifiers; and
3) Solids concentration filtration

These components will be used to effectively reduce total suspended solids, total nitrogen and biological oxygen. The waste treatment system will remove more than 90% of the monthly mass of feed. Solids will need to be collected from tank sumps, parabolic and other contact filters and drum filters.

All solids and fish feces will be removed from re-circulated process water by mechanical filters and discharged as sludge to underground collection tanks. The collected waste will be removed by vacuum tanker and disposed of by licensed contractors at approved facilities.

After water has passed through the drum filter, it normally flows by gravity into a moving bed biofilter with kaldness media. Biofiltration will remove the ammonia produced by the fish as well as carbon dioxide that needs to be exhausted from the system. After biofiltration, the culture water normally goes to a primary sump pump where the water is pumped through a second filter to remove suspended solids, dissolved solids and biofilm. The hatchery will use a bead filter.

After water has passed through secondary filtration (bead filter) it will flow by gravity feed into a degasser unit that will remove gases. From there the water will drop into a Low Head Oxygenerator (LHO) responsible for replacing oxygen that has been consumed by fish.

To fulfill the Oxygen need of the culture tanks, an oxygen saturation system will be installed to ensure the oxygen level on the culture tanks are optimal for fish growth. This system will also help reduce the nitrogen on the system water. An oxygen generation system including an oxygen storage tank will be required to be sized to meet the hatchery demand.

After degasification and re-oxygenation, water will continue to flow by gravity to culture tanks. Gravity flow is essential whenever it is possible to be able to manage operating and maintenance costs.

A number of workers and management will be required on-site every day to operate the hatchery. The facility will have a kitchen/lunch room, washrooms, showers, etc., and numerous other fixtures that will contribute to a sanitary sewage effluent that will require on-site treatment and disposal. An in-ground sanitary treatment system comprising of a septic tank and disposal field will be required.

The Waste Management Plan will reduce the type, volume and disposition of waste effluents. The plan will be audited annually and changed as required to meet targets set for reducing all waste streams where possible. Materials and supplies will be delivered in biodegradable or recyclable packaging wherever possible.

The proponent anticipates an average daily dry waste generation of approximately 50kg/day which equates to less than 20 metric tonnes of waste per year.

3.3.11 Noise Control

Due to the location of the site, it is not anticipated that noise will be an issue. There are no other buildings, commercial operations or residential dwellings in the immediate vicinity of the site.

The incubation fry, parr and smolt units will have insulated walls to filter out any minimal amount of noise from machinery operating inside the hatchery. The access road will be paved and speed limits will be posted to ensure traffic noise is minimized. In order to reduce the impact any noise may have on adjacent properties, deliveries to / from the hatchery will take place, whenever possible, during regular business hours.

3.3.3.12 Quality and ECO Standards

NHSF will manage the hatchery with a continued focus on quality and service that will be maintained as the undertaking progresses from construction through to operation. Key issues of focus include sustainability, food safety, quality and the environment.

NHSF provides its fish with an Eco-Friendly diet that is more sustainable than traditional diets. The fish are fed a premium diet that is higher in Omega 3 and Vitamin E, than traditional diets. The feed is produced in pants that are HACCP certified, enabling safety systems to track and trace raw materials and finished product.

3.4 Employment and Human Resources

3.4.1 Enumeration and Breakdown for Construction

Construction of Smolt Buildings No. 1 and No. 2 (Phase I of the hatchery) will begin in the Fall of 2010 and will be completed by June 2011. A Fry Building (Phase II of the hatchery) is planned for the Spring of 2011. Appendix A shows the location and site plans of the hatchery.

Workers during construction will include supervisors and laborers for concrete footings and erectors of the pre-engineered steel building. There will also be electricians, plumbers, carpenters and finish trades for installing equipment, tanks, and various building systems and finishes. There is a potential need for up to 150 full-time / part-time workers during construction.

3.4.2 Enumeration and Breakdown for Operation

The hatchery when fully operational will have the potential to employ a mix of both full-time and part-time employees. These employees may consist of a hatchery manager, assistant manager, two fish hatchery machinery technicians, a fish hatchery technician with expertise in recycling flow facilities, an aquaculture farm technician, a bacteriological technician, a food bacteriological technician, a microbiological quality control technologist, an accountant/office manager, a security guard and a janitor.

3.4.3 Workforce, Contractor and Spin-Off Activities

The hatchery has the potential to generate approximately 150 jobs during construction. During operation of the hatchery, 16 full and part-time permanent positions may be generated and double that number will potentially be generated as permanent spin-off positions within the community. The hatchery will make a positive and significant contribution to the local economy.

3.4.4 Employment Equity (Age and Gender)

NHSF is an equal opportunity employer and is committed to ensuring that its policies, practices, and programs are free of barriers, emphasize diversity, and promote participation to ensure dignity, respect, and equal access for all employees. Employment decisions are made on the basis of merit and unlawful discrimination is prohibited.

3.5 Alternatives Considered

NHSF has been working to locate a modern recirc salmon hatchery in Stephenville, NL since 2008. No other locations or sites were considered. Appendix A shows the location and site plans of the hatchery.

4.0 Marine and Terrestrial Biological Environments

4.1 Water Bodies and Drainage Basins

A number of small water bodies including Noel's Pond, Mine Pond and Gull Pond drain into Port Harmon adjacent to the hatchery site. Several protected well fields also exist to the north-west of the site. The closest, Stephenville well field, is 3.5km away, and the Kippens well field, which is further west, is 5.5km from the site. The hatchery site is down-gradient of the established well fields as the general topography of the area consists of elevated hills to the west, north and east of the site with the majority of the precipitation collecting in nearby drainage basins (Noel's Pond, Mine Pond, etc.) and eventually flowing towards the ocean near the site at Port Harmon.

4.2 Topography, Surficial Geology, Bedrock Geology and Hydrogeology

The hatchery site is located near the cusp of two physiographic regions in western Newfoundland, the Stephenville Lowlands and the Blow-Me-Down Highlands. (AMEC, 2008) The actual coordinates of the hatchery site fall within the Stephenville Lowlands physiographic region. The surficial geology is predominantly sand and gravel within the Stephenville area and the topographic terrain ranges from approximately 50m to 150m above sea level throughout. (AMEC, 2008) Appendix F shows the surficial geology. The surficial geology of the Stephenville area can be defined as unconsolidated sediments, well sorted sand and gravel with depths from 1.5m to 50m. Gravel is pebble to cobble in size and forms approximately 50-95% of the sediment including eskers, kames and outwash planes. (AMEC, 2008)

The bedrock geology within the hatchery site is comprised of clastic sedimentary rocks and minor coal beds. Bedrock geology in the area can be defined as part of the Barachois Group, Arkosic and subarkosic, grey to red sandstones, grey to red siltstones, grey to black shale and coal beds as well as Codroy Group rock, coarse to fine red beds, evaporates such as sulphate and chloride salts, limestones and dolostones with some grey lacustrine siliciclastic rocks. (AMEC, 2008) Appendix F shows the bedrock geology.

4.3 Vegetation

Stephenville is located within the St. George's Bay sub eco-region which is described as a forested rolling and flat topography with deep soils composed primarily of glaciofluvial deposits and till. The area tends to be nutrient poor with coarse soils and marginally productive forests that extend into the coastal zones with extensive bogs in the lowlands that are precipitation dependant. (South, 1983) This eco-region is one of the largest in the province covering approximately 1,000,000 hectares. See Appendix E for eco-region information. The predominant vegetation is forest with species ranging from Balsam Fir, Black Spruce, White Pine, Red Maple, Trembling Aspen and Alders to Yellow Birch and the uncommon Black Ash. The undergrowth of these forests tends to be dominated by ferns. (NFDOEC, 2010)

A number of Botanical Ecological Reserves exist on the island such as Burt Cape, Hawke Hill, King George IV, Redfir Lake-Kapitagas Channel, Watts Point and West Brook which serve as areas that represent important flora areas in Newfoundland and Labrador. (NFDOEC, 2010) The closest

Botanical Ecological Reserve to the hatchery site is King George IV which is 75km to the south-east.

The Newfoundland and Labrador Housing Corporation previously conducted a wetland survey that encompassed the hatchery site. The report did not identify any wetlands of significance that would require environmental investigation / assessment for new developments by the NLHC.

A plant species query was obtained from the Atlantic Canada Conservation Data Centre (ACCDC) for plant species within a 5km buffer of the hatchery site. Records indicate 14 occurrences of rare and common plant life. Among the 14 sightings, 5 are considered rare plant occurrences: Fernald's chuckleypear, St. Lawrence serviceberry *(Amelanchier fernaldii),* hardstem bulrush *(Schoenoplectus acutus var. acutus)*, northern speedwell *(Veronica serphyllifolia subsp. Humifusa)*, spiked watermilfoil *(Myriophyllum sibiricum)* and whorled watermilfoil *(Myriophyllum verticuillatum).* However, these rare plant species have not yet been assessed under COSEWIC or the Provincial Endangered Species Act. (ACCDC, 2010) It should be noted that none of the above species were observed within the immediate footprint of the project area.

No provincial or federally listed species of concern were found to have distribution ranges that overlapped that of the general Stephenville area.

4.4 Wildlife Species

Newfoundland and Labrador is home to several species at risk or those that require special concern in relation to environmental changes that may affect important habitat required for survival. Species at risk can be designated both federally and provincially. The following species are listed under the federal Species at Risk Act (SARA) and have distribution ranges or migratory patterns that overlap but are not limited to the general Stephenville area: Piping Plover *(Charadrius melodus melodus)*, Eskimo Curlew (Numenius borealis), American Marten or Newfoundland Pine Marten *(Martes Americana atrata)*, Northern Wolffish (*Anarchichas denticulatus)*, Woodland Caribou *(Rangifer tarandus caribou),* Banded Killfish *(Fundulus daiphanious)*, Harlequin Duck *(Histrionicus histrionicus)*, Short Eared Owl *(Asio flammeus)*, Harbour Porpoise *(Phocoena phocoena)*, Atlantic Codfish *(Gadus morhua)*, Red Crossbill *(Loxia curvirostra)* and the Barrow's Goldeneye *(Bucephala islandica)*. (SARA, 2010)

Newfoundland and Labrador's Endangered Species Act provides special protection for species within the province that are considered to be endangered, threatened or vulnerable. Species are assessed based on recommendations from the committee on the Status of Endangered Wildlife in Canada (COSEWIC) and / or the Species Status Advisory Committee (SSAC), both independent committees who determine the status of species, subspecies and population. Those that have distribution ranges within the general Stephenville area include: Piping Plover *(Charadrius melodus melodus)*, Eskimo Curlew (Numenius borealis), American Marten or Newfoundland Pine Marten *(Martes Americana atrata)*, Northern Wolfish *(Anarchichas denticulatus)*, Woodland Caribou *(Rangifer tarandus caribou)*, Banded Killfish *(Fundulus daiphanious)*, Harlequin Duck *(Histrionicus histrionicus)*, Short Eared Owl *(Asio flammeus)*, Red Knot *(Calidris canutus)*, Red Crossbill *(Loxia curvirostra)*, Barrow's Goldeneye *(Bucephala islandica)*, Rusty Blackbird *(Euphagus carolinus)*, Grey-cheeked Thrush *(Catharus minimus)*, and the American Eel *(Anguilla* *rostrata)*. (NFDOEC, 2010)

A search by the Atlantic Canada Conservation Data Centre in Corner Brook, NL lists 511 occurrences of rate to common fauna between the years of 1992 and 2005 within a 5km buffer of the hatchery site. All of these sightings were of birds; no other vertebrates or invertebrates were recorded within the buffer zone. Among these sightings, 69 would be considered rare occurrences and 3 of these were of the Short Eared Owl *(Asio flammeus)* which has been assessed as a species of special concern under both COSEWIC and SARA and listed as vulnerable under the provincial listings. 6 of these sightings were of two species, the Ivory Gull *(Pagophila eburnean)* and the Red Crossbill *(Loxia curvirostra)*, which are both considered endangered under COSEWIC, SARA and provincial listings. One sighting of the Red Knot *(Calidris canutus)* species is listed as endangered under COSEWIC and provincial listings. One sighting of the Barrow's Goldeneye *(Bucephala islandica)* is considered a species of special concern under COSEWIC and SARA and as vulnerable under provincial listings. Lastly, one sighting of the Killdeer *(Charadrius vociferous)* species is being considered as a candidate for listing under COSEWIC. (ACCDC, 2010) It should be noted that none of the above species were observed within the immediate footprint of the proposed project area. See Appendix E for distribution maps.

In summary, the hatchery site is a previously disturbed site within an industrialized area and is adjacent to an airport and a recently closed mill. (Town of Stephenville, 2010) As such, the immediate build area is not likely to offer suitable habitat for most of the species listed above. It is not anticipated that the proposed project's activities would result in significant negative impacts on the aforementioned species or their habitat.

5.0 SOCIO-ECONOMIC ENVIRONMENT

5.1 Demography

The town of Stephenville, formerly named 'Indian Head', is located on the west coast of Newfoundland and has a population, as of 2006, of 6,588. Stephenville is a major service centre for the southwestern part of Newfoundland.

The town was founded in 1844 by two English families, William Hunt and James Penny, of Margaree, Cape Breton. In 1846, Felix Gallant, also arrived with his family from Margaree. The following year as they revisited Margaree, the Gallants encouraged others to relocate to Stephenville.

The name 'Stephenville' first appeared in 1874 when the population had reached 268. Farming was the main occupation but by the early 1900's, people had turned to lobster and herring.

By 1935 the population of the town of Stephenville had reached 1,000, many being employed in the pulp-wood industry and at saw mills.

In 1941, Stephenville became the site for construction of the Ernest Harmon Air Force Base – the largest U.S. Air Force Base outside of the Continental United States. Construction of the base impacted Stephenville significantly increasing the population to 7000, almost overnight. In 1966, the base closed, leaving considerable economic devastation in the region.

In the 1970's the Abitibi-Consolidated Pulp and Paper Mill opened. The College of the North Atlantic also established its main campus in Stephenville at this time.

The closing of the base proved to be not the only economic crisis that the citizens of Stephenville have had to endure during the past several decades. The Abitibi-Consolidated Pulp and Paper Mill also closed its doors, again leaving considerable economic devastation in the region. Stephenville, survived, however, and is continuing to grow economically.

6.0 LAND INFORMATION

6.1 Zone Information

The proposed undertaking is situated within the Planning Area Boundary of the Town of Stephenville, and hence it is subject to development regulations and bylaws as established by the town. The subject property is zoned Industrial General (IG).

6.2 Land Ownership

The proposed undertaking is encompassed by a track of land that is owned by the Town of Stephenville. NHSF is currently in negotiations with the Town of Stephenville to acquire this land for the construction and operation of the hatchery.

7.0 SCHEDULE

NHSF plans to complete construction of Smolt Buildings No. 1 and No. 2 (Phase I of the hatchery) by June 2011. A tentative schedule for the project has been provided below:

Project Schedule - Indian Head Hatchery			
Task	Description	Start Date	End Date
1	Site Selection	2009	May 2010
2	Conceptual Plan	May 2010	August 2010
3	Land Acquisition	August 2010	October 2010
4	Geotechnical Analysis	August 2010	September 2010
5	Building Design	June 2010	November 2010
6	Regulatory Approvals	September 2010	November 2010
7	Development of Fresh Water Supply	September 2010	December 2010
8	Construction	Fall of 2010	June 2011
9	Process Installation	January 2011	June 2011
10	Commissioning	May 2011	June 2011
11	Operations	June 2011	---

8.0 FUNDING

NHSF plans to develop an $11 million modern recirc salmon hatchery in Stephenville, NL. To assist the company with setting up operations in the province, the Government of Newfoundland and Labrador will provide 50 per cent of the cost of setting up the hatchery. This funding will be provided through the Aquaculture Capital Equity Investment Program and will be based on a matching investment from the company. In return, the Provincial Government will have an equity position in the expanded company until the development is completed and the provincial investment is repaid in seven years.

9.0 REFERENCES

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Town of Stephenville. 2010. (Online: http://www.town.stephenville.nf.ca)

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Atlantic Canada Conservation Data Centre (ACCDC). 2010. Query Results.

APPENDIX A

Location & Site Plans

NORTHERN HARVEST SEA FARMS

LOCATION PLAN

09-10-054.00

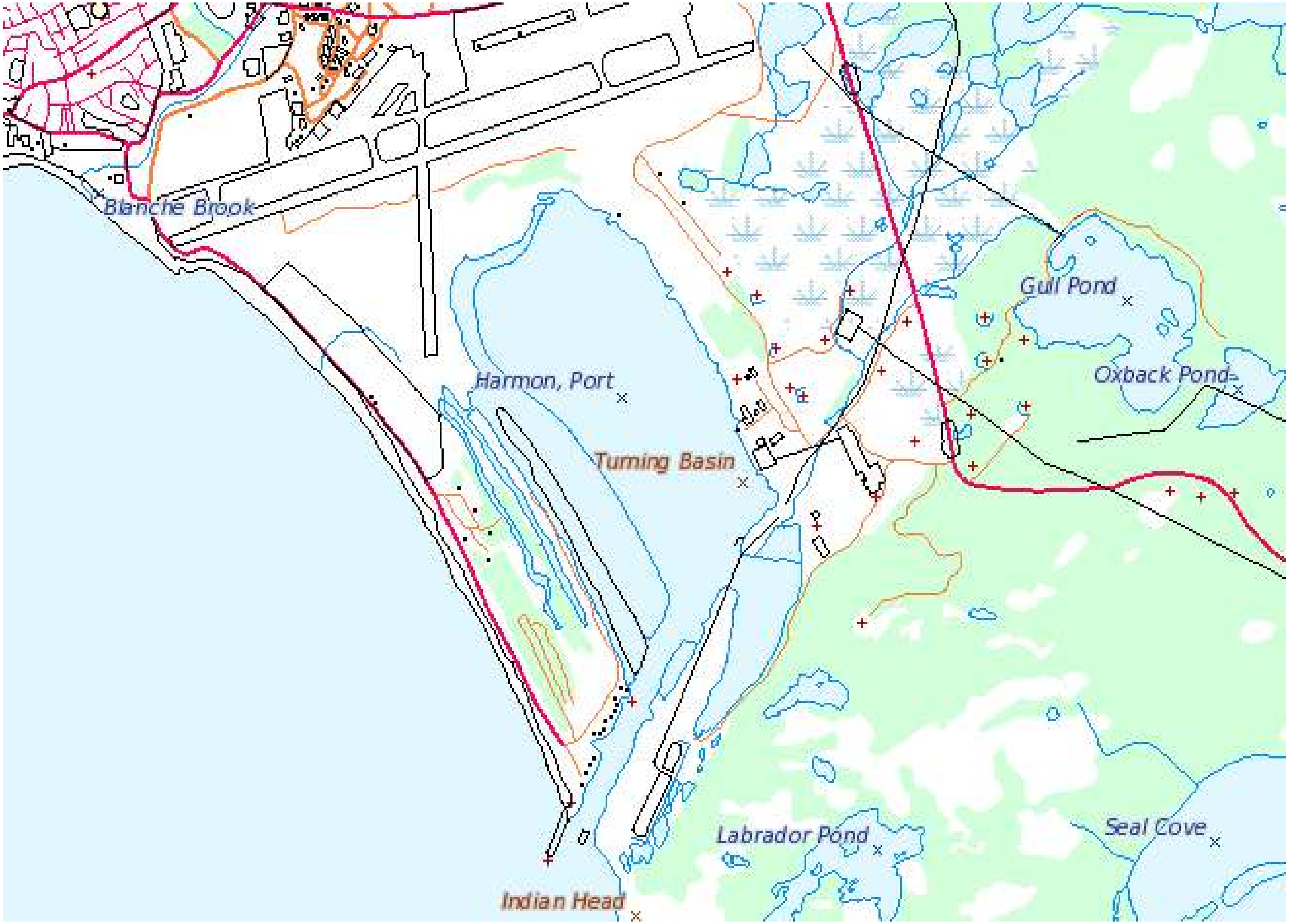
INDIAN HEAD HATCHERY

M.E. | DNS

REVISION DESCRIPTION

Silk Stevens Limited
Design and Consulting Engineers
55 Main Street, St. George, New Brunswick, E5H 3G9


FINAL SITE PLAN
BUILDINGS 1 & 2
SEPTEMBER 16 2010
SMOLT
BLDG #1
FRY
BLDG #3
SMOLT
BLDG #2
160'
120'
120'
50'
50'
479.96'

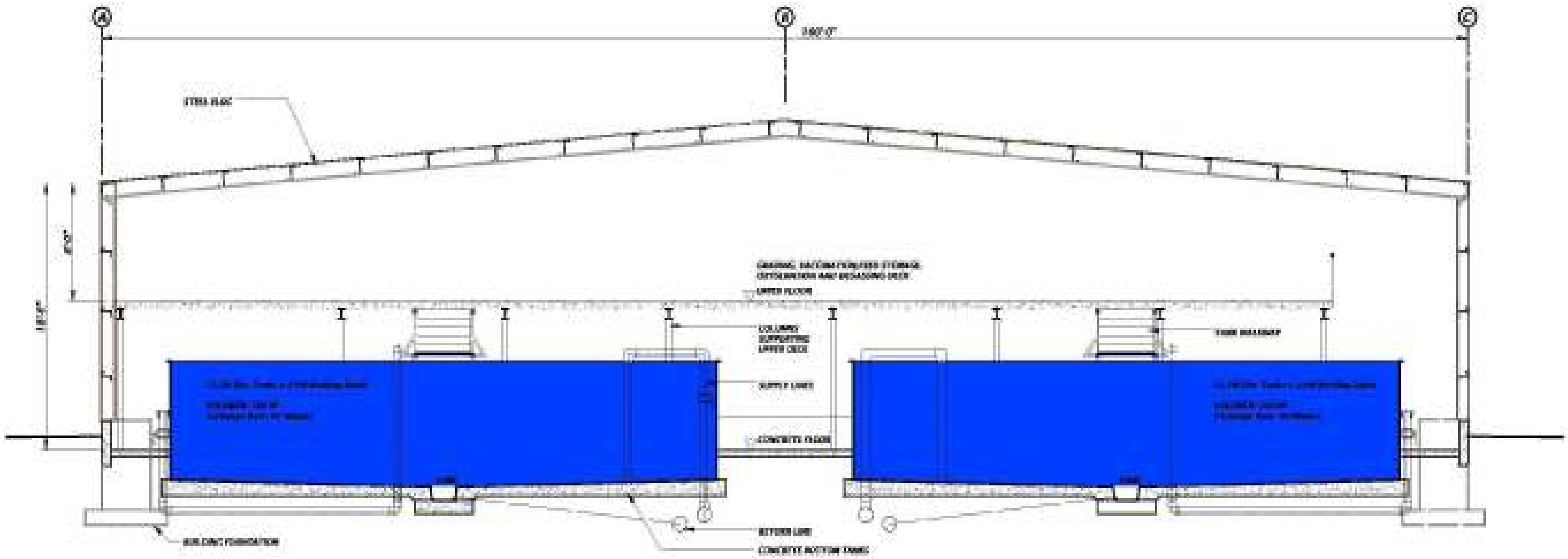

Blanche Brook
Harmon, Port
Turning Basin
Gull Pond
Oxback Pond
Labrador Pond
Seal Cove
Indian Head


Bay
Black Point
Port au Port
Tanks
Com
195
TABLE
Cold Brook
HEAD
Romaines
Kippens
Port
au Port
East
Stephenville
Felix Cove
Isthmus Bay
Noels Pond
Whites Road
Black Duck
Local Service District
Town Limits
Limits
Stephenville
84
123
490
461
Port Harmon
Indian Head
Stephenville
Crossing
Rothesay Bay
Com 117
Com 180
Water
GEORGE'S
Main Gut
Mattis Point
Black Bank
Provincial Park
Harbour Point
St George's Harbour
Turf Point
Island
Barachois
Brook
Mistaken Pond
Black Duck Pond
Little Long Pond
Long Gull Pond
625
500
100
8
7

APPENDIX B

Floor Plans, Elevations & Sections

Preliminary



1 CROSS SECTION A-A THRU 12M TANKS

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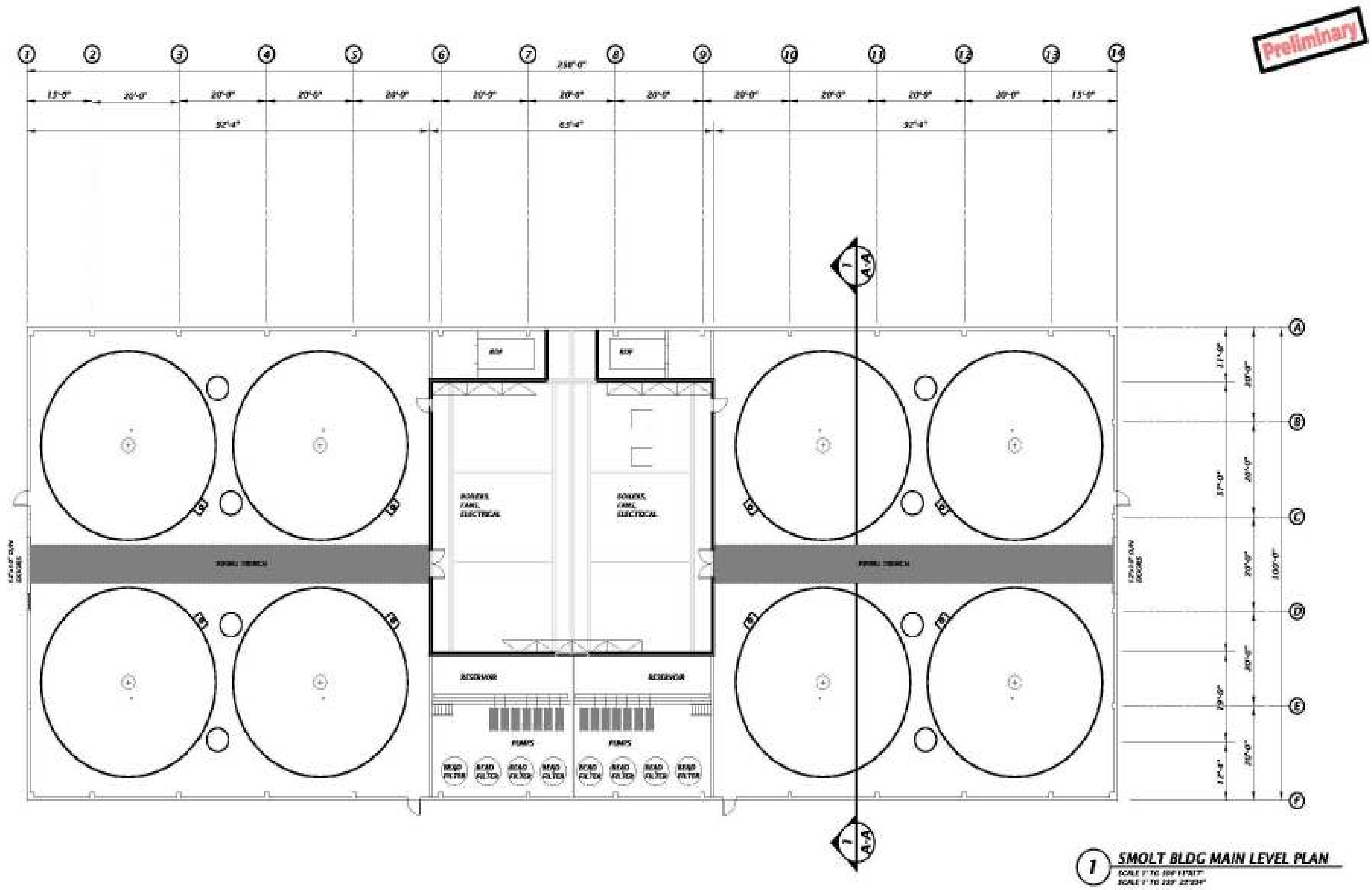
		09-10-054.00		2 OF 2

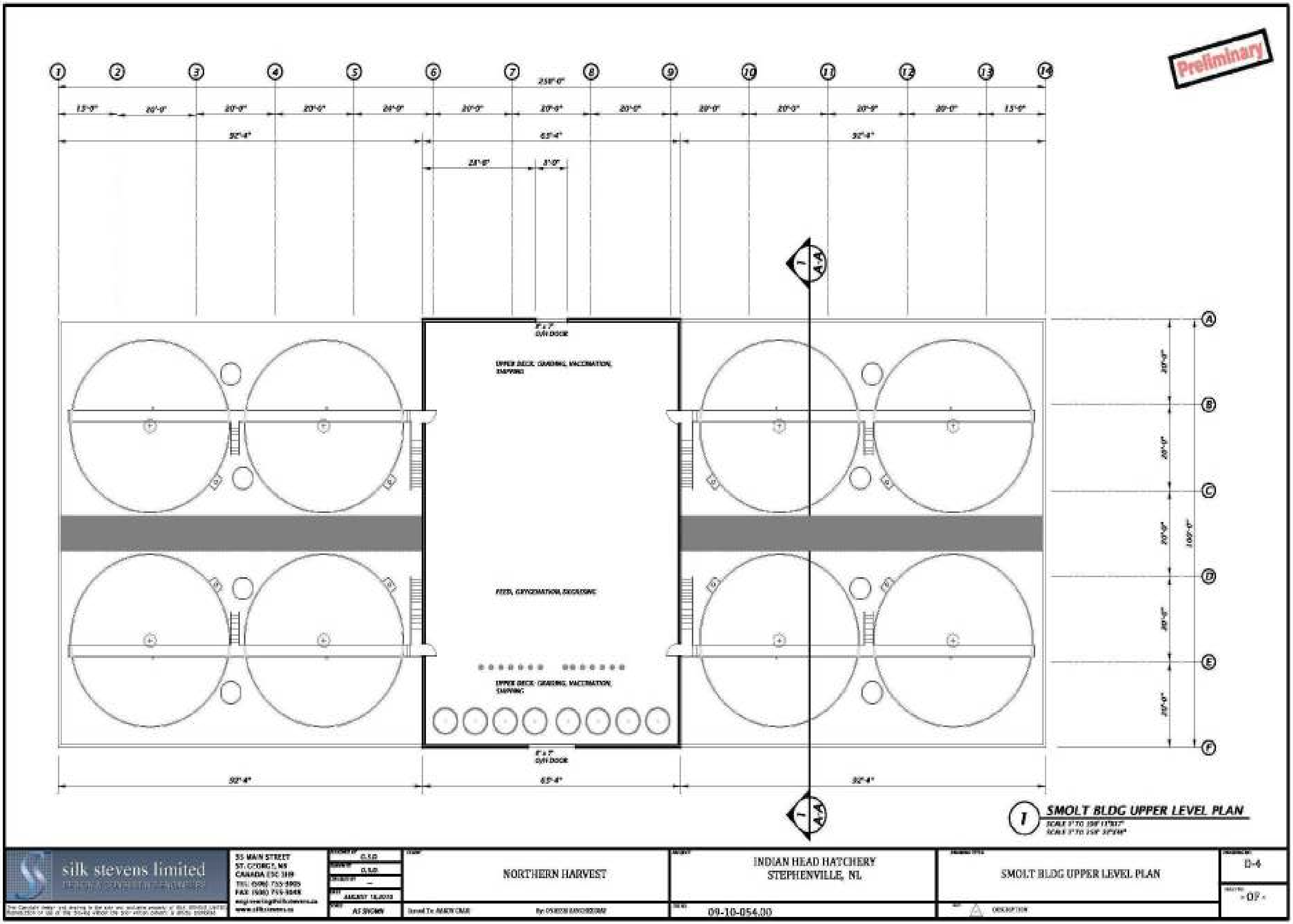


1 SMOLT BLDG MAIN LEVEL PLAN

silk stevens limited
35 MAIN STREET
ST. GEORGE, NB
CANADA E5C 3H9
TEL: (506) 755-3005
FAX: (506) 755-3048
engineering@silkstevens.ca
www.silkstevens.ca

Designed by	D.S.D.
Drawn by	D.S.D.
Checked by	—
Date	AUGUST 11, 2010
Scale	AS SHOWN

Client	Project	Drawing Title	Drawing No.
NORTHERN HARVEST	INDIAN HEAD HATCHERY STEPHENVILLE, NL	SMOLT BLDG MAIN LEVEL PLAN	D-3
	09-10-054.00		- OF -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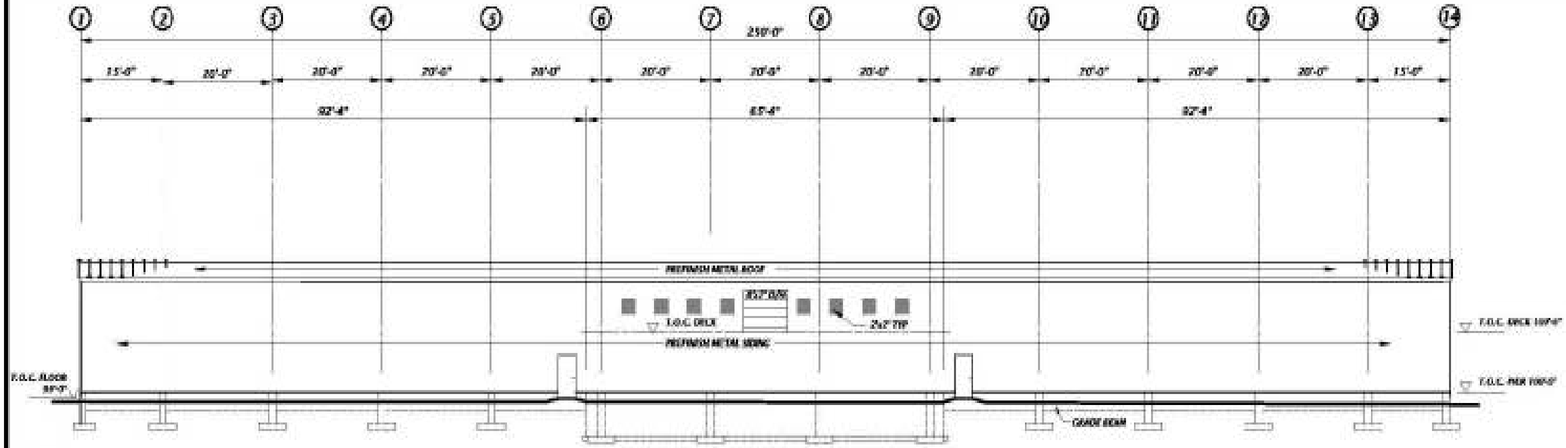
250'-0"
15'-0" 20'-0" 20'-0" 20'-0" 20'-0" 20'-0" 20'-0" 20'-0" 20'-0" 20'-0" 20'-0" 20'-0" 15'-0"
92'-4"
65'-4"
92'-4"
23'-6"
3'-0"
8' x 7' O/H DOOR
UPPER DECK: GRADING, VACCINATION, TAPPING
FEED, OXYGENATION, DEGASSING
UPPER DECK: GRADING, VACCINATION, TAPPING
8' x 7' O/H DOOR
A B C D E F
20'-0" 20'-0" 20'-0" 20'-0" 20'-0"
100'-0"
1 A-A
1 SMOLT BLDG UPPER LEVEL PLAN
silk stevens limited
55 MAIN STREET
ST. GEORGE, NS
CANADA
NORTHERN HARVEST
INDIAN HEAD HATCHERY
STEPHENVILLE, NL
SMOLT BLDG UPPER LEVEL PLAN
D-4
09-10-054.00
D.S.D.
AUGUST 18, 2010
AS SHOWN
DESCRIPTION
- OF -

Preliminary



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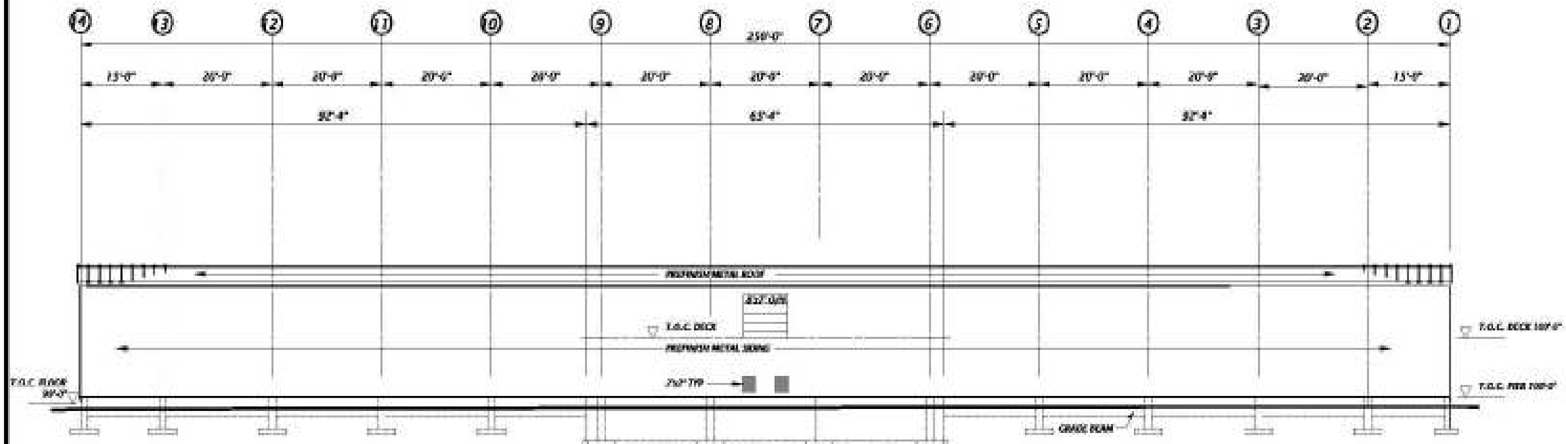
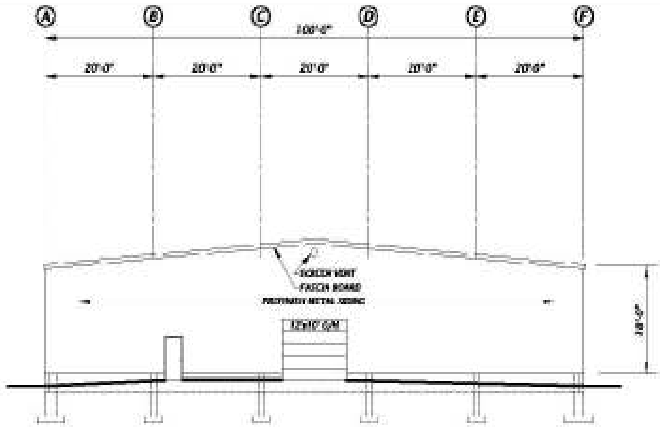


2 LEFTWALL ELEVATION

silk stevens limited

35 MAIN STREET
ST. GEORGE, NB
CANADA

Client	NORTHERN HARVEST
Project	INDIAN HEAD HATCHERY STEPHENVILLE, NL
Drawing Title	ELEVATIONS
Drawing No.	D-5
Date	AUGUST
Scale	AS SHOWN
Job No.	09-10-054.00



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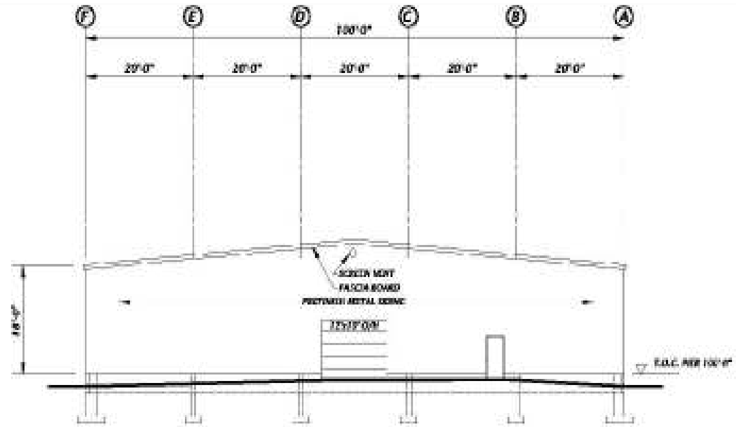


2 BACK SIDE ELEVATION

silk stevens limited
DESIGN & CONSULTING ENGINEERS
35 MAIN STREET
ST. GEORGE, NB
CANADA E5C 3H9
TEL: (506) 755-8005
FAX: (506) 755-8040
engineering@silkstevens.ca
www.silkstevens.ca

DRAWN BY	D.S.D.
CHECKED BY	D.S.D.
APPROVED BY	–
DATE	AUGUST 30,2019
SCALE	AS SHOWN

CLIENT: NORTHERN HARVEST

PROJECT: INDIAN HEAD HATCHERY
STEPHENVILLE, NL

JOB NO.: 09-10-054.00

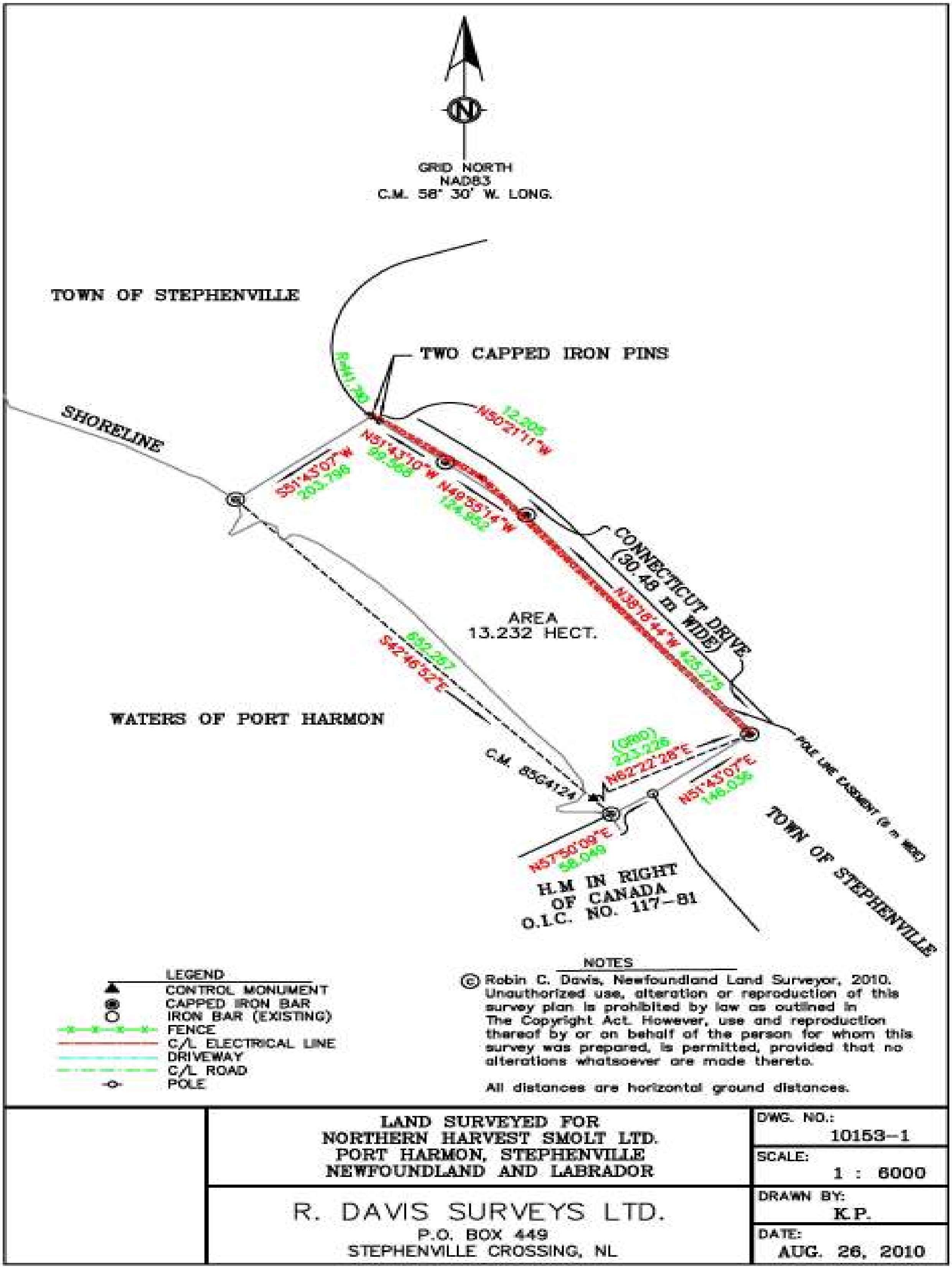
DRAWING TITLE: ELEVATIONS

DRAWING NO.: D-6

SHEET NO.: - OF -

APPENDIX C

Survey Drawing & Land Description



Description of Land Surveyed for
Northern Harvest Smolt Ltd.

Port Harmon, Stephenville
Newfoundland and Labrador

All that piece or parcel of land situate and being at Stephenville, District of St. George's-Stephenville East, Newfoundland and Labrador, Canada abutted and bounded as follows,

That is to say; Beginning at a point being N 62° 22' 28" E a distance of 223.226 meters (grid) from Control Monument number 85G4124,

Thence by the sideline of Connecticut Drive, 30.48 meters wide, N 38° 18' 44" W a distance of 425.275 meters,

Thence N 49° 55' 14" W a distance of 124.952 meters,

Thence N 51° 43' 10" W a distance of 99.568 meters to a point in a curve having a radius of 141.740 meters,

Thence following the said curve having a radius of 141.740 meters, in a general northerly direction to a second point in the curve being N 50° 21' 11" W a distance of 12.205 meters from the last mentioned point in the curve,

Thence by land of the Town of Stephenville S 51° 43' 07" W a distance of 203.796 meters to a point in the high water mark along the shoreline of Port Harmon,

Thence following the shoreline of Port Harmon in a general southerly direction to a second point in the high-water mark being S 42° 46' 52" E a distance of 652.267 meters from the last mentioned point,

Thence by land of H.M. in right of Canada (O.I.C. No. 117-81) N 57° 50' 09" E a distance of 58.049 meters,

Thence by land of the Town of Stephenville N 51° 43' 07" E a distance of 146.036 meters to the point of beginning,

The herein described piece or parcel of land contains an area of 13.232 hectares and is more particularly delineated on a plan number 10153-1 hereto attached,

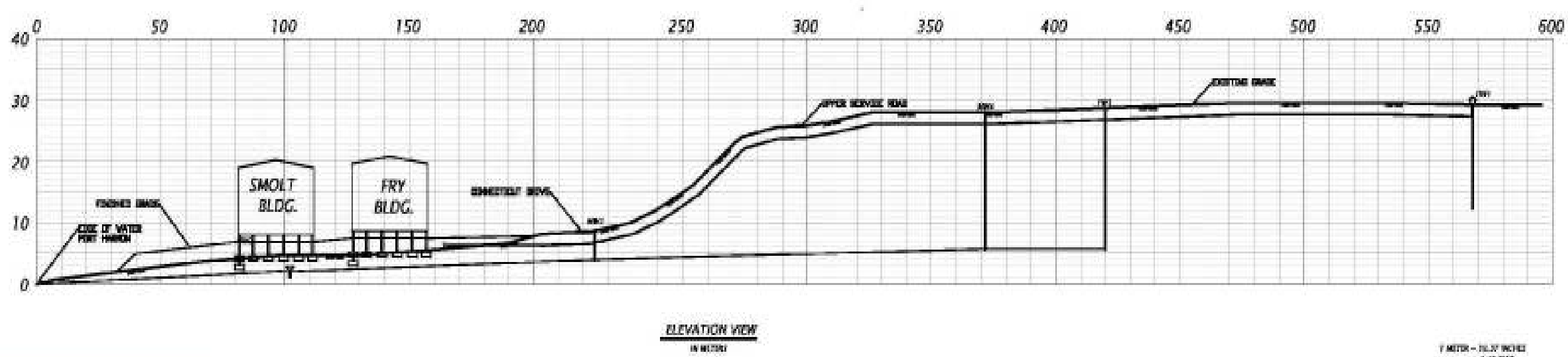
The above described parcel of land being subject to a pole line easement, 6 meters wide along the front of the property as shown,

All bearings refer to the meridian of fifty-eight degrees thirty minutes west longitude of the Three Degree Transverse Mercator Projection (NAD83).

Robin C. Davis
Newfoundland Land Surveyor
August 26, 2010
Stephenville Crossing, NL

APPENDIX D

Water Supply Information



silk stevens limited	33 MAIN STREET ST. GEORGE, NB CANADA E5C 3H9 TEL: (506) 755-3069 FAX: (506) 755-5048 www.silkstevens.ca	A.C. W.B. D.R.S. SEPTEMBER 28, 2010	NORTHERN HARVEST SEA FARMS	INDIAN HEAD HAYCHERY STEPHENVILLE, NL	HATCHERY WATER SUPPLY WELL AND PIPELINE	1
			ISSUED TO: BARRY COATES BY: D. STEVENS P.ENG.	09-10-080.00 / AS SHOWN		1 of 2

Fracflow Consultants Inc.

Environmental, Hydrogeological and Geotechnical Engineering Consultants

PROVINCE OF NEWFOUNDLAND
PERMIT HOLDER
CLASS "A"
This Permit Allows
FRACFLOW CONSULTANTS INC.
To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by APEGN D0169 which is valid for the year 2010

TECHNICAL MEMORANDUM

TO:	Northern Harvest Sea Farms Limited	FFC-NL-520-003
FROM:	Fracflow Consultants Inc.	
DATE:	October 21, 2010	
SUBJECT:	Factual Report on Well Drilling, Aquifer Testing at Exploratory Test Well PW1	

1.0 INTRODUCTION

An exploratory test water supply well was constructed at the site of a potential land-based aquaculture operation in Stephenville, NL between August 5 and 9, 2009. The location of PW1 is given in **Appendix A.** That well was also tested to determine the aquifer properties and to obtain water samples to assess groundwater quality. The scope of work, field methods, data collected, and the results are presented in this factual report.

1.1 Scope

The scope of work was to design, drill and construct an exploratory water supply well in the overburden materials to investigate the overburden aquifer properties between 30 and 50 m below ground surface and to obtain groundwater samples to determine the chemistry of the groundwater at the depth drilled. The design, size, and depth of the well was dictated by the cost and the uncertainty with respect to the depth and nature of the overburden materials in the depth range of interest.

1.2 Scope of Work

This phase of the project consisted of the following activities:

- Cleared and prepared the access road about 20 m beyond monitoring well MW4 to permit the setup of the drill rig;
- Drilled and constructed a 6-inch diameter well, with a K-Packer and well screen installed in the well;

- Conducted a Step Drawdown Test to determine well drawdown for the available pump capacity and the maximum pumping rate for the aquifer test;
- Conducted an Aquifer Test on the new production well to collect data required to estimate the aquifer characteristics. This included monitoring water levels in the overburden aquifer at MW4 to determine aquifer Storativity (S) and Transmissivity (T). Also monitored water levels in MW1, MW2 and MW3 to identify potential well interference effects;
- Measured geochemical field parameters, collected a suite of water samples and completed selective chemical analysis on selected samples; and
- Prepared and submitted this technical memo report.

2.0 DRILLING AND WELL CONSTRUCTION

2.1 Site Clearing and Road Work

Prior to the well drilling rig mobilizing to the site, an access road was cleared and prepared, about 20 m beyond monitoring well MW4 to permit the setup of the drill rig on the well location.

2.2 Borehole Drilling

Fracflow retained Northeast Well Drilling Co. Ltd. of Springdale, NL, to drill and construct the well. An air rotary drilling rig was mobilized to the site on August 5, 2009. Surface casing consisting of 152 mm (6 inch) diameter, Schedule 40 was advanced to a depth of 50 m below grade and the well was completed by retracting the well casing to approximately 40 m to expose the well screen from approximately 40 m to a depth of 50 m (163 feet) below ground surface. Soil samples were collected during drilling of PW1 commencing at 36.5 m (120 feet) to 48.7 m (160 feet) every 1.5 m (5 feet) to assess the overburden at this depth. Sieve analysis completed on the 8 (eight) samples gave CFEM classifications of "Sand, trace Silt and/or Clay". The location of PW1 is shown in **Appendix A**. A copy of the borehole/well construction log is presented in **Appendix B**. The grain size data are presented in **Appendix C**.

Samples were not collected between ground surface and 36.5 m (120 feet) as the production test well, PW1, was completed near the previously completed observation well, MW4 which was completed to a depth of 29.6 m below ground surface and soil samples were recovered every 1.5 m (5 feet).

2.3 Well Construction

The slotted well screen and the various sections of blank steel casing were cut, welded and placed inside the 6-inch diameter well between August 6 and 7, 2009. The completed well consisted of the following materials, from the bottom up:

- Blank Casing - (1.5 m) 5 feet at the bottom with an end plate and access port;
- Stainless Screen - three lengths, each 3 m long, wire-wrapped, 20 slot;
- Blank casing - 1.5 m;
- K-Packer placed at approximately 38 m below ground surface;
- Blank casing - from approximately 40 m to surface (allowing for 0.6 m of stick-up above grade level); and
- Centralizers installed as required.

A copy of the well construction log is attached in **Appendix B**.

2.4 Well Development

The well was developed on August 7, 2009, for a period of 2 hours, until the discharge water was clear.

3.0 AQUIFER TESTING

3.1 Equipment Setup

The aquifer test equipment was installed on August 8 and 9, 2009. A 5 hp pump, connected to a 0.07 m (3-inch) diameter rigid PVC discharge pipe, was installed in PW1 to a depth of approximately 36 m below the top of the well casing. The plumbing configuration at the well head included a re-circulation loop and flow control valve to direct any excess flow back into the well, control valves for sampling and flow rate regulation on the main discharge line, and an in-line flow meter. A levelogger was also installed in PW1, inside a 32 mm (1.25-inch) diameter stilling tube, along with leveloggers installed at MW1, MW2, MW3, and a baralogger was placed within the well head protector at MW2. Manual water level readings were collected from MW4.

The pump discharge pipe was connected to a 50 mm (2-inch) diameter combination rigid (near the well head) and flexible lay-flat discharge hose that was laid to the northwest of the well. The point of discharge to ground surface was roughly 200 m (656 feet) to the northwest of the well where the production water was directed over top of the land towards a pond.

3.2 Step Test

A Step Drawdown Test was completed at PW1 using the set up as described in Section 3.1. Three steps were completed with the initial static water level at 23.13 m below the top of the casing. The initial step was set at a flow rate of 30 imperial gallons per minute (Igpm) for a period of 80 minutes with the water rising due to the high re-circulation rate in the casing. A second step was set at a flow rate of about 50 Igpm for a period of 55 minutes with a drawdown of 1.283 m. The third step, was conducted at a flow rate of 76 Igpm for 20 minutes and had a drawdown of 1.8 m.

3.3 Aquifer Test

The equipment used in the Step Test was used to conduct the 114 hr Aquifer Test. The test commenced at 14:09 on August 11, 2009 and ended 6,875 minutes later on August 16 at 8:42. The average pumping rate during the test was 59.8 Igpm. The water level dropped from an initial static level of 23.20 m to a near steady-state pumping level of 24.66 m below top of casing (i.e., the difference between these two readings equals a total drawdown of 1.46 m).

Levelogger data recorded during the Aquifer Test and hand measured data during the Aquifer Test are presented in **Appendix D**. The aquifer test analysis reports for Storativity and Transmissivity are presented in **Appendix E**.

3.3.1 Field Chemistry

Field measurements of pH, electrical conductivity and temperature were made throughout the 3-day Aquifer Test. Field measurements are presented in **Appendix D**. The pH varied irregularly between 6.95 and 8.55 during the monitoring period. The electrical conductivity varied between 88.5 µS/cm to 93.1 µS/cm during the same monitoring period. The measured groundwater temperature at the sampling port varied widely in response to daily heating and cooling of the ground-surface discharge line. Field water quality readings at the end of the aquifer test had a pH of 8.14, electrical conductivity of 92.9 µS/cm and a temperature of 9.8 °C.

3.3.2 Water Chemistry

Water samples from PW1 were collected on August 11, 13 and 16, 2009 during the aquifer test. Samples were submitted to Maxxam Analytics and tested for general chemistry and metals.

The laboratory chemical data are presented in **Appendix F**.

4.0 DISCUSSION AND RECOMMENDATIONS

The aquifer test data gave a Transmissivity of 8.40E-4 m^2/s and a Storativity of 0.05. This aquifer is an unconfined aquifer. Bedrock was not encountered in PW1 and the depth of the overburden is not known. It is expected that the thickness and grain size of the overburden material will be variable from location to location within the area of interest.

Based on the specific capacity of the PW1 well during this 114 hr aquifer test, the aquifer should be able to produce approximately 150 to 170 Lpm per metre of drawdown, if a properly sized pump can be installed in the well, and, if the well efficiency does not decrease with increasing drawdown.

The client's representative (M. Puga, personal communication) concluded that the water that was being produced during this 114 hr aquifer test was suitable for the fish hatchery purposes.

APPENDIX A

Figures

Figure A1 General location map of the potential Northern Harvest Sea Farms site, Stephenville, NL.

Project No:	Scale
520	1 km Grid
Location	Date
Stephenville, NL	October 2010

FFC

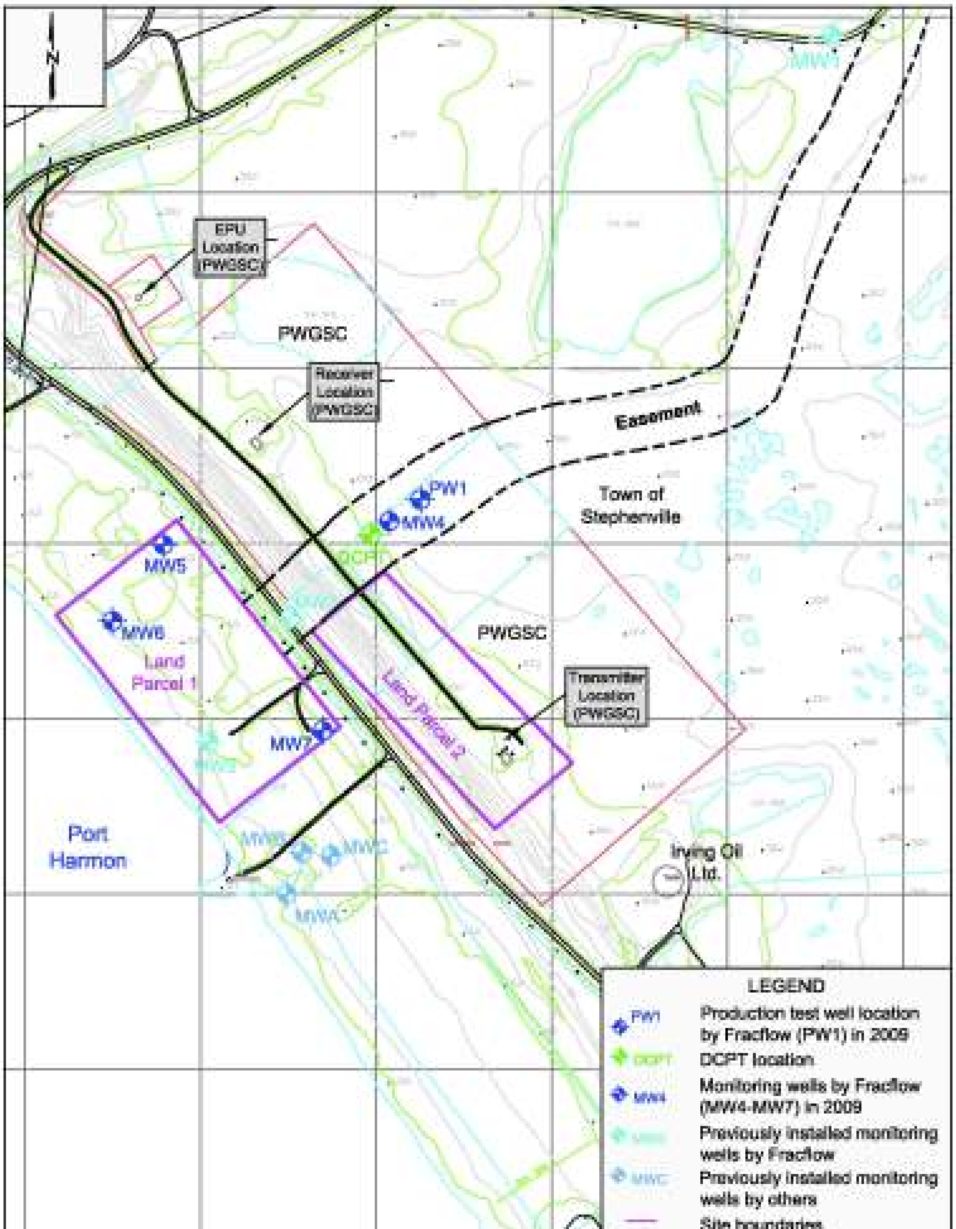


Figure A2 Topographic map depicting site boundaries and well locations.

Project No.	Scale
520	200 m Grid
Location	**Date**
Stephenville, NL	October 2010

FFC

APPENDIX B

Well Log for PW1

Project: Water Suppy Well
Location: Stephenville, NL
Client: Nothern Harvest Sea Farms Ltd.
Drilling Supervisor: Kevin Gale

Well Log: PW1

Project No: 520
Date: August 5 - 7, 2009

Depth Below Ground Surface (Feet / Metres)	Symbol	Geologic Description	Estimated Elevation (metres)	Well Data	Well Description
0 / 0		Ground Surface	27.90		– Casing stickup of 0.61m AGS.
0 – 9 m		Field - Sand	18.90		– Well seal to be added as part of well completion.
9 – 24 m		Field - Sand with Gravel	3.90		– 0.15m dia. Steel Casing from surface to 38.00m BGS. – Water Level of 23.13m BGS, Aug. 11/09.
24 – 29.45 m		Field - Sand with Gravel USCS - SP (poorly graded sand) CFEM - Sand, trace Silt and/or Clay	-1.55		
29.45 – 36.57 m		No Samples Recovered	-8.67		
36.57 – 50 m		Field - Sand USCS - SP (poorly graded sand) CFEM - Sand, trace Silt and/or Clay	-22.10		– 0.15 m dia. Telescopic, SS tight wrap with a SS K-Packer and weld rings from 38.00m to 39.50m BGS. – 3 x 3 m lengths, 0.15m dia. Telescopic, SS, Slot 20 Screen with weld rings from 39.50m to 48.50m BGS. – 0.15m dia. Telescopic, SS tight wrap with an end plate and weld rings from 48.50m to 50.00m BGS.
		End of Hole (50 m BGS)			

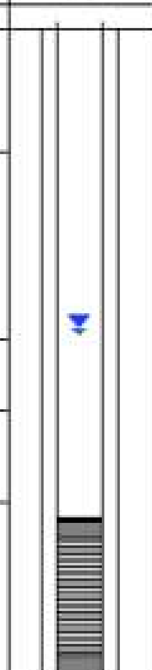


Figure B1 Borehole log and well construction for PW1.

Driller: Northeast Well Drilling Co. Ltd.	Datum: Geodetic
Drilling Method: Air Rotary Rig	Scale: As Shown

FFC

APPENDIX C

Grain Size Analysis for PW1

GRAIN SIZE ANALYSIS

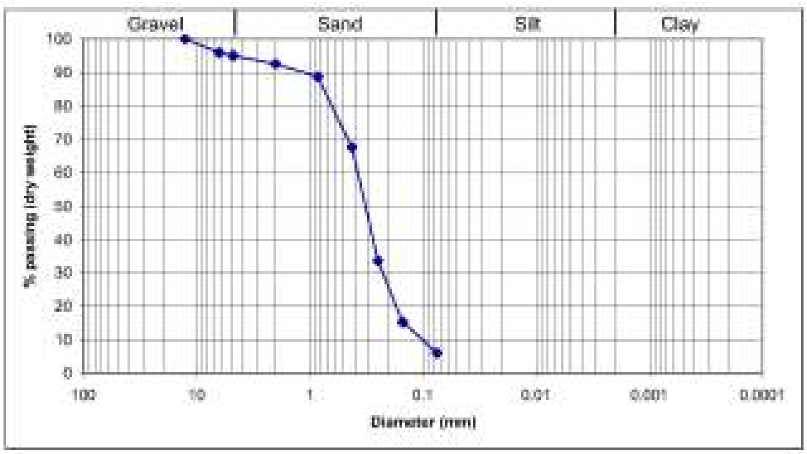
Project : 520 - Stephenville

Sample No. : PW1-120 to 125

Sieve Analysis

Dry weight of sample (g) = 154.90

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	6.42	4.14	4.14	95.86
4	4.76	1.40	0.90	5.05	94.95
10	2.00	3.73	2.41	7.46	92.54
20	0.85	5.94	3.83	11.29	88.71
40	0.425	32.74	21.14	32.43	67.57
60	0.25	52.57	33.94	66.37	33.63
100	0.15	28.39	18.33	84.69	15.31
200	0.075	14.25	9.20	93.89	6.11
pan	---	9.46	6.11	100.00	---
		154.90			



D_{10} = 0.1
D_{30} = 0.23
D_{60} = 0.37

Cu = 3.70
Cc = 1.43

USCS: SP-SM (Poorly graded sand with silt)?

R_{200} = 93.89
R_4 = 5.05
R_4/R_{200} = 0.05
SF = 88.84
GF = 5.05

% Gravel = 5.05
% Sand = 88.84
% Silt & Clay = 6.11
% Clay = NA
CFEM: Sand, trace Silt and/or Clay, trace Gravel

GRAIN SIZE ANALYSIS

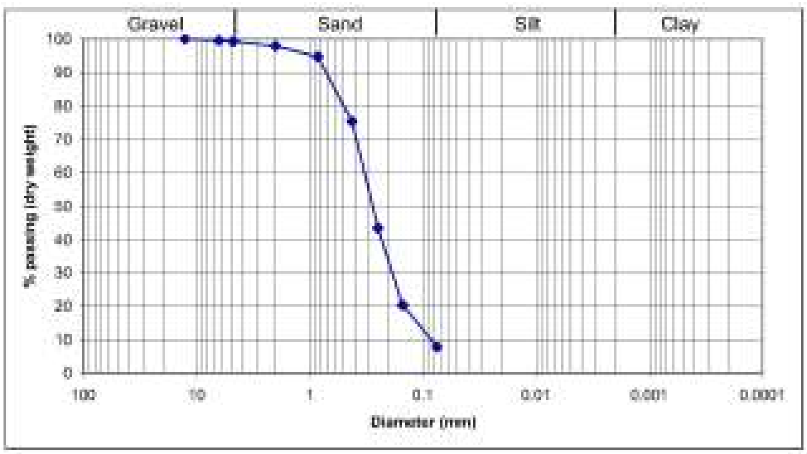
Project : 520 - Stephenville

Sample No. : PW1-125 to 130

Sieve Analysis

Dry weight of sample (g) = 138.19

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	0.00	0.00	0.00	100.00
1/4"	6.35	0.55	0.40	0.40	99.60
4	4.76	0.39	0.28	0.68	99.32
10	2.00	1.92	1.39	2.07	97.93
20	0.85	4.47	3.23	5.30	94.70
40	0.425	26.58	19.23	24.54	75.46
60	0.25	44.31	32.06	56.60	43.40
100	0.15	31.79	23.00	79.61	20.39
200	0.075	17.26	12.49	92.10	7.90
pan	---	10.92	7.90	100.00	---
		138.19			



D_{10} = 0.084

D_{30} = 0.18

D_{60} = 0.33

Cu = 3.93

Cc = 1.17

USCS: SP-SM (Poorly graded sand with silt)?

R_{200} = 92.10

R_4 = 0.68

R_4/R_{200} = 0.01

SF = 91.42

GF = 0.68

% Gravel = 0.68

% Sand = 91.42

% Silt & Clay = 7.90

% Clay = NA

CFEM: Sand, trace Silt and/or Clay

GRAIN SIZE ANALYSIS

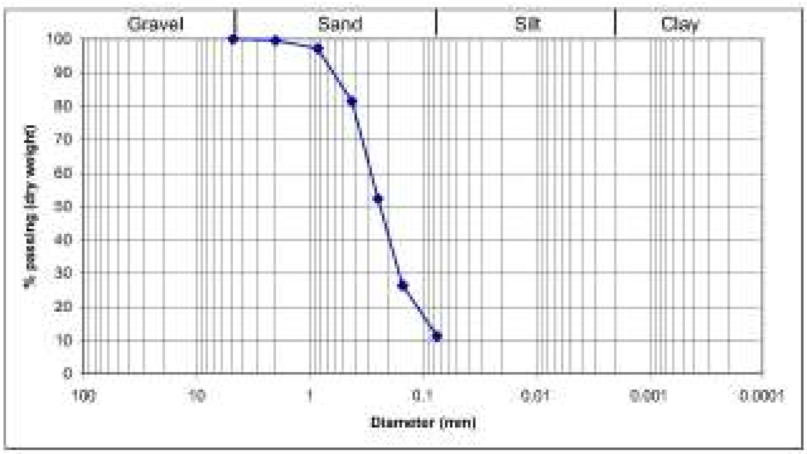
Project : 520 - Stephenville

Sample No. : PW1-130 to 135

Sieve Analysis

Dry weight of sample (g) = 122.41

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	---	---		
1/4"	6.35	---	---		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.52	0.42	0.42	99.58
20	0.85	3.04	2.48	2.91	97.09
40	0.425	19.25	15.73	18.63	81.37
60	0.25	35.64	29.12	47.75	52.25
100	0.15	31.66	25.86	73.61	26.39
200	0.075	18.65	15.24	88.85	11.15
pan	---	13.65	11.15	100.00	---
		122.41			



D_{10} = 0.07

D_{30} = 0.16

D_{60} = 0.29

Cu = 4.14

Cc = 1.26

USCS: SP-SM (Poorly graded sand with silt)?

R_{200} = 88.85

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 88.85

GF = 0.00

% Gravel = 0.00

% Sand = 88.85

% Silt & Clay = 11.15

% Clay = NA

CFEM: Sand, some Silt and/or Clay

GRAIN SIZE ANALYSIS

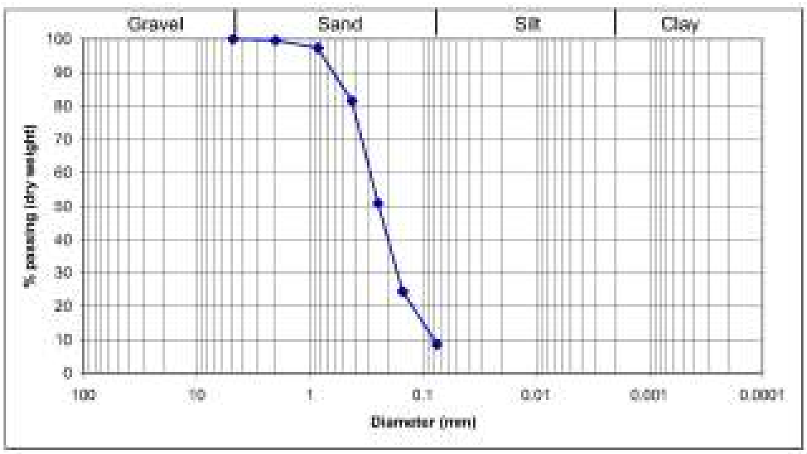
Project : 520 - Stephenville

Sample No. : PW1-135 to 140

Sieve Analysis

Dry weight of sample (g) = 142.06

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	---	---		
1/4"	6.35	---	---		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.58	0.41	0.41	99.59
20	0.85	3.25	2.29	2.70	97.30
40	0.425	22.49	15.83	18.53	81.47
60	0.25	43.59	30.68	49.21	50.79
100	0.15	37.48	26.38	75.59	24.41
200	0.075	22.42	15.78	91.38	8.62
pan	---	12.25	8.62	100.00	---
		142.06			



D_{10} = 0.08
D_{30} = 0.17
D_{60} = 0.29

Cu = 3.63
Cc = 1.25

USCS: SP-SM (Poorly graded sand with silt)?

R_{200} = 91.38
R_4 = 0.00
R_4/R_{200} = 0.00
SF = 91.38
GF = 0.00

% Gravel = 0.00
% Sand = 91.38
% Silt & Clay = 8.62
% Clay = NA
CFEM: Sand, trace Silt and/or Clay

GRAIN SIZE ANALYSIS

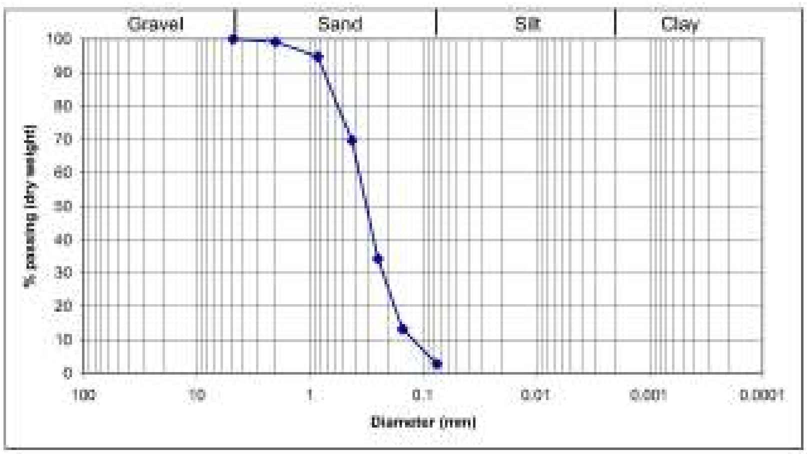
Project : 520 - Stephenville

Sample No. : PW1-140 to 145

Sieve Analysis

Dry weight of sample (g) = 148.29

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	---	---		
1/4"	6.35	---	---		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	1.34	0.90	0.90	99.10
20	0.85	6.50	4.38	5.29	94.71
40	0.425	37.03	24.97	30.26	69.74
60	0.25	52.54	35.43	65.69	34.31
100	0.15	31.46	21.22	86.90	13.10
200	0.075	15.43	10.41	97.31	2.69
pan	---	3.99	2.69	100.00	---
		148.29			



D_{10} = 0.12
D_{30} = 0.22
D_{60} = 0.37

Cu = 3.08
Cc = 1.09

USCS: SP (Poorly graded sand)

R_{200} = 97.31
R_4 = 0.00
R_4/R_{200} = 0.00
SF = 97.31
GF = 0.00

% Gravel = 0.00
% Sand = 97.31
% Silt & Clay = 2.69
% Clay = NA
CFEM: Sand, trace Silt and/or Clay

GRAIN SIZE ANALYSIS

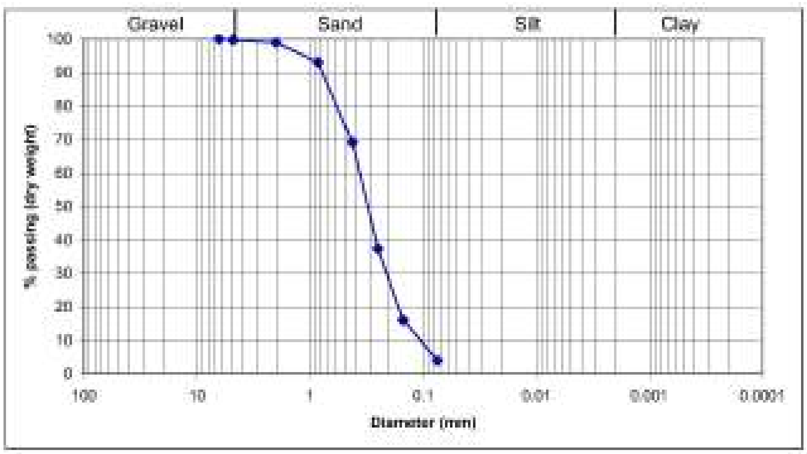
Project : 520 - Stephenville

Sample No. : PW1-145 to 150

Sieve Analysis

Dry weight of sample (g) = 130.17

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	---	---		
1/4"	6.35	0.00	0.00	0.00	100.00
4	4.76	0.45	0.35	0.35	99.65
10	2.00	0.92	0.71	1.05	98.95
20	0.85	7.66	5.88	6.94	93.06
40	0.425	31.13	23.91	30.85	69.15
60	0.25	41.32	31.74	62.60	37.40
100	0.15	27.97	21.49	84.08	15.92
200	0.075	15.64	12.02	96.10	3.90
pan	---	5.08	3.90	100.00	---
		130.17			



D_{10} = 0.105

D_{30} = 0.21

D_{60} = 0.36

Cu = 3.43

Cc = 1.17

USCS: SP (Poorly graded sand)

R_{200} = 96.10

R_4 = 0.35

R_4/R_{200} = 0.00

SF = 95.75

GF = 0.35

% Gravel = 0.35

% Sand = 95.75

% Silt & Clay = 3.90

% Clay = NA

CFEM: Sand, trace Silt and/or Clay

GRAIN SIZE ANALYSIS

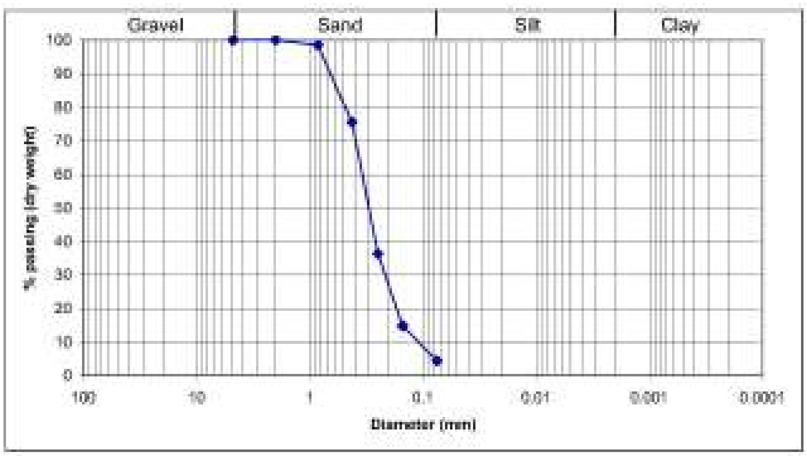
Project : 520 - Stephenville

Sample No. : PW1-150 to 155

Sieve Analysis

Dry weight of sample (g) = 219.86

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	---	---		
1/4"	6.35	---	---		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.06	0.03	0.03	99.97
20	0.85	3.40	1.55	1.57	98.43
40	0.425	50.10	22.79	24.36	75.64
60	0.25	86.64	39.41	63.77	36.23
100	0.15	47.09	21.42	85.19	14.81
200	0.075	22.94	10.43	95.62	4.38
pan	---	9.63	4.38	100.00	---
		219.86			



D_{10} = 0.11

D_{30} = 0.22

D_{60} = 0.35

Cu = 3.18

Cc = 1.26

USCS: SP (Poorly graded sand)

R_{200} = 95.62

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 95.62

GF = 0.00

% Gravel = 0.00

% Sand = 95.62

% Silt & Clay = 4.38

% Clay = NA

CFEM: Sand, trace Silt and/or Clay

GRAIN SIZE ANALYSIS

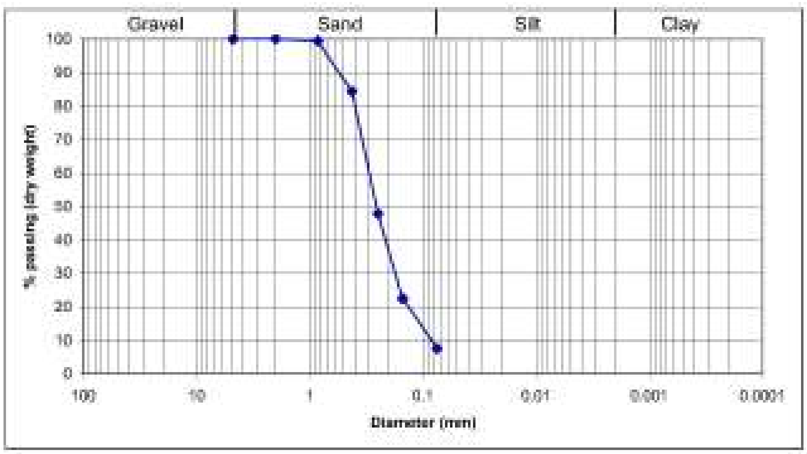
Project : 520 - Stephenville

Sample No. : PW1-155 to 160

Sieve Analysis

Dry weight of sample (g) = 157.75

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	---	---		
1	25.4	---	---		
1/2"	12.7	---	---		
1/4"	6.35	---	---		
4	4.76	0.00	0.00	0.00	100.00
10	2.00	0.00	0.00	0.00	100.00
20	0.85	0.95	0.60	0.60	99.40
40	0.425	23.70	15.02	15.63	84.37
60	0.25	57.67	36.56	52.18	47.82
100	0.15	40.10	25.42	77.60	22.40
200	0.075	23.49	14.89	92.49	7.51
pan	---	11.84	7.51	100.00	---
		157.75			



D_{10} = 0.085
D_{30} = 0.175
D_{60} = 0.3

Cu = 3.53
Cc = 1.20

USCS: SP-SM (Poorly graded sand with silt)?

R_{200} = 92.49
R_4 = 0.00
R_4/R_{200} = 0.00
SF = 92.49
GF = 0.00

% Gravel = 0.00
% Sand = 92.49
% Silt & Clay = 7.51
% Clay = NA
CFEM: Sand, trace Silt and/or Clay

APPENDIX D

Aquifer Test Data for PW1

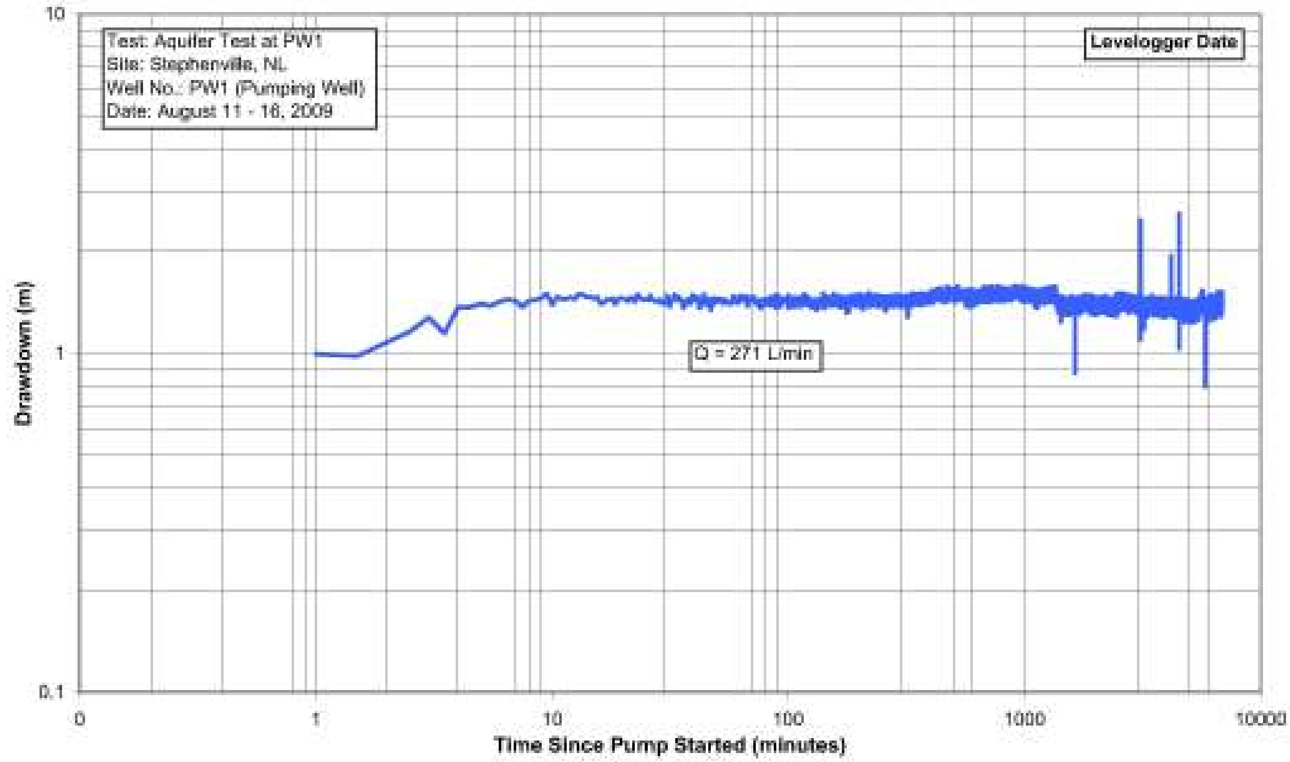


Figure D1 Log-log plot of drawdown versus time for the pumping well, PW1, during the aquifer test.

Project No.	Scale
520	As Shown
Location	Date
Stepenville, NL	October 2010

FFC

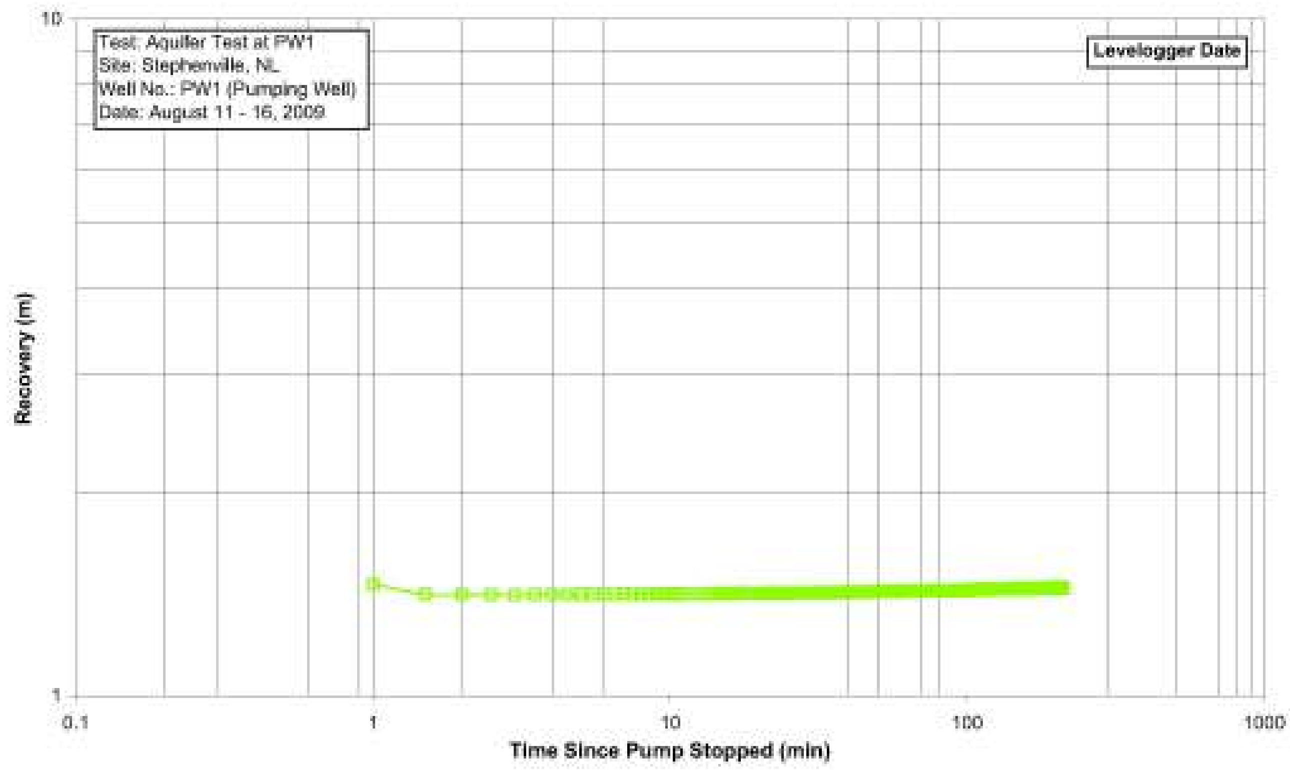


Figure D2 Plot of recovery versus time for water level recovery in the pumping well, PW1 after the termination of the aquifer test.

Project No.	Scale
520	As Shown
Location	Date
Stephenville, NL	October 2010

FFC

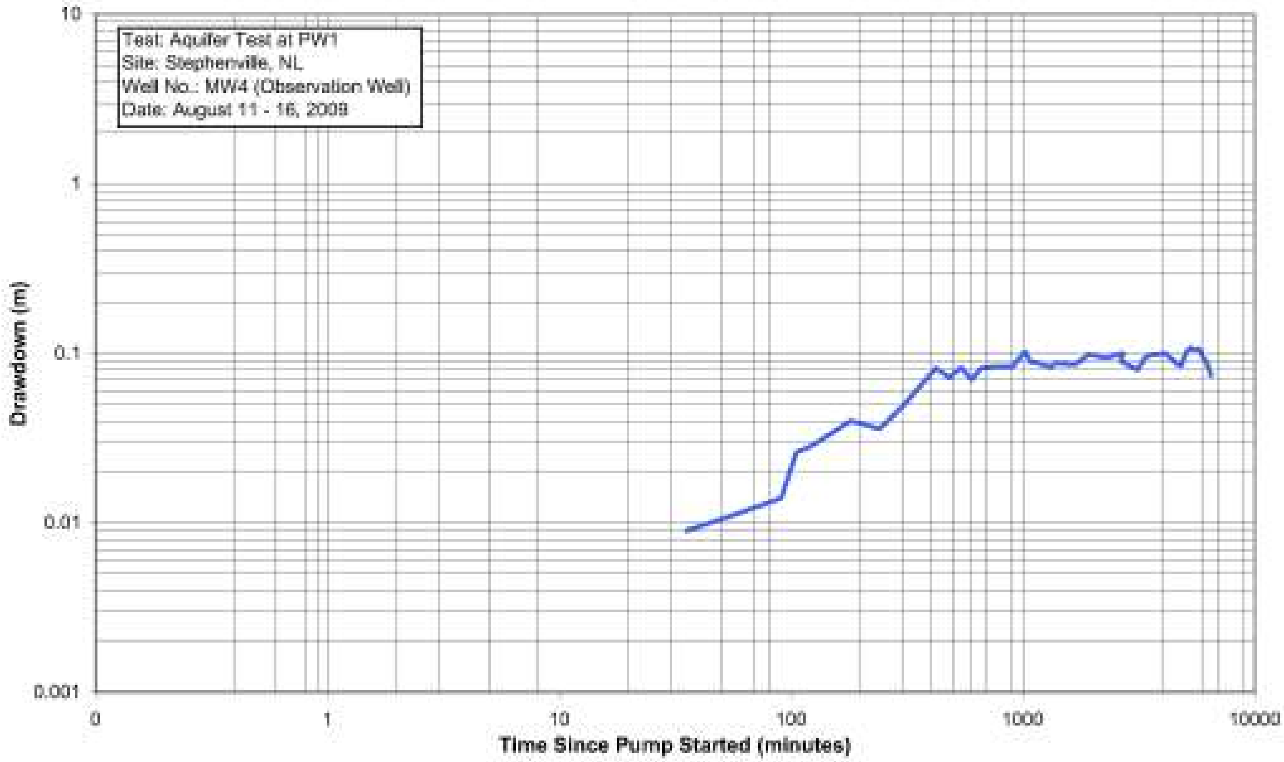


Figure D3 Log-log plot of drawdown versus time for the observation well, MW4, during the aquifer test at PW1.

Project No.	Scale
520	As Shown
Location	Date
Stephenville, NL	October 2010

FFC

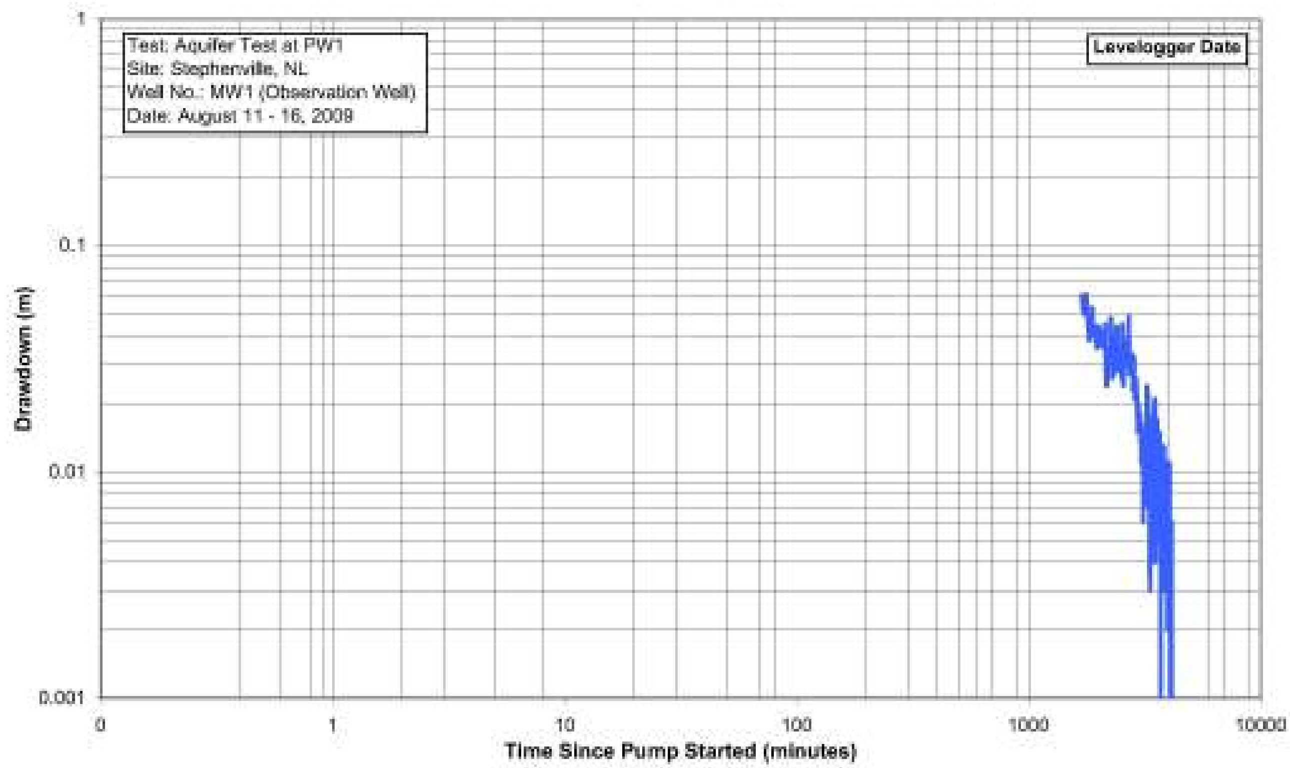


Figure D4 Log-log plot of drawdown versus time for observation well, MW1, during the aquifer test at PW1.

Project No. 520	Scale As Shown
Location Stephenville, NL	Date October, 2010

FFC

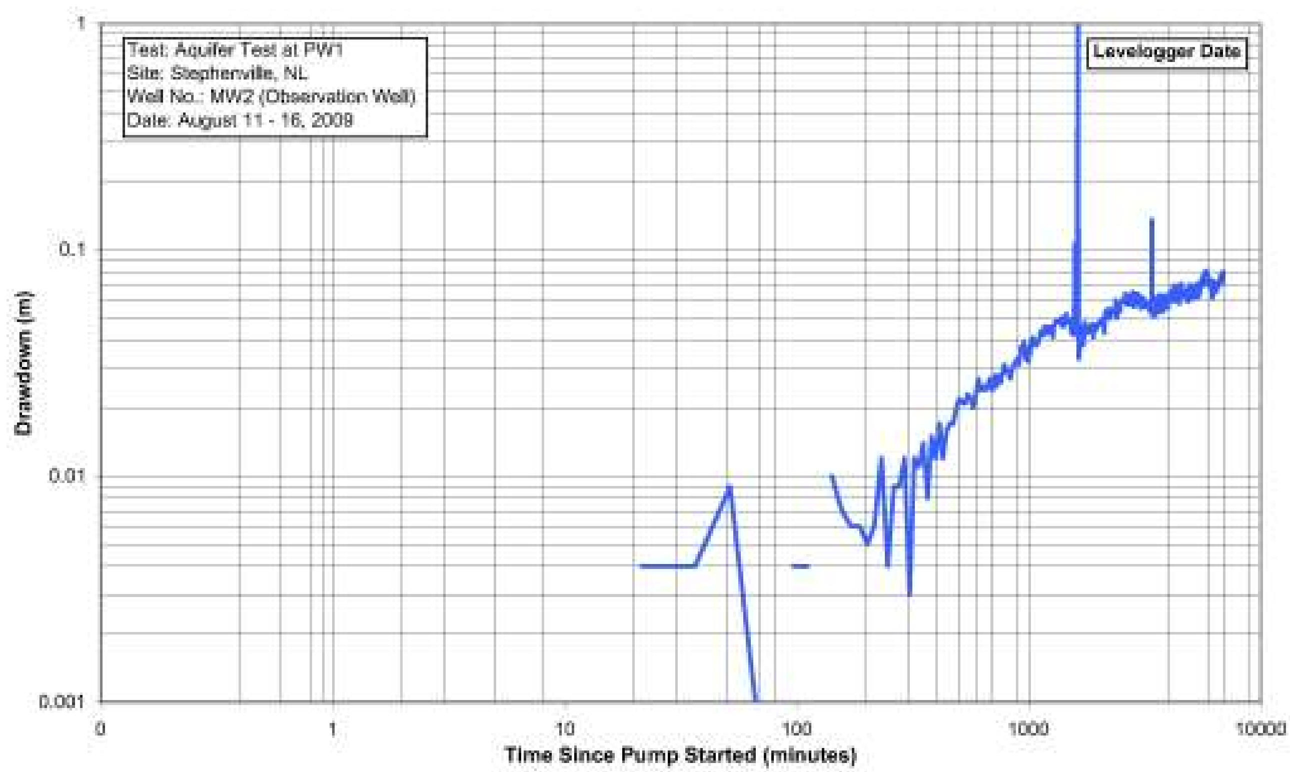


Figure D5 Log-log plot of drawdown versus time for observation well, MW2, during the aquifer test at PW1.

Project No.	Scale
520	As shown
Location	Date
Stephenville, NL	October 2010

FFC

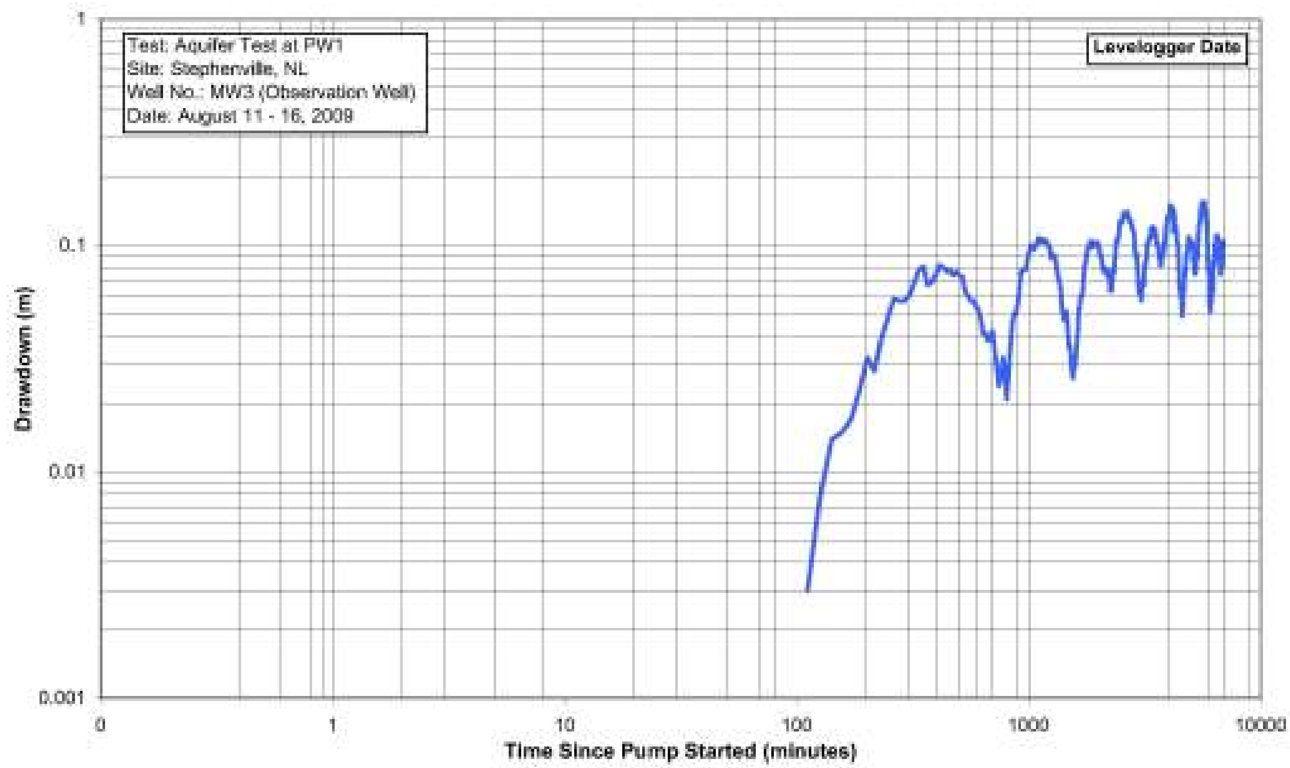


Figure D6 Log-log plot of drawdown versus time for the observation well, MW3, during the aquifer test at PW1.

Project No.	Scale
520	As Shown
Location	Date
Stephenville, NL	October 2010

FFC

APPENDIX E

Storativity and Transmissivity Analysis Reports

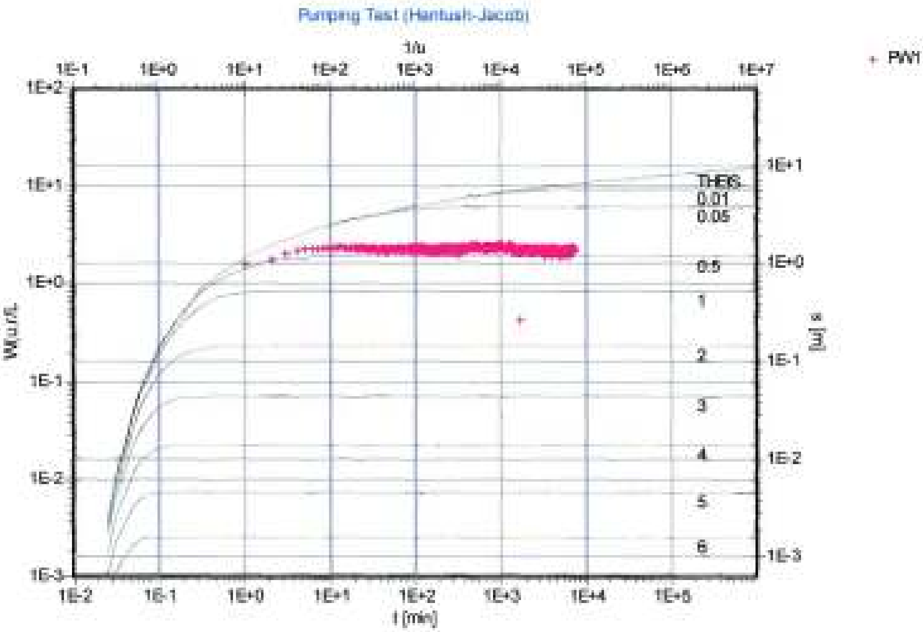
Fracflow Consultants Inc.
154 Major's Path
St. John's NL
Phone (709) 139-7270

Pumping Test Analysis Report

Project: PW1-Pumping

No: 520

Client: Northern Harvest Sea Farm NL Ltd.



Test name: **Pumping Test**

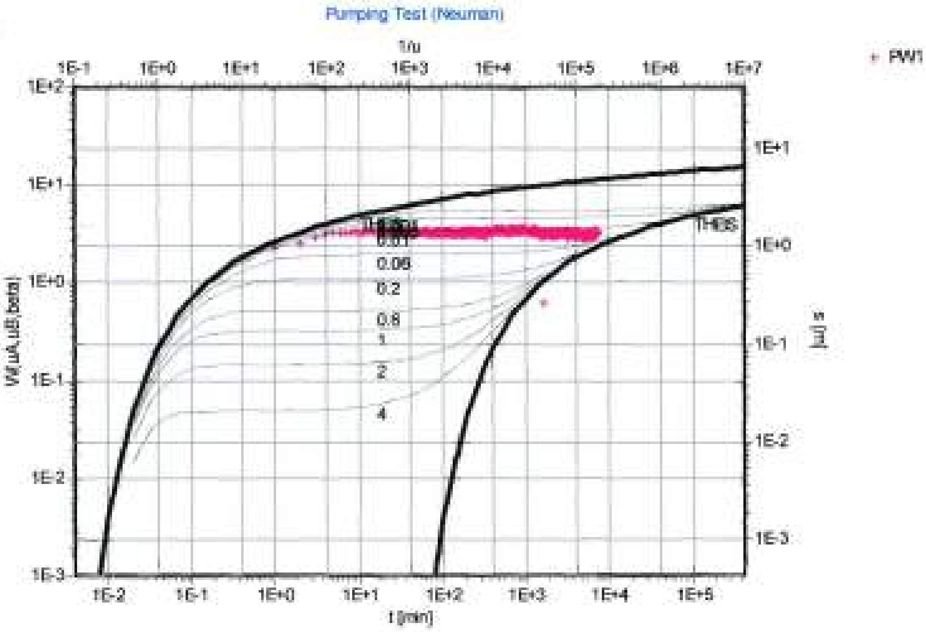
Analysis method: **Hantush-Jacob**

Analysis results: Conductivity: 1.94E-5 [m/s]

Test parameters:				
	Pumping well:	PW1	Aquifer thickness:	30 [m]
	Casing radius:	0.084 [m]		
	Screen length:	9 [m]		
	Screen radius:	0.076 [m]		
	Discharge rate:	4.52 [l/s]		

Analysis of 114 hour pumping test on PW1 using the Hantush method on a log-log plot.

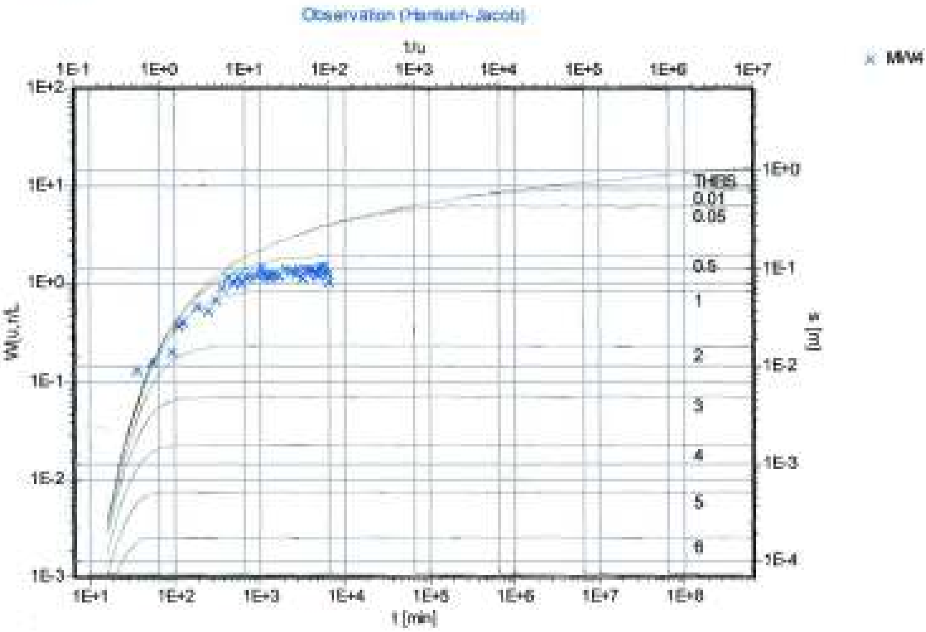
	Fracflow Consultants Inc.	**Pumping Test Analysis Report**	
	154 Major's Path	Project:	PW1-Pumping
	St. John's NL	No:	520
	Phone (709) 139-7270	Client:	Northern Harvest Sea Farm NL Ltd.



Test name:	**Pumping Test**			
Analysis method:	**Neuman**			
Analysis results:	Transmissivity:	8.43E-4 [m²/s]	Conductivity:	2.81E-5 [m/s]
Test parameters:	Pumping well:	PW1	Aquifer thickness:	30 [m]
	Casing radius	0.084 [m]		
	Screen length:	9 [m]		
	Screen radius:	0.076 [m]		
	Discharge rate:	4.52 [l/s]		
	LOG(Sy/S):	4		

Analysis of 114 hour pumping test on PW1 using the Neuman method on a log-log plot.

	Fracflow Consultants Inc.	**Pumping Test Analysis Report**
	154 Major's Path	Project: PW1-Pumping
	St. John's NL	No: 520
	Phone (709) 139-7270	Client: Northern Harvest Sea Farm NL Ltd.



Test name: **Observation**

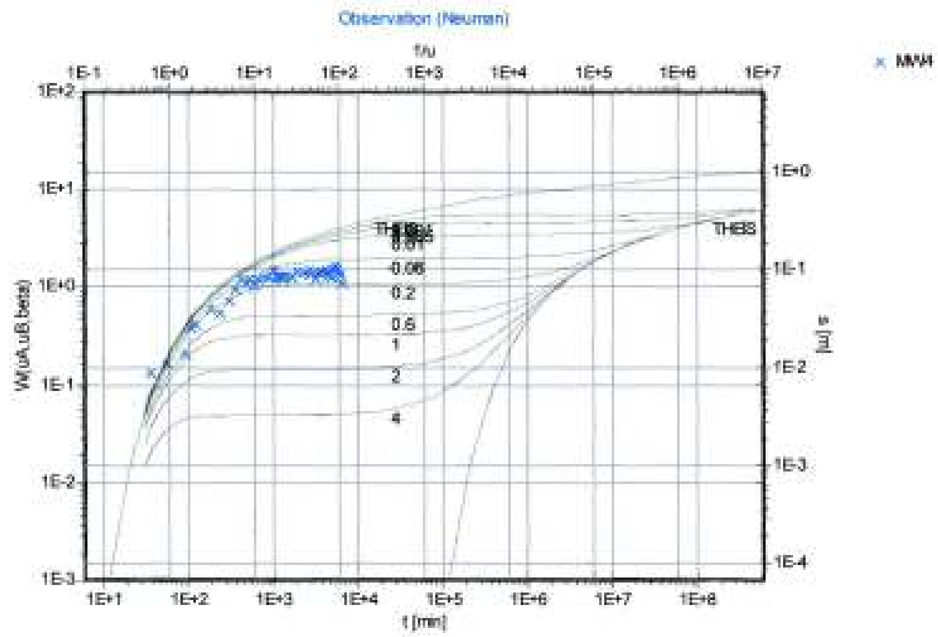
Analysis method: **Hantush-Jacob**

Analysis results:	Transmissivity:	5.16E-3 [m²/s]	Conductivity:	1.72E-4 [m/s]
	Storativity:	5.00E-2	c:	5.17E+7 [min]

Test parameters:	Pumping well:	PW1	Aquifer thickness:	30 [m]
	Casing radius:	0.084 [m]	r/L:	0.01
	Screen length:	9 [m]		
	Screen radius:	0.076 [m]		
	Discharge rate:	4.52 [l/s]		

Analysis of aquifer test on MW4 (observation well) using the Hantush method on a log-log plot during 114 hour aquifer test on PW1 (pumping well).

Fracflow Consultants Inc.	Pumping Test Analysis Report
154 Major's Path	Project: PW1-Pumping
St. John's NL	No: 520
Phone (709) 139-7270	Client: Northern Harvest Sea Farm NL Ltd.



Test name: **Observation**

Analysis method: **Neuman**

Analysis results:	Transmissivity:	5.39E-3 [m²/s]	Conductivity:	1.80E-4 [m/s]
	Storativity:	4.88E-2	Specific yield:	4.88E+2

Test parameters:	Pumping well:	PW1	Aquifer thickness:	30 [m]
	Casing radius	0.084 [m]	Beta:	0.005
	Screen length:	9 [m]		
	Screen radius:	0.076 [m]		
	Discharge rate:	4.52 [l/s]		
	LOG(Sy/S):	4		

Analysis of aquifer test on MW4 (observation well) using the Neuman method on a log-log plot during 114 hour aquifer test on PW1 (pumping well).

APPENDIX F

PW1 Water Laboratory Results

RCP 829

Maxxam Analytics Inc

49-55 Elizabeth Avenue, Suite 101A, St. John's, NL A1A 1W9 Tel: 709-754-0203 Fax: 709-754-8612 Toll Free: 1-888-492-7227 www.maxxamanalytics.com

CHAIN OF CUSTODY RECORD

30149

INVOICE INFORMATION:	
Company Name:	FRACFLOW CONSULTANTS
Contact Name:	JOHN GALE
Address:	154 Majors Path St. John's, NL A1A 5A1
Email:	ffc-nfld@nf.net
Ph:	(709) 739-7270 Fax: (709) 753-5101

REPORT INFORMATION (if differs from invoice):	
Company Name:	
Contact Name:	
Address:	
Email:	
Ph:	Fax:

PO #:	2905
Project #:	520
Proj. Name:	
Location:	Stephenville, NL
Quotation #:	~~Standing offer~~ 09-179KG
Submitted By:	
Site Task #:	

MAXXAM JOB NUMBER:	A9A8545
ENTERED BY, init:	TS
Client Code:	11664

Specify Guideline Requirements:

*Specify Matrix: Surface/Soil/Ground/Tapwater/Sewage/Effluent/Seawater Potable/NonPotable/Tissue/Soil/Sludge/Metal

DUE DATE:

STANDARD: [X]

RUSH Due Date:

For extra cost rush, specify Due Date. Rush analysis must be scheduled prior to sample submission.

Client will be contacted if Rush date cannot be met.

Sample Identification	Matrix*	Date/Time Sampled	# & type of bottles	Field Filtered & Preserved	Lab Filtration Required	RCAp-30 Dissolved Total or Diss Metals	RCAp-MS Dissolved Diss Metals	Metals Water: Total Digest (Default Method)	Metals Water: Dissolved	Mercury (Mercury is not included in soil or water metals scan)	Metals Soil: Available Metals Digest Default Method (HNO3/HCl)	Metals Soil: Total Digest - for sediments (HNO3/HF/HCLO4)	Metals Soil: To required for CCME soils	Metals Soil: Selenium (for next Reg's for CCME Residential, Parkland, Agricultural)	Metals Soil: Hot Water soluble Boron (required for CCME Agricultural)	TPH MUST (BTEX, C6-C32)	Soil (Potable), TPH MUST, NS Fuel Oil Spill Policy Low Level BTEX & C6-C32	NB Potable Water BTEX, VPH, Low Level TEH	TPH Fractionation	PAH's	PCB's	VOC's EPA 624/8260	Other Analysis or Comments/Hazards
520-PW1-001	water	Aug 11/09	1×250mL 1×50mL				X																Preserved DL4970
520-PW1-001	water	Aug 11/09	1×50mL	X					X														975
520-PW1-002	water	Aug 13/09	1×250mL 1×50mL				X																Preserved 980
520-PW1-002	water	Aug 13/09	1×50mL	X					X														981
520-PW1-004	water	Aug 14/09	1×250mL 1×60mL				X		X														Preserved 986
520-PW1-004	water	Aug 14/09	1×50mL	X					X														996

SHIPPED FROM [date] 9 2009 MAXXAM - ST. JOHN'S

[stamp] AUG 20 2009

RELINQUISHED BY: (Signature/Print)	RECEIVED BY: (Signature/Print)	DATE / TIME	PURPOSE OF CHANGE / REMARKS	TEMP @ Maxxam Receipt
NATALIE LIPPA	[signature] [signature]	Aug 19/09		<2 <2 <2 / 1.0°C
	[signature]	Aug 19/09 1:45pm		INTEGRITY Yes / No: (No) [initials] Temp y9

Your P.O. #: 2905
Your Project #: 520
Site:STEPHENVILLE,NL
Your C.O.C. #: 30149

Attention: John Gale
Fracflow Consultants Inc
154 Major's Path
St. John's, NL
A1A 5A1

Report Date: 2009/08/27

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: A9A8545
Received: 2009/08/20, 10:00

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Carbonate, Bicarbonate and Hydroxide	3	N/A	2009/08/25		
Alkalinity	3	N/A	2009/08/25	ATL SOP 00013 R4	Based on EPA310.2
Chloride	3	N/A	2009/08/26	ATL SOP 00014 R6	Based on SM4500-Cl-
Colour	3	N/A	2009/08/26	ATL SOP 00020 R3	Based on SM2120C
Conductance - water	3	N/A	2009/08/25	ATL SOP 00004 R4/00006 R4	Based on SM2510B
Hardness (calculated as CaCO3)	3	N/A	2009/08/26	ATL SOP 00048	Based on SM2340B
Metals Water Total OES - Partial Scan	3	N/A	2009/08/25	ATL SOP 00025 R4	Based on EPA200.7
Metals Water Diss. MS	3	N/A	2009/08/26	ATL SOP 00024 R4	Based on EPA6020A
Metals Water Total MS	3	N/A	2009/08/25	ATL SOP 00024 R4	Based on EPA6020A
Ion Balance (% Difference)	3	N/A	2009/08/27		
Anion and Cation Sum	3	N/A	2009/08/26		
Nitrogen Ammonia - water	3	N/A	2009/08/25	ATL SOP 00015 R5	Based on USEPA 350.1
Nitrogen - Nitrate + Nitrite	3	N/A	2009/08/26	ATL SOP 00016 R4	Based on USGS - Enz.
Nitrogen - Nitrite	3	N/A	2009/08/26	ATL SOP 00017 R4	Based on USEPA 354.1
Nitrogen - Nitrate (as N)	3	N/A	2009/08/27	ATL SOP 00018 R3	Based on ASTMD3867
pH	3	N/A	2009/08/25	ATL SOP 00003 R5/00005 R6	Based on EPA150.1
Phosphorus - ortho	3	N/A	2009/08/26	ATL SOP 00021 R3	Based on USEPA 365.1
Sat. pH and Langelier Index (@ 20C)	3	N/A	2009/08/27		
Sat. pH and Langelier Index (@ 4C)	3	N/A	2009/08/27		
Reactive Silica	3	N/A	2009/08/25	ATL SOP 00022 R3	Based on EPA 366.0
Sulphate	3	N/A	2009/08/26	ATL SOP 00023 R3	Based on EPA 375.4
Total Dissolved Solids (TDS calc)	3	N/A	2009/08/27		
Organic carbon - Total (TOC)	3	N/A	2009/08/25	ATL SOP 00037 R3	Based on SM5310C
Turbidity	3	N/A	2009/08/26	ATL SOP 00011 R4	based on EPA 180.1

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

../2

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Maxxam Analytics International Corporation o/a Maxxam Analytics 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free 800-565-7227 Fax: 902-420-8612 www.maxxamanalytics.com

Your P.O. #: 2905
Your Project #: 520
Site:STEPHENVILLE,NL
Your C.O.C. #: 30149

Attention: John Gale
Fracflow Consultants Inc
154 Major's Path
St. John's, NL
A1A 5A1

Report Date: 2009/08/27

CERTIFICATE OF ANALYSIS

-2-

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

STACY JOSEPH, Project Manager
Email: Stacy.Joseph.Reports@maxxamanalytics.com
Phone# (902) 420-0203

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. SCC and CALA have approved this reporting process and electronic report format.

Total cover pages: 2

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Maxxam Job #: A9A8545
Report Date: 2009/08/27

Fracflow Consultants Inc
Client Project #: 520
Project name: STEPHENVILLE,NL
Your P.O. #: 2905

RESULTS OF ANALYSES OF WATER

Maxxam ID		DL4970	DL4980	DL4986		
Sampling Date		2009/08/11	2009/08/13	2009/08/16		
COC Number		30149	30149	30149		
Registration #						
	Units	**520-PW1-001**	**520-PW1-002**	**520-PW1-004**	**RDL**	**QC Batch**
Calculated Parameters						
Anion Sum	me/L	3.51	3.17	3.43	N/A	1915165
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	147	131	143	1	1915161
Calculated TDS	mg/L	177	166	177	1	1915169
Carb. Alkalinity (calc. as CaCO3)	mg/L	2	2	2	1	1915161
Cation Sum	me/L	3.18	3.16	3.28	N/A	1915165
Hardness (CaCO3)	mg/L	140	140	140	1	1915163
Ion Balance (% Difference)	%	4.93	0.160	2.24	N/A	1915164
Langelier Index (@ 20C)	N/A	0.487	0.496	0.516		1915167
Langelier Index (@ 4C)	N/A	0.246	0.246	0.266		1915168
Nitrate (N)	mg/L	0.31	0.30	0.30	0.05	1914470
Saturation pH (@ 20C)	N/A	7.56	7.60	7.56		1915167
Saturation pH (@ 4C)	N/A	7.81	7.85	7.81		1915168
Inorganics						
Total Alkalinity (Total as CaCO3)	mg/L	150	130	150	30	1917925
Dissolved Chloride (Cl)	mg/L	15	14	15	1	1917931
Colour	TCU	ND	ND	ND	5	1917935
Nitrate + Nitrite	mg/L	0.31	0.30	0.30	0.05	1917939
Nitrite (N)	mg/L	ND	ND	ND	0.01	1917941
Nitrogen (Ammonia Nitrogen)	mg/L	ND	ND	ND	0.05	1918078
Total Organic Carbon (C)	mg/L	ND	ND	ND	0.5	1918312
Orthophosphate (P)	mg/L	ND	ND	ND	0.01	1917937
pH	pH	8.06	8.10	8.08	N/A	1917912
Reactive Silica (SiO2)	mg/L	6.4	6.3	6.3	0.5	1917933
Dissolved Sulphate (SO4)	mg/L	5	4	4	2	1917932
Turbidity	NTU	0.1	ND	ND	0.1	1919086
Conductivity	uS/cm	290	300	300	1	1917921

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: A9A8545
Report Date: 2009/08/27

Fracflow Consultants Inc
Client Project #: 520
Project name: STEPHENVILLE,NL
Your P.O. #: 2905

ELEMENTS BY ICP-AES (WATER)

Maxxam ID		DL4970	DL4980	DL4986		
Sampling Date		2009/08/11	2009/08/13	2009/08/16		
COC Number		30149	30149	30149		
Registration #						
	Units	**520-PW1-001**	**520-PW1-002**	**520-PW1-004**	**RDL**	**QC Batch**
Metals						
Total Calcium (Ca)	mg/L	44	45	45	0.1	1917884
Total Magnesium (Mg)	mg/L	6.9	7.0	7.1	0.1	1917884
Total Phosphorus (P)	mg/L	ND	ND	ND	0.1	1917884
Total Potassium (K)	mg/L	1.0	1.1	0.9	0.1	1917884
Total Sodium (Na)	mg/L	9.1	9.2	9.6	0.1	1917884

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: A9A8545
Report Date: 2009/08/27

Fracflow Consultants Inc
Client Project #: 520
Project name: STEPHENVILLE,NL
Your P.O. #: 2905

ELEMENTS BY ICP/MS (WATER)

Maxxam ID		DL4970	DL4980	DL4986		
Sampling Date		2009/08/11	2009/08/13	2009/08/16		
COC Number		30149	30149	30149		
Registration #						
	Units	520-PW1-001	520-PW1-002	520-PW1-004	RDL	QC Batch
Metals						
Dissolved Aluminum (Al)	ug/L	21	66	49	10	1918936
Total Aluminum (Al)	ug/L	260	35	36	10	1917688
Dissolved Antimony (Sb)	ug/L	ND	ND	ND	2	1918936
Total Antimony (Sb)	ug/L	ND	ND	ND	2	1917688
Dissolved Arsenic (As)	ug/L	ND	ND	ND	2	1918936
Total Arsenic (As)	ug/L	ND	ND	ND	2	1917688
Dissolved Barium (Ba)	ug/L	34	33	35	5	1918936
Total Barium (Ba)	ug/L	35	36	37	5	1917688
Dissolved Beryllium (Be)	ug/L	ND	ND	ND	2	1918936
Total Beryllium (Be)	ug/L	ND	ND	ND	2	1917688
Dissolved Bismuth (Bi)	ug/L	ND	ND	ND	2	1918936
Total Bismuth (Bi)	ug/L	ND	ND	ND	2	1917688
Dissolved Boron (B)	ug/L	6	6	5	5	1918936
Total Boron (B)	ug/L	7	7	7	5	1917688
Dissolved Cadmium (Cd)	ug/L	ND	ND	ND	0.3	1918936
Total Cadmium (Cd)	ug/L	ND	ND	ND	0.3	1917688
Dissolved Chromium (Cr)	ug/L	ND	ND	ND	2	1918936
Total Chromium (Cr)	ug/L	ND	ND	ND	2	1917688
Dissolved Cobalt (Co)	ug/L	ND	ND	ND	1	1918936
Total Cobalt (Co)	ug/L	ND	ND	ND	1	1917688
Dissolved Copper (Cu)	ug/L	ND	ND	ND	2	1918936
Total Copper (Cu)	ug/L	ND	ND	ND	2	1917688
Dissolved Iron (Fe)	ug/L	ND	90	ND	50	1918936
Total Iron (Fe)	ug/L	150	ND	ND	50	1917688
Dissolved Lead (Pb)	ug/L	ND	0.6	ND	0.5	1918936
Total Lead (Pb)	ug/L	0.6	ND	ND	0.5	1917688
Dissolved Manganese (Mn)	ug/L	3	4	ND	2	1918936
Total Manganese (Mn)	ug/L	5	ND	ND	2	1917688
Dissolved Molybdenum (Mo)	ug/L	ND	ND	ND	2	1918936
Total Molybdenum (Mo)	ug/L	ND	ND	ND	2	1917688

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Driven by Service and Science

Maxxam Job #: A9A8545
Report Date: 2009/08/27

Fracflow Consultants Inc
Client Project #: 520
Project name: STEPHENVILLE,NL
Your P.O. #: 2905

ELEMENTS BY ICP/MS (WATER)

Maxxam ID		DL4970	DL4980	DL4986		
Sampling Date		2009/08/11	2009/08/13	2009/08/16		
COC Number		30149	30149	30149		
Registration #						
	Units	520-PW1-001	520-PW1-002	520-PW1-004	RDL	QC Batch
Dissolved Nickel (Ni)	ug/L	ND	ND	ND	2	1918936
Total Nickel (Ni)	ug/L	ND	ND	ND	2	1917688
Dissolved Selenium (Se)	ug/L	ND	ND	ND	2	1918936
Total Selenium (Se)	ug/L	ND	ND	ND	2	1917688
Dissolved Silver (Ag)	ug/L	ND	ND	ND	0.5	1918936
Total Silver (Ag)	ug/L	ND	ND	ND	0.5	1917688
Dissolved Strontium (Sr)	ug/L	78	76	77	5	1918936
Total Strontium (Sr)	ug/L	79	81	81	5	1917688
Dissolved Thallium (Tl)	ug/L	ND	ND	ND	0.1	1918936
Total Thallium (Tl)	ug/L	ND	ND	ND	0.1	1917688
Dissolved Tin (Sn)	ug/L	ND	ND	ND	2	1918936
Total Tin (Sn)	ug/L	ND	ND	ND	2	1917688
Dissolved Titanium (Ti)	ug/L	ND	ND	ND	2	1918936
Total Titanium (Ti)	ug/L	2	ND	ND	2	1917688
Dissolved Uranium (U)	ug/L	0.3	0.5	0.4	0.1	1918936
Total Uranium (U)	ug/L	0.4	0.3	0.3	0.1	1917688
Dissolved Vanadium (V)	ug/L	ND	ND	ND	2	1918936
Total Vanadium (V)	ug/L	ND	ND	ND	2	1917688
Dissolved Zinc (Zn)	ug/L	16	11	ND	5	1918936
Total Zinc (Zn)	ug/L	20	11	5	5	1917688

ND = Not detected
RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: A9A8545
Report Date: 2009/08/27

Fracflow Consultants Inc
Client Project #: 520
Project name: STEPHENVILLE,NL
Your P.O. #: 2905

GENERAL COMMENTS

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics [illegible] Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada [illegible] Tel: [illegible] Toll-free [illegible] Fax: [illegible] www.maxxamanalytics.com

Maxxam Analytics — *Driven by Service and Science*

Fracflow Consultants Inc
Attention: John Gale
Client Project #: 520
P.O. #: 2905
Project name: STEPHENVILLE,NL

Quality Assurance Report

Maxxam Job Number: DA9A8545

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1917688 DLB	Matrix Spike	Total Aluminum (Al)	2009/08/25		108	%	80 - 120
		Total Antimony (Sb)	2009/08/25		100	%	80 - 120
		Total Arsenic (As)	2009/08/25		106	%	80 - 120
		Total Barium (Ba)	2009/08/25		NC	%	80 - 120
		Total Beryllium (Be)	2009/08/25		100	%	80 - 120
		Total Bismuth (Bi)	2009/08/25		102	%	80 - 120
		Total Boron (B)	2009/08/25		96	%	80 - 120
		Total Cadmium (Cd)	2009/08/25		104	%	80 - 120
		Total Chromium (Cr)	2009/08/25		98	%	80 - 120
		Total Cobalt (Co)	2009/08/25		100	%	80 - 120
		Total Copper (Cu)	2009/08/25		NC	%	80 - 120
		Total Lead (Pb)	2009/08/25		99	%	80 - 120
		Total Manganese (Mn)	2009/08/25		99	%	80 - 120
		Total Molybdenum (Mo)	2009/08/25		106	%	80 - 120
		Total Nickel (Ni)	2009/08/25		99	%	80 - 120
		Total Selenium (Se)	2009/08/25		101	%	80 - 120
		Total Silver (Ag)	2009/08/25		100	%	80 - 120
		Total Strontium (Sr)	2009/08/25		NC	%	80 - 120
		Total Thallium (Tl)	2009/08/25		97	%	80 - 120
		Total Tin (Sn)	2009/08/25		97	%	80 - 120
		Total Titanium (Ti)	2009/08/25		100	%	80 - 120
		Total Uranium (U)	2009/08/25		101	%	80 - 120
		Total Vanadium (V)	2009/08/25		102	%	80 - 120
		Total Zinc (Zn)	2009/08/25		NC	%	80 - 120
	QC Standard	Total Aluminum (Al)	2009/08/25		98	%	80 - 120
		Total Antimony (Sb)	2009/08/25		127 (1)	%	80 - 120
		Total Arsenic (As)	2009/08/25		99	%	80 - 120
		Total Barium (Ba)	2009/08/25		99	%	80 - 120
		Total Beryllium (Be)	2009/08/25		102	%	80 - 120
		Total Boron (B)	2009/08/25		94	%	80 - 120
		Total Cadmium (Cd)	2009/08/25		98	%	80 - 120
		Total Chromium (Cr)	2009/08/25		99	%	80 - 120
		Total Cobalt (Co)	2009/08/25		102	%	80 - 120
		Total Copper (Cu)	2009/08/25		97	%	80 - 120
		Total Iron (Fe)	2009/08/25		108	%	80 - 120
		Total Lead (Pb)	2009/08/25		99	%	80 - 120
		Total Manganese (Mn)	2009/08/25		96	%	80 - 120
		Total Molybdenum (Mo)	2009/08/25		106	%	80 - 120
		Total Nickel (Ni)	2009/08/25		102	%	80 - 120
		Total Selenium (Se)	2009/08/25		99	%	80 - 120
		Total Strontium (Sr)	2009/08/25		103	%	80 - 120
		Total Thallium (Tl)	2009/08/25		108	%	80 - 120
		Total Uranium (U)	2009/08/25		78 (2)	%	80 - 120
		Total Vanadium (V)	2009/08/25		99	%	80 - 120
		Total Zinc (Zn)	2009/08/25		97	%	80 - 120
	Spiked Blank	Total Aluminum (Al)	2009/08/25		102	%	80 - 120
		Total Antimony (Sb)	2009/08/25		96	%	80 - 120
		Total Arsenic (As)	2009/08/25		96	%	80 - 120
		Total Barium (Ba)	2009/08/25		97	%	80 - 120
		Total Beryllium (Be)	2009/08/25		99	%	80 - 120
		Total Bismuth (Bi)	2009/08/25		103	%	80 - 120
		Total Boron (B)	2009/08/25		94	%	80 - 120
		Total Cadmium (Cd)	2009/08/25		97	%	80 - 120
		Total Chromium (Cr)	2009/08/25		96	%	80 - 120
		Total Cobalt (Co)	2009/08/25		101	%	80 - 120

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Fracflow Consultants Inc
Attention: John Gale
Client Project #: 520
P.O. #: 2905
Project name: STEPHENVILLE,NL

Quality Assurance Report (Continued)

Maxxam Job Number: DA9A8545

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1917688 DLB	Spiked Blank	Total Copper (Cu)	2009/08/25		98	%	80 - 120
		Total Lead (Pb)	2009/08/25		96	%	80 - 120
		Total Manganese (Mn)	2009/08/25		96	%	80 - 120
		Total Molybdenum (Mo)	2009/08/25		99	%	80 - 120
		Total Nickel (Ni)	2009/08/25		100	%	80 - 120
		Total Selenium (Se)	2009/08/25		93	%	80 - 120
		Total Silver (Ag)	2009/08/25		98	%	80 - 120
		Total Strontium (Sr)	2009/08/25		98	%	80 - 120
		Total Thallium (Tl)	2009/08/25		94	%	80 - 120
		Total Tin (Sn)	2009/08/25		96	%	80 - 120
		Total Titanium (Ti)	2009/08/25		100	%	80 - 120
		Total Uranium (U)	2009/08/25		96	%	80 - 120
		Total Vanadium (V)	2009/08/25		99	%	80 - 120
		Total Zinc (Zn)	2009/08/25		96	%	80 - 120
	Method Blank	Total Aluminum (Al)	2009/08/25	ND, RDL=10		ug/L	
		Total Antimony (Sb)	2009/08/25	ND, RDL=2		ug/L	
		Total Arsenic (As)	2009/08/25	ND, RDL=2		ug/L	
		Total Barium (Ba)	2009/08/25	ND, RDL=5		ug/L	
		Total Beryllium (Be)	2009/08/25	ND, RDL=2		ug/L	
		Total Bismuth (Bi)	2009/08/25	ND, RDL=2		ug/L	
		Total Boron (B)	2009/08/25	ND, RDL=5		ug/L	
		Total Cadmium (Cd)	2009/08/25	ND, RDL=0.3		ug/L	
		Total Chromium (Cr)	2009/08/25	ND, RDL=2		ug/L	
		Total Cobalt (Co)	2009/08/25	ND, RDL=1		ug/L	
		Total Copper (Cu)	2009/08/25	ND, RDL=2		ug/L	
		Total Iron (Fe)	2009/08/25	ND, RDL=50		ug/L	
		Total Lead (Pb)	2009/08/25	ND, RDL=0.5		ug/L	
		Total Manganese (Mn)	2009/08/25	ND, RDL=2		ug/L	
		Total Molybdenum (Mo)	2009/08/25	ND, RDL=2		ug/L	
		Total Nickel (Ni)	2009/08/25	ND, RDL=2		ug/L	
		Total Selenium (Se)	2009/08/25	ND, RDL=2		ug/L	
		Total Silver (Ag)	2009/08/25	ND, RDL=0.5		ug/L	
		Total Strontium (Sr)	2009/08/25	ND, RDL=5		ug/L	
		Total Thallium (Tl)	2009/08/25	ND, RDL=0.1		ug/L	
		Total Tin (Sn)	2009/08/25	ND, RDL=2		ug/L	
		Total Titanium (Ti)	2009/08/25	ND, RDL=2		ug/L	
		Total Uranium (U)	2009/08/25	ND, RDL=0.1		ug/L	
		Total Vanadium (V)	2009/08/25	ND, RDL=2		ug/L	
		Total Zinc (Zn)	2009/08/25	ND, RDL=5		ug/L	
	RPD [DL4970-01]	Total Aluminum (Al)	2009/08/25	18.3		%	25
		Total Antimony (Sb)	2009/08/25	NC		%	25
		Total Arsenic (As)	2009/08/25	NC		%	25
		Total Barium (Ba)	2009/08/25	1.7		%	25
		Total Beryllium (Be)	2009/08/25	NC		%	25
		Total Bismuth (Bi)	2009/08/25	NC		%	25
		Total Boron (B)	2009/08/25	NC		%	25
		Total Cadmium (Cd)	2009/08/25	NC		%	25
		Total Chromium (Cr)	2009/08/25	NC		%	25
		Total Cobalt (Co)	2009/08/25	NC		%	25
		Total Copper (Cu)	2009/08/25	NC		%	25
		Total Iron (Fe)	2009/08/25	NC		%	25
		Total Lead (Pb)	2009/08/25	NC		%	25
		Total Manganese (Mn)	2009/08/25	NC		%	25
		Total Molybdenum (Mo)	2009/08/25	NC		%	25
		Total Nickel (Ni)	2009/08/25	NC		%	25

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Fracflow Consultants Inc
Attention: John Gale
Client Project #: 520
P.O. #: 2905
Project name: STEPHENVILLE,NL

Quality Assurance Report (Continued)

Maxxam Job Number: DA9A8545

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1917688 DLB	RPD [DL4970-01]	Total Selenium (Se)	2009/08/25	NC		%	25
		Total Silver (Ag)	2009/08/25	NC		%	25
		Total Strontium (Sr)	2009/08/25	4.6		%	25
		Total Thallium (Tl)	2009/08/25	NC		%	25
		Total Tin (Sn)	2009/08/25	NC		%	25
		Total Titanium (Ti)	2009/08/25	NC		%	25
		Total Uranium (U)	2009/08/25	NC		%	25
		Total Vanadium (V)	2009/08/25	NC		%	25
		Total Zinc (Zn)	2009/08/25	NC		%	25
1917884 SSI	Matrix Spike [DL4970-01]	Total Calcium (Ca)	2009/08/25		95	%	80 - 120
		Total Magnesium (Mg)	2009/08/25		93	%	80 - 120
		Total Phosphorus (P)	2009/08/25		100	%	80 - 120
		Total Potassium (K)	2009/08/25		100	%	80 - 120
		Total Sodium (Na)	2009/08/25		102	%	80 - 120
	QC Standard	Total Calcium (Ca)	2009/08/25		99	%	80 - 120
		Total Magnesium (Mg)	2009/08/25		95	%	80 - 120
		Total Phosphorus (P)	2009/08/25		104	%	80 - 120
		Total Potassium (K)	2009/08/25		102	%	80 - 120
		Total Sodium (Na)	2009/08/25		104	%	80 - 120
	Spiked Blank	Total Calcium (Ca)	2009/08/25		95	%	80 - 120
		Total Magnesium (Mg)	2009/08/25		93	%	80 - 120
		Total Phosphorus (P)	2009/08/25		99	%	80 - 120
		Total Potassium (K)	2009/08/25		98	%	80 - 120
		Total Sodium (Na)	2009/08/25		101	%	80 - 120
	Method Blank	Total Calcium (Ca)	2009/08/25	ND, RDL=0.1		mg/L	
		Total Magnesium (Mg)	2009/08/25	ND, RDL=0.1		mg/L	
		Total Phosphorus (P)	2009/08/25	ND, RDL=0.1		mg/L	
		Total Potassium (K)	2009/08/25	ND, RDL=0.1		mg/L	
		Total Sodium (Na)	2009/08/25	ND, RDL=0.1		mg/L	
	RPD [DL4970-01]	Total Calcium (Ca)	2009/08/25	4.0		%	25
		Total Magnesium (Mg)	2009/08/25	4.1		%	25
		Total Phosphorus (P)	2009/08/25	NC		%	25
		Total Potassium (K)	2009/08/25	0.8		%	25
		Total Sodium (Na)	2009/08/25	3.3		%	25
1917912 ARS	QC Standard	pH	2009/08/25		102	%	80 - 120
	Method Blank	pH	2009/08/25	6.40, RDL=0		pH	
	RPD	pH	2009/08/25	1.3		%	25
1917921 ARS	QC Standard	Conductivity	2009/08/25		102	%	80 - 120
	Method Blank	Conductivity	2009/08/25	ND, RDL=1		uS/cm	
	RPD	Conductivity	2009/08/25	15.0		%	25
1917925 JOA	Matrix Spike [DL4980-01]	Total Alkalinity (Total as CaCO3)	2009/08/25		NC	%	80 - 120
	QC Standard	Total Alkalinity (Total as CaCO3)	2009/08/25		103	%	80 - 120
	Spiked Blank	Total Alkalinity (Total as CaCO3)	2009/08/25		114	%	80 - 120
	Method Blank	Total Alkalinity (Total as CaCO3)	2009/08/25	ND, RDL=5		mg/L	
	RPD [DL4980-01]	Total Alkalinity (Total as CaCO3)	2009/08/25	0.3		%	25
1917931 SMT	Matrix Spike [DL4980-01]	Dissolved Chloride (Cl)	2009/08/26		103	%	80 - 120
	QC Standard	Dissolved Chloride (Cl)	2009/08/26		104	%	80 - 120
	Spiked Blank	Dissolved Chloride (Cl)	2009/08/26		105	%	80 - 120
	Method Blank	Dissolved Chloride (Cl)	2009/08/26	ND, RDL=1		mg/L	
	RPD [DL4980-01]	Dissolved Chloride (Cl)	2009/08/26	1.9		%	25
1917932 JOA	Matrix Spike [DL4980-01]	Dissolved Sulphate (SO4)	2009/08/26		107	%	80 - 120

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Fracflow Consultants Inc
Attention: John Gale
Client Project #: 520
P.O. #: 2905
Project name: STEPHENVILLE,NL

Quality Assurance Report (Continued)

Maxxam Job Number: DA9A8545

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1917932 JOA	QC Standard	Dissolved Sulphate (SO4)	2009/08/26		105	%	80 - 120
	Spiked Blank	Dissolved Sulphate (SO4)	2009/08/26		106	%	80 - 120
	Method Blank	Dissolved Sulphate (SO4)	2009/08/26	ND, RDL=2		mg/L	
	RPD [DL4980-01]	Dissolved Sulphate (SO4)	2009/08/26	NC		%	25
1917933 JBK	Matrix Spike						
	[DL4980-01]	Reactive Silica (SiO2)	2009/08/25		NC	%	80 - 120
	QC Standard	Reactive Silica (SiO2)	2009/08/25		99	%	75 - 125
	Spiked Blank	Reactive Silica (SiO2)	2009/08/25		101	%	80 - 120
	Method Blank	Reactive Silica (SiO2)	2009/08/25	ND, RDL=0.5		mg/L	
	RPD [DL4980-01]	Reactive Silica (SiO2)	2009/08/25	0.5		%	25
1917935 SMT	QC Standard	Colour	2009/08/26		108	%	80 - 120
	Method Blank	Colour	2009/08/26	ND, RDL=5		TCU	
	RPD [DL4980-01]	Colour	2009/08/26	NC		%	25
1917937 SMT	Matrix Spike						
	[DL4980-01]	Orthophosphate (P)	2009/08/26		89	%	80 - 120
	QC Standard	Orthophosphate (P)	2009/08/26		98	%	80 - 120
	Spiked Blank	Orthophosphate (P)	2009/08/26		98	%	80 - 120
	Method Blank	Orthophosphate (P)	2009/08/26	ND, RDL=0.01		mg/L	
	RPD [DL4980-01]	Orthophosphate (P)	2009/08/26	NC		%	25
1917939 JOA	Matrix Spike						
	[DL4980-01]	Nitrate + Nitrite	2009/08/26		103	%	80 - 120
	QC Standard	Nitrate + Nitrite	2009/08/26		100	%	80 - 120
	Spiked Blank	Nitrate + Nitrite	2009/08/26		103	%	80 - 120
	Method Blank	Nitrate + Nitrite	2009/08/26	ND, RDL=0.05		mg/L	
	RPD [DL4980-01]	Nitrate + Nitrite	2009/08/26	1.4		%	25
1917941 JOA	Matrix Spike						
	[DL4980-01]	Nitrite (N)	2009/08/26		100	%	80 - 120
	QC Standard	Nitrite (N)	2009/08/26		95	%	80 - 120
	Spiked Blank	Nitrite (N)	2009/08/26		97	%	80 - 120
	Method Blank	Nitrite (N)	2009/08/26	ND, RDL=0.01		mg/L	
	RPD [DL4980-01]	Nitrite (N)	2009/08/26	NC		%	25
1918078 SMT	Matrix Spike	Nitrogen (Ammonia Nitrogen)	2009/08/25		NC	%	80 - 120
	QC Standard	Nitrogen (Ammonia Nitrogen)	2009/08/25		97	%	80 - 120
	Spiked Blank	Nitrogen (Ammonia Nitrogen)	2009/08/25		94	%	80 - 120
	Method Blank	Nitrogen (Ammonia Nitrogen)	2009/08/25	ND, RDL=0.05		mg/L	
	RPD	Nitrogen (Ammonia Nitrogen)	2009/08/25	1.1		%	25
1918312 CRA	Matrix Spike	Total Organic Carbon (C)	2009/08/25		105	%	75 - 125
	QC Standard	Total Organic Carbon (C)	2009/08/25		105	%	80 - 120
	Spiked Blank	Total Organic Carbon (C)	2009/08/25		112	%	75 - 125
	Method Blank	Total Organic Carbon (C)	2009/08/25	ND, RDL=0.5		mg/L	
	RPD	Total Organic Carbon (C)	2009/08/25	NC		%	25
1918936 DLB	Matrix Spike						
	[DL4980-02]	Dissolved Aluminum (Al)	2009/08/26		NC	%	80 - 120
		Dissolved Antimony (Sb)	2009/08/26		98	%	80 - 120
		Dissolved Arsenic (As)	2009/08/26		105	%	80 - 120
		Dissolved Barium (Ba)	2009/08/26		NC	%	80 - 120
		Dissolved Beryllium (Be)	2009/08/26		110	%	80 - 120
		Dissolved Bismuth (Bi)	2009/08/26		77 (3)	%	80 - 120
		Dissolved Boron (B)	2009/08/26		102	%	80 - 120
		Dissolved Cadmium (Cd)	2009/08/26		103	%	80 - 120
		Dissolved Chromium (Cr)	2009/08/26		105	%	80 - 120
		Dissolved Cobalt (Co)	2009/08/26		101	%	80 - 120
		Dissolved Copper (Cu)	2009/08/26		101	%	80 - 120
		Dissolved Lead (Pb)	2009/08/26		102	%	80 - 120
		Dissolved Manganese (Mn)	2009/08/26		104	%	80 - 120

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Fracflow Consultants Inc
Attention: John Gale
Client Project #: 520
P.O. #: 2905
Project name: STEPHENVILLE,NL

Quality Assurance Report (Continued)

Maxxam Job Number: DA9A8545

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1918936 DLB	Matrix Spike [DL4980-02]	Dissolved Molybdenum (Mo)	2009/08/26		90	%	80 - 120
		Dissolved Nickel (Ni)	2009/08/26		101	%	80 - 120
		Dissolved Selenium (Se)	2009/08/26		105	%	80 - 120
		Dissolved Silver (Ag)	2009/08/26		96	%	80 - 120
		Dissolved Strontium (Sr)	2009/08/26		NC	%	80 - 120
		Dissolved Thallium (Tl)	2009/08/26		105	%	80 - 120
		Dissolved Tin (Sn)	2009/08/26		88	%	80 - 120
		Dissolved Titanium (Ti)	2009/08/26		102	%	80 - 120
		Dissolved Uranium (U)	2009/08/26		104	%	80 - 120
		Dissolved Vanadium (V)	2009/08/26		106	%	80 - 120
		Dissolved Zinc (Zn)	2009/08/26		115	%	80 - 120
	QC Standard	Dissolved Aluminum (Al)	2009/08/26		106	%	80 - 120
		Dissolved Antimony (Sb)	2009/08/26		122 (1)	%	80 - 120
		Dissolved Arsenic (As)	2009/08/26		88	%	80 - 120
		Dissolved Barium (Ba)	2009/08/26		97	%	80 - 120
		Dissolved Beryllium (Be)	2009/08/26		94	%	80 - 120
		Dissolved Bismuth (Bi)	2009/08/26		105	%	80 - 120
		Dissolved Boron (B)	2009/08/26		90	%	80 - 120
		Dissolved Cadmium (Cd)	2009/08/26		98	%	80 - 120
		Dissolved Chromium (Cr)	2009/08/26		103	%	80 - 120
		Dissolved Cobalt (Co)	2009/08/26		98	%	80 - 120
		Dissolved Copper (Cu)	2009/08/26		94	%	80 - 120
		Dissolved Iron (Fe)	2009/08/26		93	%	80 - 120
		Dissolved Lead (Pb)	2009/08/26		96	%	80 - 120
		Dissolved Manganese (Mn)	2009/08/26		100	%	80 - 120
		Dissolved Molybdenum (Mo)	2009/08/26		104	%	80 - 120
		Dissolved Nickel (Ni)	2009/08/26		97	%	80 - 120
		Dissolved Selenium (Se)	2009/08/26		83	%	80 - 120
		Dissolved Silver (Ag)	2009/08/26		89	%	80 - 120
		Dissolved Strontium (Sr)	2009/08/26		94	%	80 - 120
		Dissolved Thallium (Tl)	2009/08/26		99	%	80 - 120
		Dissolved Vanadium (V)	2009/08/26		103	%	80 - 120
		Dissolved Zinc (Zn)	2009/08/26		86	%	80 - 120
	Spiked Blank	Dissolved Aluminum (Al)	2009/08/26		110	%	80 - 120
		Dissolved Antimony (Sb)	2009/08/26		100	%	80 - 120
		Dissolved Arsenic (As)	2009/08/26		99	%	80 - 120
		Dissolved Barium (Ba)	2009/08/26		103	%	80 - 120
		Dissolved Beryllium (Be)	2009/08/26		108	%	80 - 120
		Dissolved Bismuth (Bi)	2009/08/26		112	%	80 - 120
		Dissolved Boron (B)	2009/08/26		104	%	80 - 120
		Dissolved Cadmium (Cd)	2009/08/26		100	%	80 - 120
		Dissolved Chromium (Cr)	2009/08/26		105	%	80 - 120
		Dissolved Cobalt (Co)	2009/08/26		104	%	80 - 120
		Dissolved Copper (Cu)	2009/08/26		104	%	80 - 120
		Dissolved Lead (Pb)	2009/08/26		108	%	80 - 120
		Dissolved Manganese (Mn)	2009/08/26		109	%	80 - 120
		Dissolved Molybdenum (Mo)	2009/08/26		105	%	80 - 120
		Dissolved Nickel (Ni)	2009/08/26		105	%	80 - 120
		Dissolved Selenium (Se)	2009/08/26		96	%	80 - 120
		Dissolved Silver (Ag)	2009/08/26		98	%	80 - 120
		Dissolved Strontium (Sr)	2009/08/26		104	%	80 - 120
		Dissolved Thallium (Tl)	2009/08/26		105	%	80 - 120
		Dissolved Tin (Sn)	2009/08/26		113	%	80 - 120
		Dissolved Titanium (Ti)	2009/08/26		105	%	80 - 120

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Project name: STEPHENVILLE,NL

Quality Assurance Report (Continued)

Maxxam Job Number: DA9A8545

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1918936 DLB	Spiked Blank	Dissolved Uranium (U)	2009/08/26		102	%	80 - 120
		Dissolved Vanadium (V)	2009/08/26		104	%	80 - 120
		Dissolved Zinc (Zn)	2009/08/26		109	%	80 - 120
	Method Blank	Dissolved Aluminum (Al)	2009/08/26	ND, RDL=10		ug/L	
		Dissolved Antimony (Sb)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Arsenic (As)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Barium (Ba)	2009/08/26	ND, RDL=5		ug/L	
		Dissolved Beryllium (Be)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Bismuth (Bi)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Boron (B)	2009/08/26	ND, RDL=5		ug/L	
		Dissolved Cadmium (Cd)	2009/08/26	ND, RDL=0.3		ug/L	
		Dissolved Chromium (Cr)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Cobalt (Co)	2009/08/26	ND, RDL=1		ug/L	
		Dissolved Copper (Cu)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Iron (Fe)	2009/08/26	ND, RDL=50		ug/L	
		Dissolved Lead (Pb)	2009/08/26	ND, RDL=0.5		ug/L	
		Dissolved Manganese (Mn)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Molybdenum (Mo)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Nickel (Ni)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Selenium (Se)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Silver (Ag)	2009/08/26	ND, RDL=0.5		ug/L	
		Dissolved Strontium (Sr)	2009/08/26	ND, RDL=5		ug/L	
		Dissolved Thallium (Tl)	2009/08/26	ND, RDL=0.1		ug/L	
		Dissolved Tin (Sn)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Titanium (Ti)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Uranium (U)	2009/08/26	ND, RDL=0.1		ug/L	
		Dissolved Vanadium (V)	2009/08/26	ND, RDL=2		ug/L	
		Dissolved Zinc (Zn)	2009/08/26	ND, RDL=5		ug/L	
	RPD [DL4986-02]	Dissolved Aluminum (Al)	2009/08/26	NC		%	25
		Dissolved Antimony (Sb)	2009/08/26	NC		%	25
		Dissolved Arsenic (As)	2009/08/26	NC		%	25
		Dissolved Barium (Ba)	2009/08/26	1.1		%	25
		Dissolved Beryllium (Be)	2009/08/26	NC		%	25
		Dissolved Bismuth (Bi)	2009/08/26	NC		%	25
		Dissolved Boron (B)	2009/08/26	NC		%	25
		Dissolved Cadmium (Cd)	2009/08/26	NC		%	25
		Dissolved Chromium (Cr)	2009/08/26	NC		%	25
		Dissolved Cobalt (Co)	2009/08/26	NC		%	25
		Dissolved Copper (Cu)	2009/08/26	NC		%	25
		Dissolved Iron (Fe)	2009/08/26	NC		%	25
		Dissolved Lead (Pb)	2009/08/26	NC		%	25
		Dissolved Manganese (Mn)	2009/08/26	NC		%	25
		Dissolved Molybdenum (Mo)	2009/08/26	NC		%	25
		Dissolved Nickel (Ni)	2009/08/26	NC		%	25
		Dissolved Selenium (Se)	2009/08/26	NC		%	25
		Dissolved Silver (Ag)	2009/08/26	NC		%	25
		Dissolved Strontium (Sr)	2009/08/26	0.1		%	25
		Dissolved Thallium (Tl)	2009/08/26	NC		%	25
		Dissolved Tin (Sn)	2009/08/26	NC		%	25
		Dissolved Titanium (Ti)	2009/08/26	NC		%	25
		Dissolved Uranium (U)	2009/08/26	NC		%	25
		Dissolved Vanadium (V)	2009/08/26	NC		%	25
		Dissolved Zinc (Zn)	2009/08/26	NC		%	25
1919086 JRC	QC Standard	Turbidity	2009/08/26		100	%	80 - 120
	Method Blank	Turbidity	2009/08/26	ND, RDL=0.1		NTU	

This document is in electronic format, hard copy is available on request.

Maxxam Analytics International Corporation o/a Maxxam Analytics 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free 800-565-7227 Fax 902-420-8612 www.maxxamanalytics.com

Driven by Service and Science

Fracflow Consultants Inc
Attention: John Gale
Client Project #: 520
P.O. #: 2905
Project name: STEPHENVILLE,NL

Quality Assurance Report (Continued)

Maxxam Job Number: DA9A8545

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1919086 JRC	RPD	Turbidity	2009/08/26	NC		%	25

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) Suspect problem with RM. Minimal impact on data quality.
(2) Typical recovery for RM matrix.
(3) Recovery within acceptance limits.

This document is in electronic format, hard copy is available on request.
Maxxam Analytics International Corporation o/a Maxxam Analytics 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free 800-565-7227 Fax 902-420-8612 www.maxxamanalytics.com

Sample Integrity Form

Invoice To:
Fracflow Consultants Inc
ATTN: Accounts Payable
154 Major's Path
St. John's, NL
A1A 5A1
Client Contact:
John Gale

Maxxam Job #:	A9A8545
Date Received:	2009/08/20
Your C.O.C. #:	30149
Your Project #:	520
Your P.O. #:	2905
Maxxam Project Manager:	STACY JOSEPH
Quote #:	A94149

No discrepancies noted.

Report Comments

Received Date: 2009/08/20 **Time:** 10:00 **By:** ________

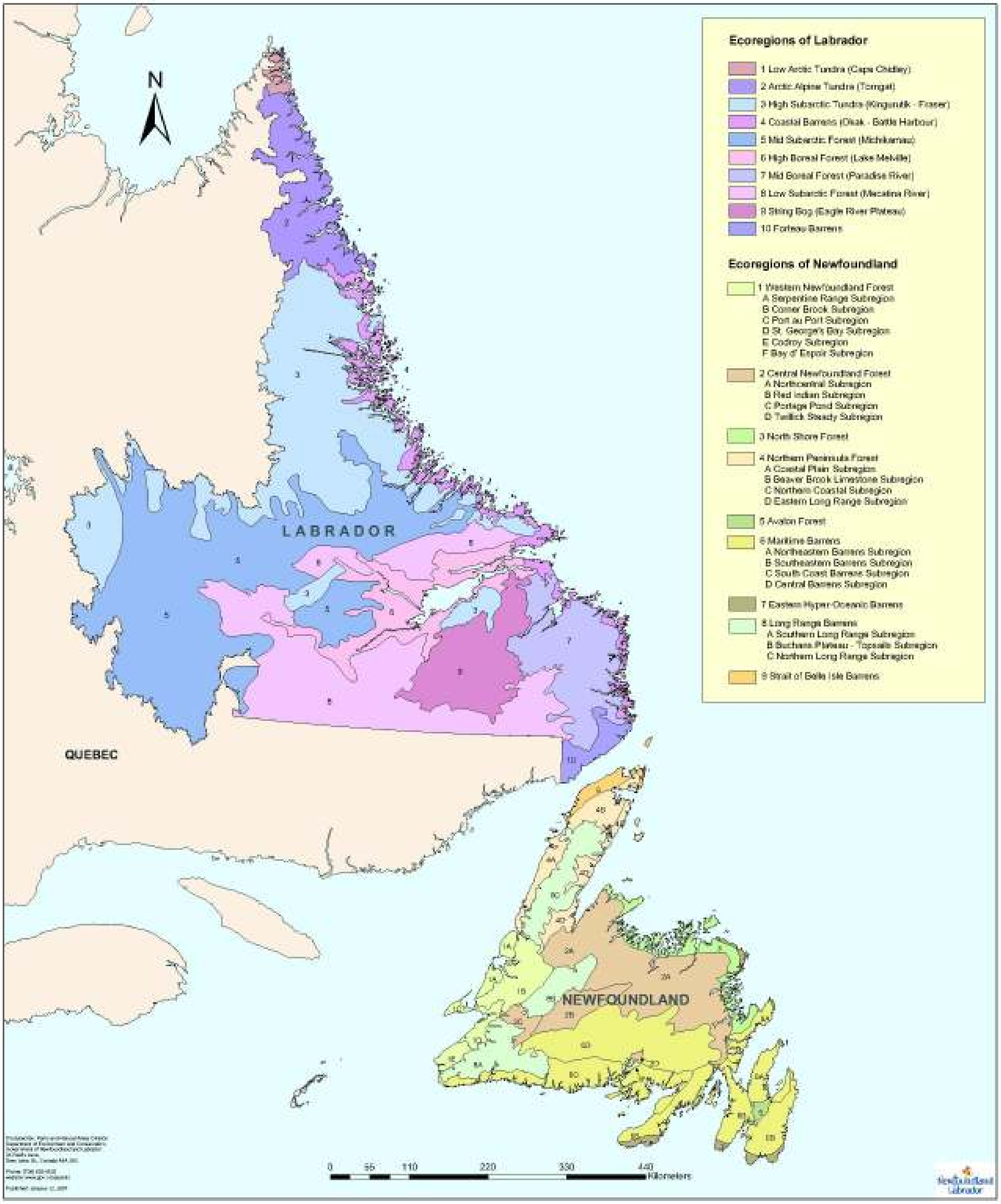
Inspected Date: ________ **Time:** ________ **By:** ________

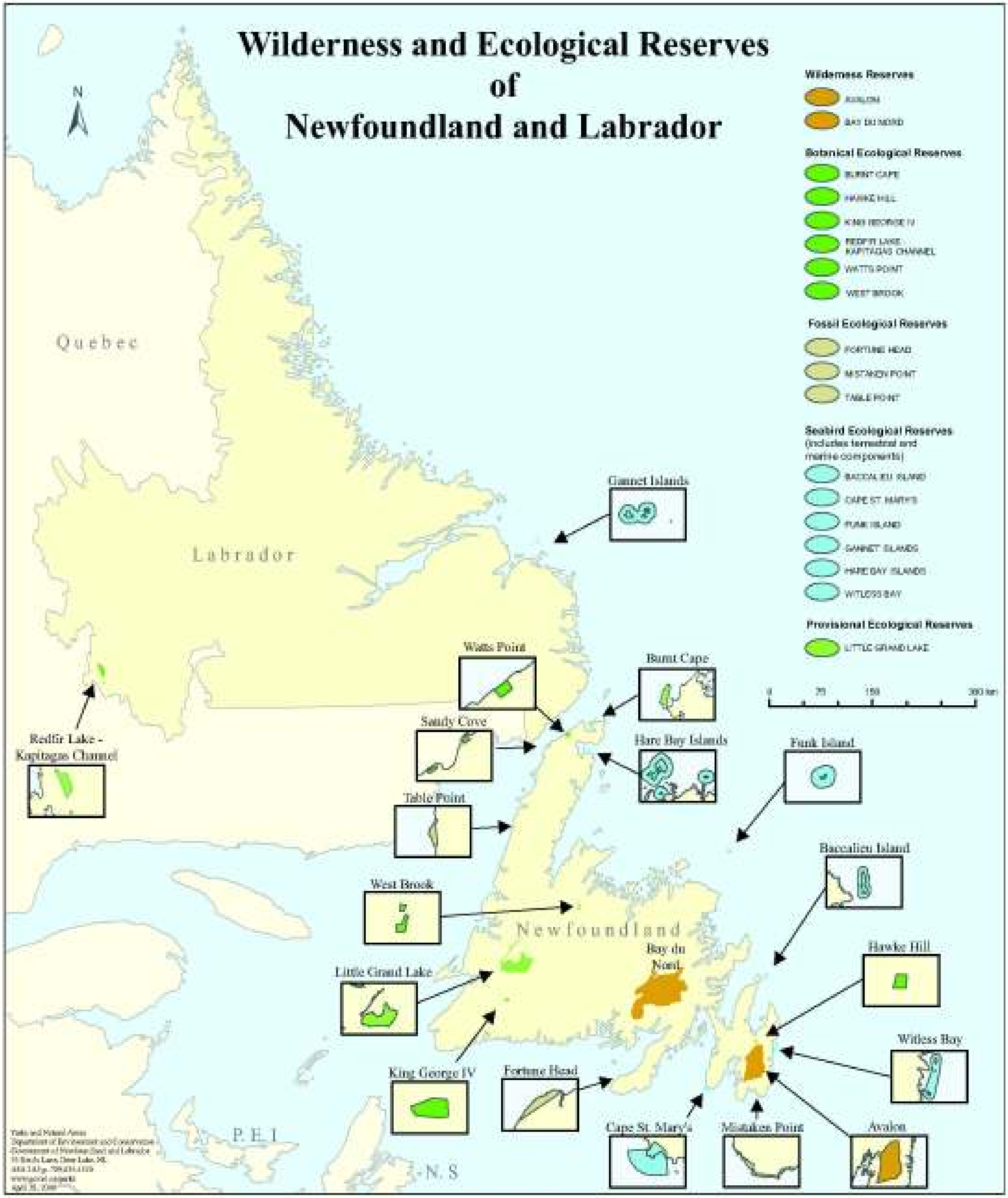
SIF Created Date: ________ **Time:** 00:00 **By:** ________

APPENDIX E

Eco-Regions, Reserves
&
Species at Risk Distribution Maps

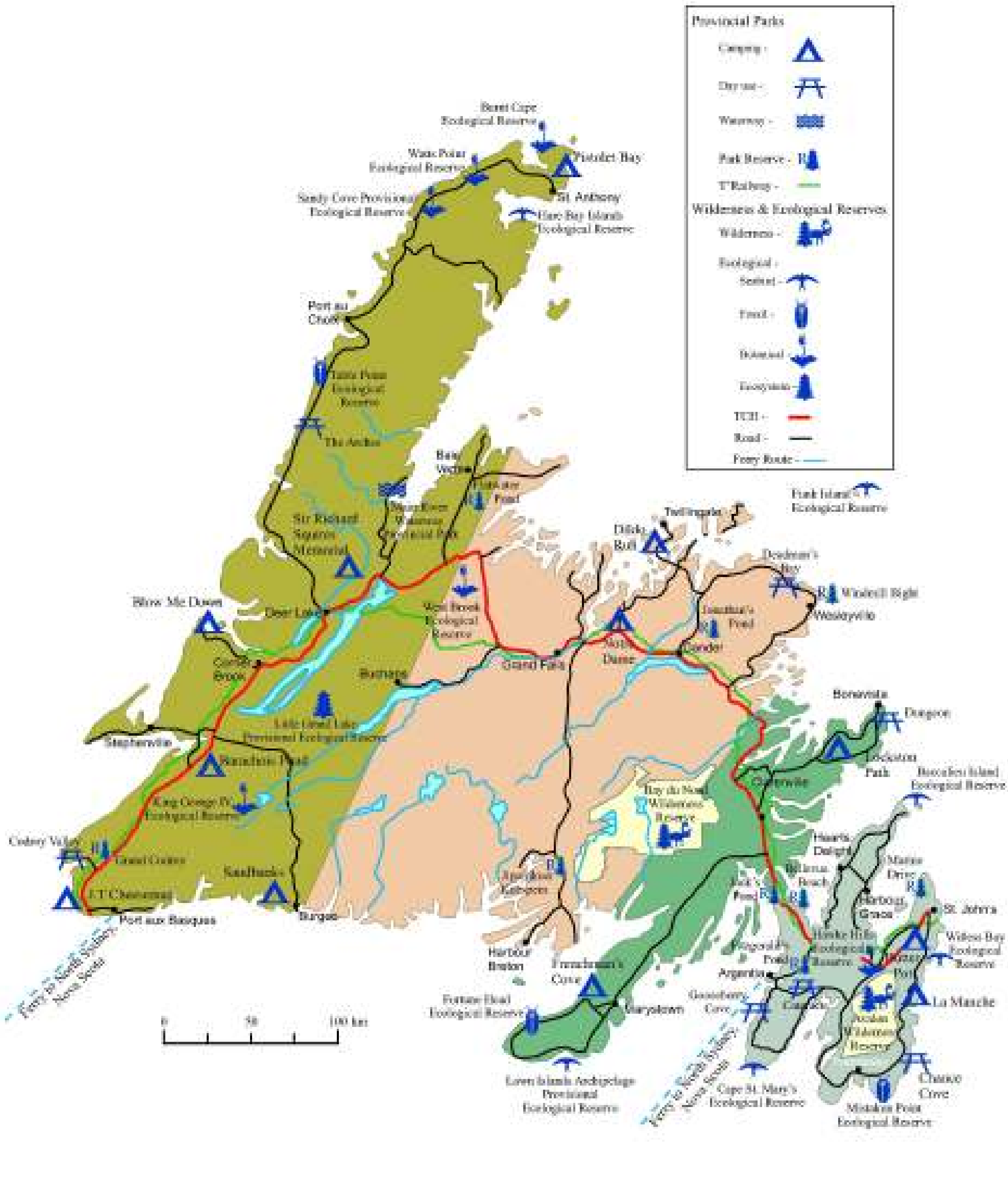
Ecoregions of Newfoundland and Labrador



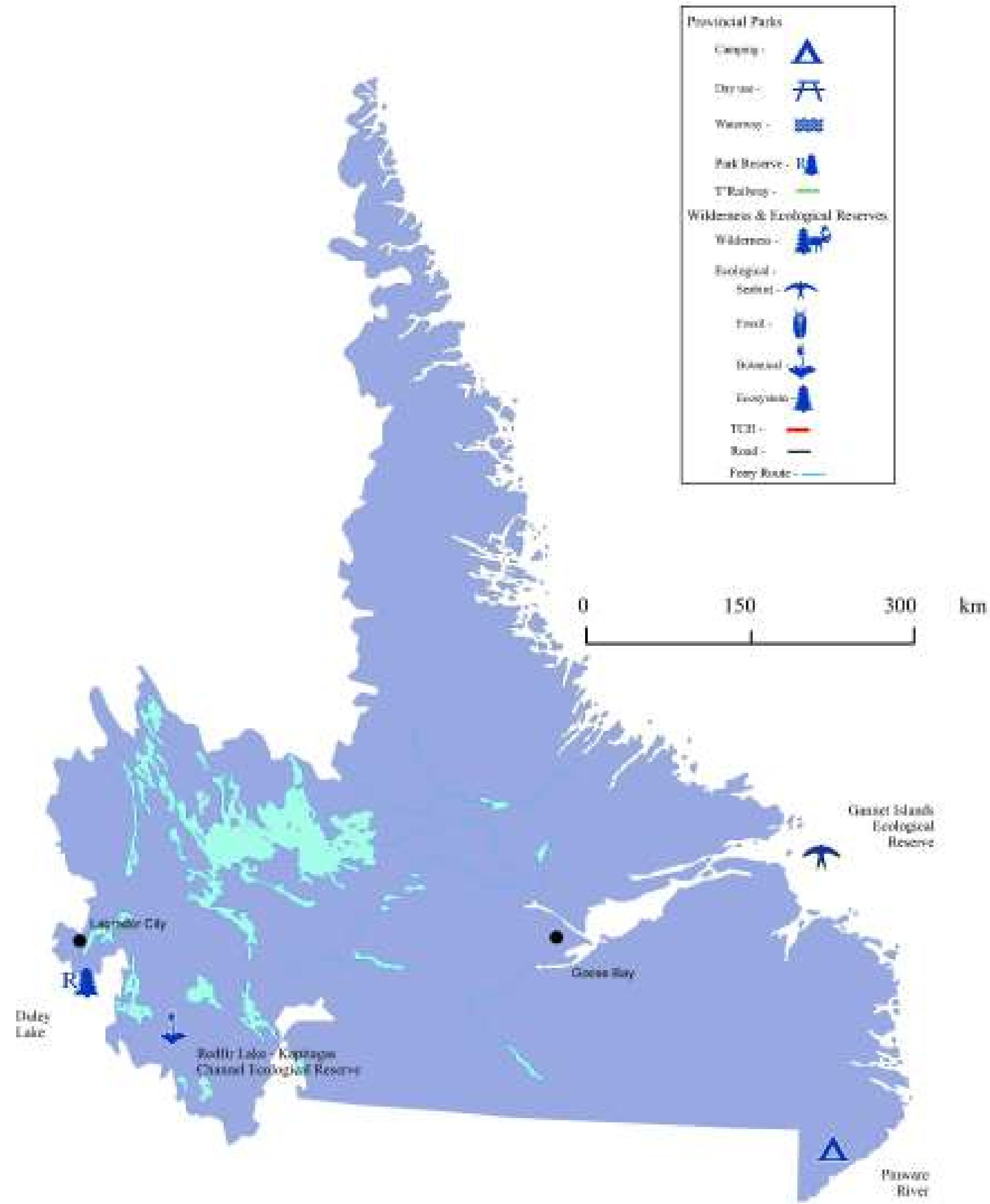


Wilderness and Ecological Reserves of Newfoundland and Labrador
N
Wilderness Reserves
AVALON
BAY DU NORD
Botanical Ecological Reserves
BURNT CAPE
HAWKE HILL
KING GEORGE IV
REDFIR LAKE - KAPITAGAS CHANNEL
WATTS POINT
WEST BROOK
Fossil Ecological Reserves
FORTUNE HEAD
MISTAKEN POINT
TABLE POINT
Seabird Ecological Reserves (includes terrestrial and marine components)
BACCALIEU ISLAND
CAPE ST. MARY'S
FUNK ISLAND
GANNET ISLANDS
HARE BAY ISLANDS
WITLESS BAY
Provisional Ecological Reserves
LITTLE GRAND LAKE
0
75
150
300 km
Quebec
Labrador
Newfoundland
P. E. I
N. S
Gannet Islands
Watts Point
Burnt Cape
Sandy Cove
Hare Bay Islands
Funk Island
Redfir Lake - Kapitagas Channel
Table Point
Baccalieu Island
West Brook
Hawke Hill
Bay du Nord
Little Grand Lake
Witless Bay
King George IV
Fortune Head
Cape St. Mary's
Mistaken Point
Avalon

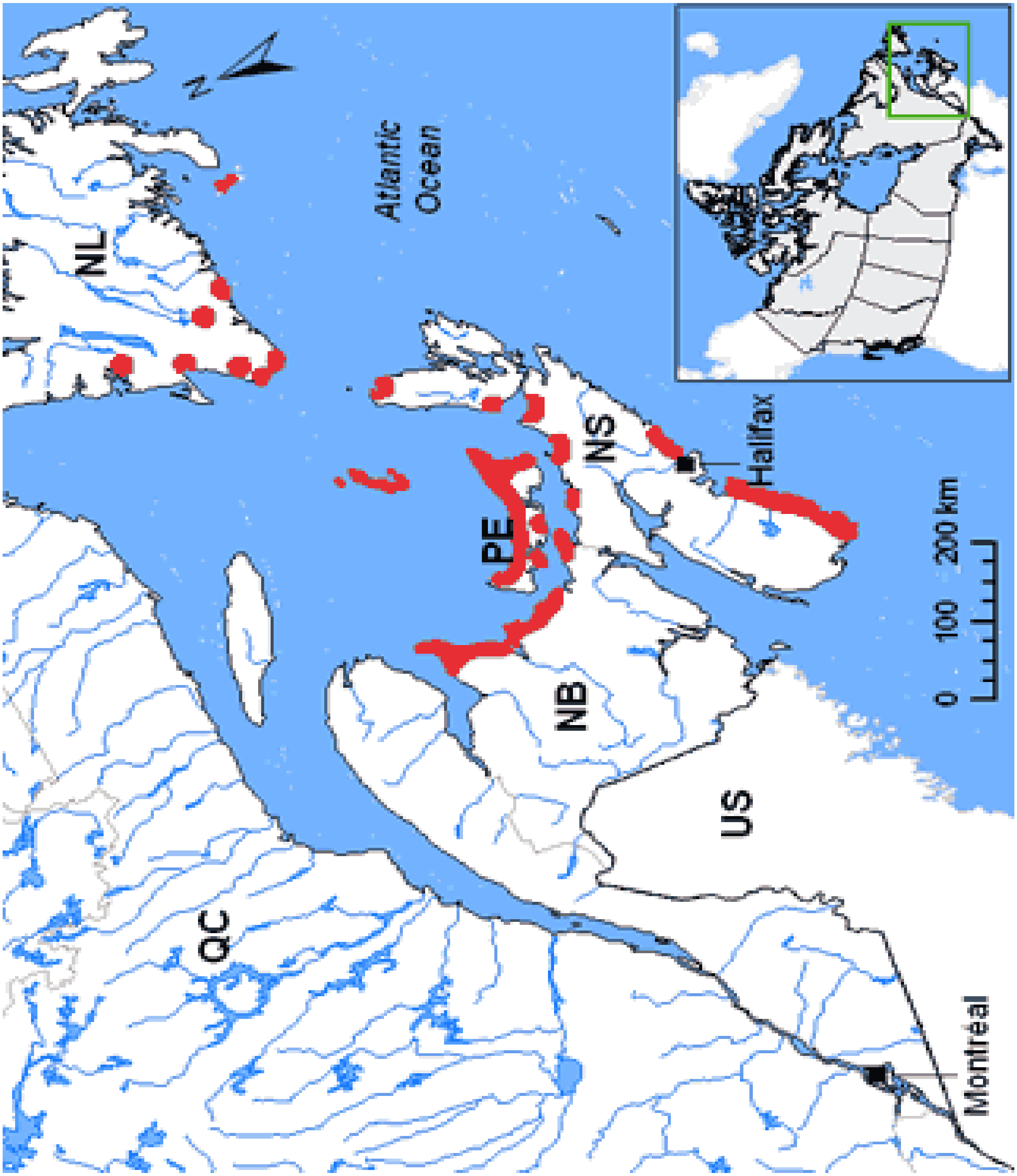
Provincial Parks and Reserves



Provincial Parks and Reserves



Piping Plover (*Charadrius melodus melodus*)

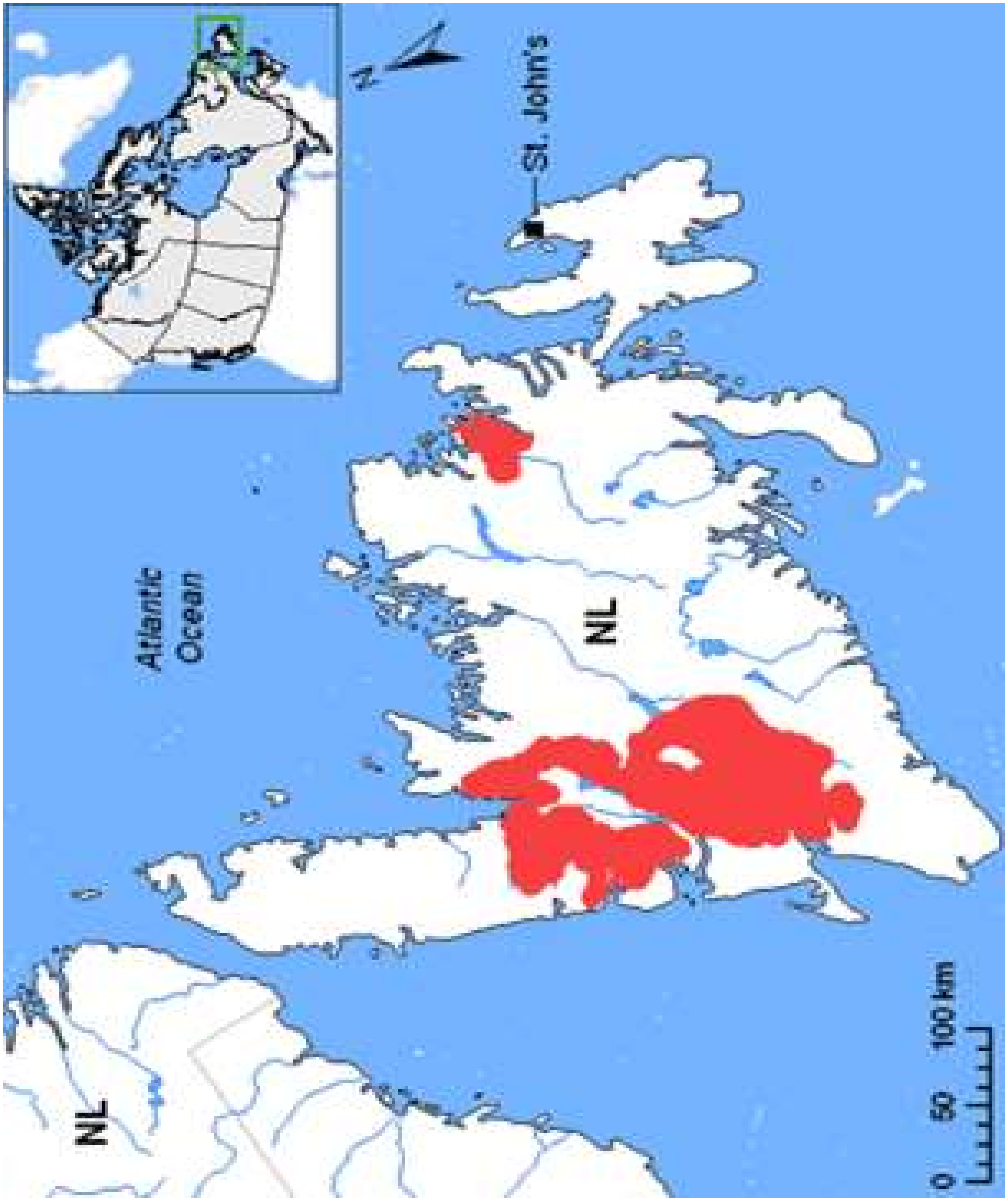


http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=687

Eskimo curlew (*Numenius borealis*)

http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/eskimo_curlew.pdf

American Marten or Newfoundland Pine Marten (*Martes americana atrata*)

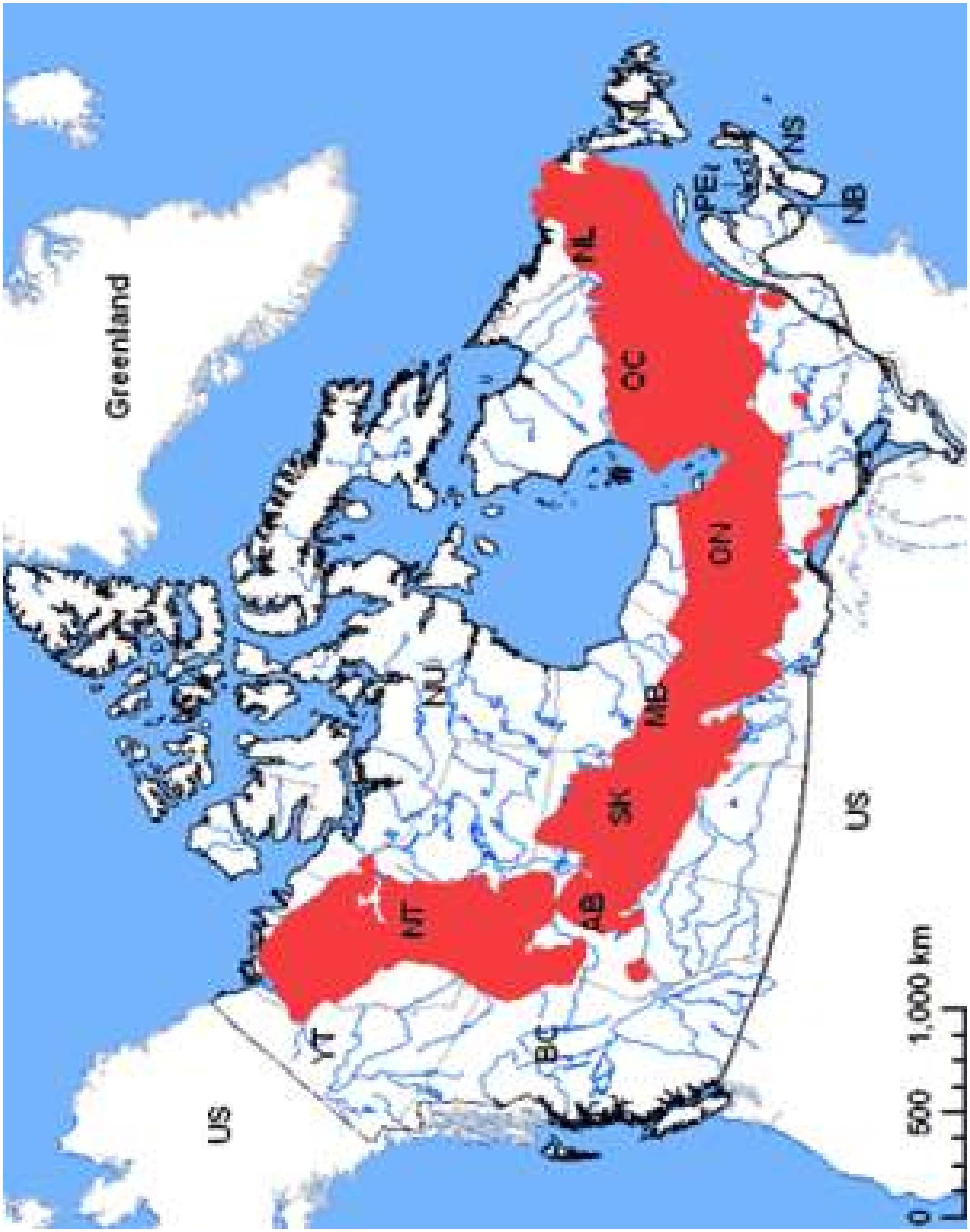


http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=134

Northern wolfish (*Anarhichas denticulatus*)

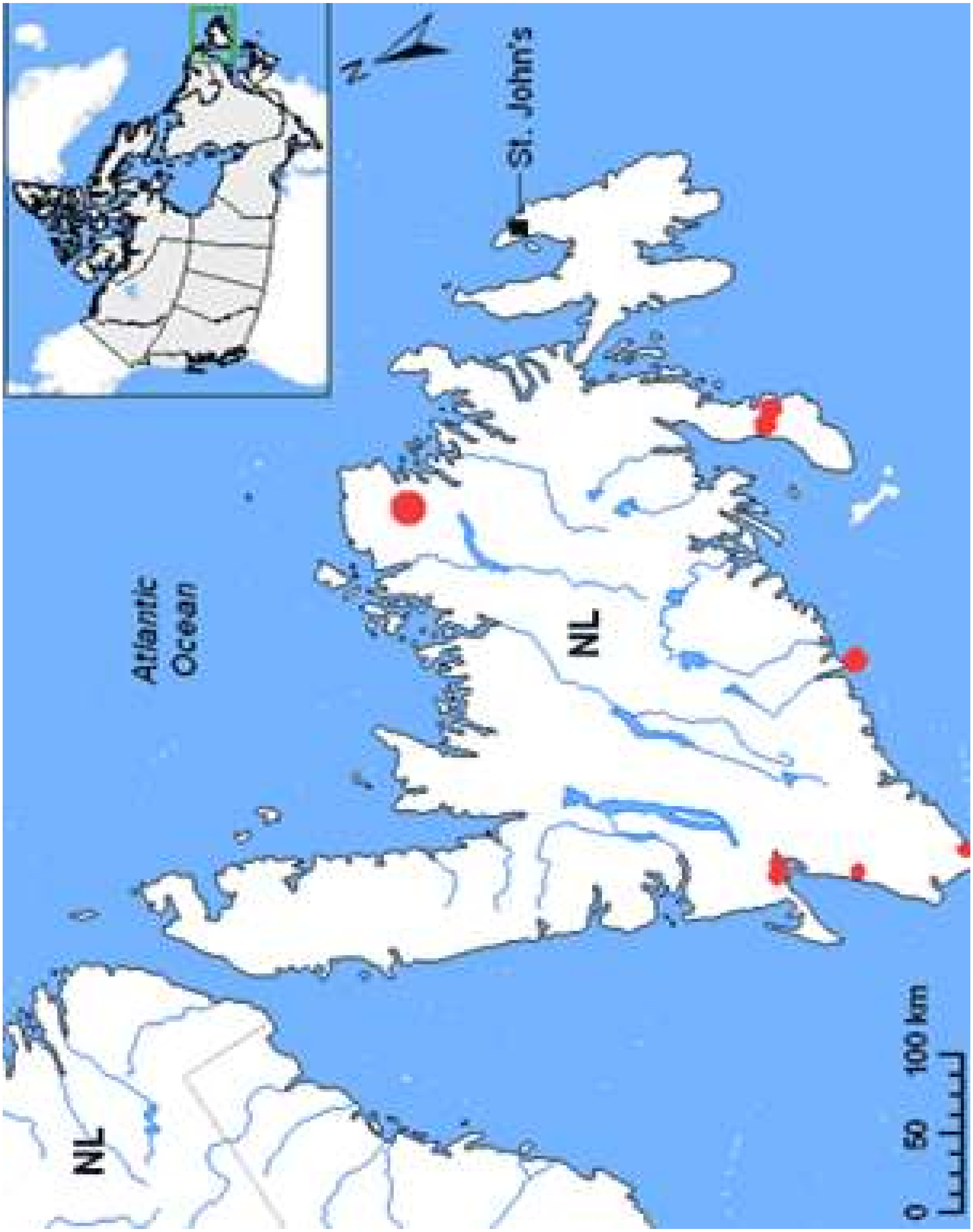
http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=667

Woodland caribou (*Rangifer tarandus caribou*)



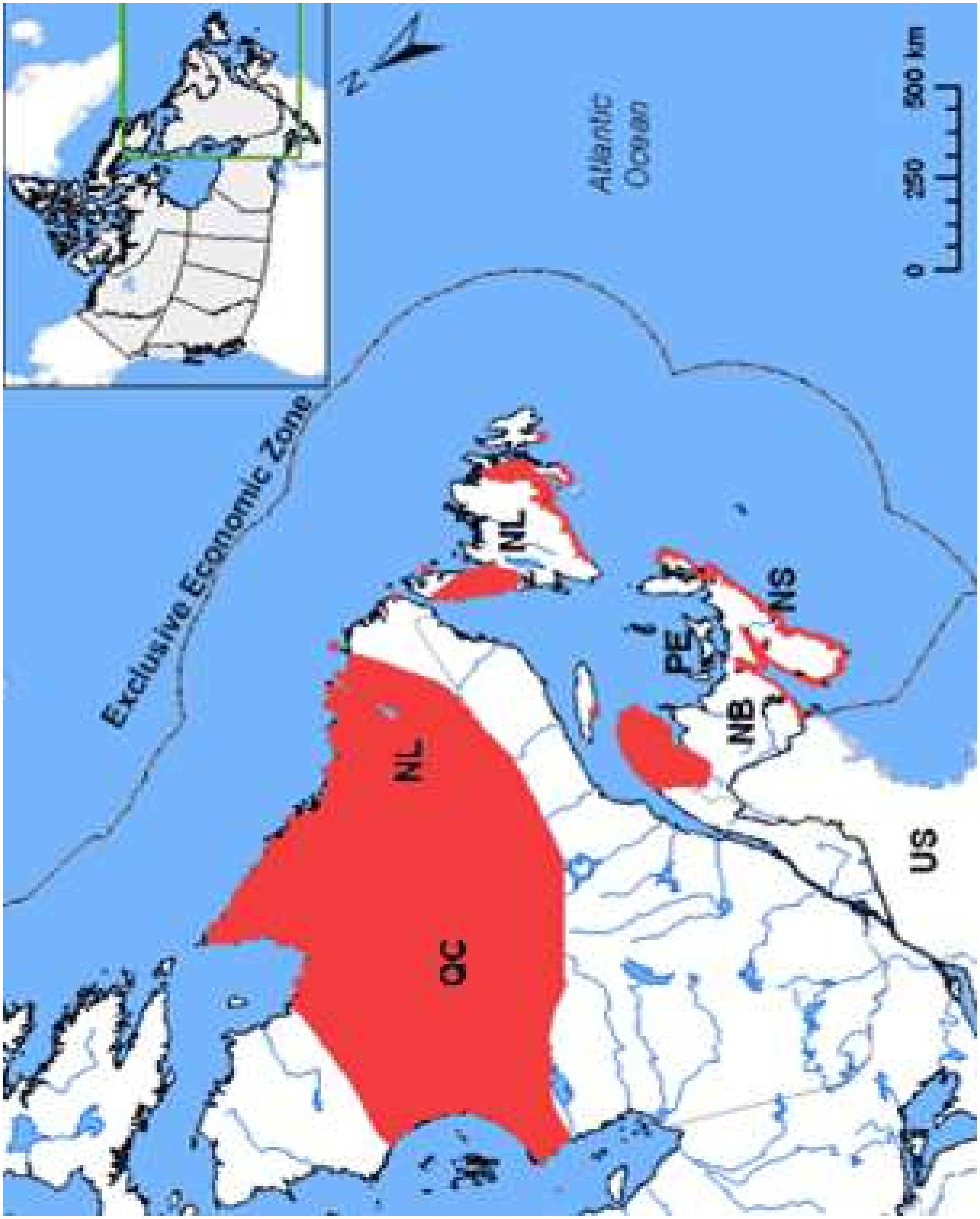
http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=636

Banded killfish (*Fundulus daiphanious*)



http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=85

Harlequin duck (*Histrionicus histrionicus*)



http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=22

Short eared owl (*Asio flammeus*)

http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/short_eared_owl.pdf

Harbour porpoise (*Phocoena phocoena*)

http://www.hww.ca/hww2.asp?id=380

APPENDIX F

Surficial Geology, Bedrock Geology & Hydrogeology

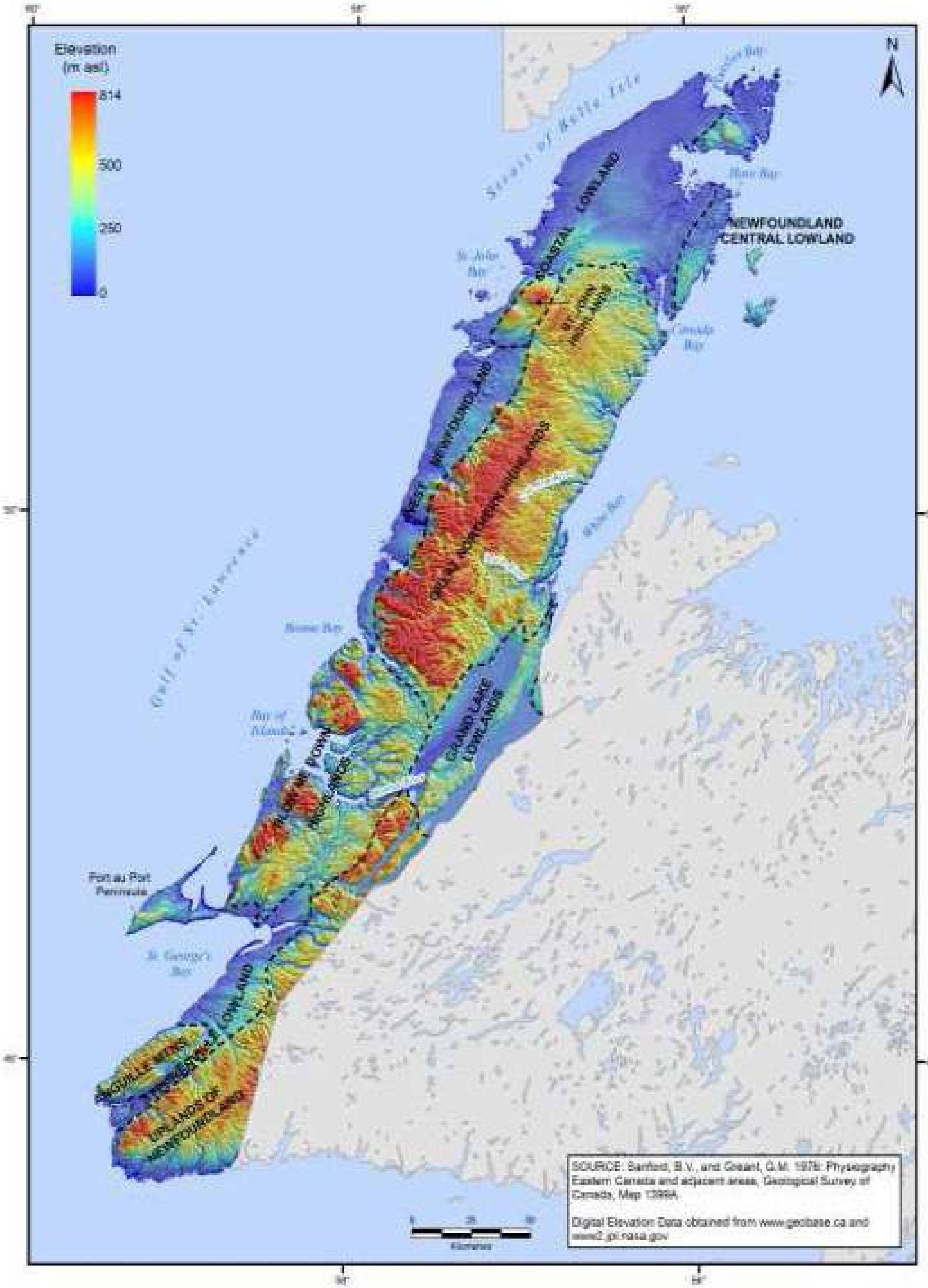


Figure 2.1: Relief and Physiographic Divisions

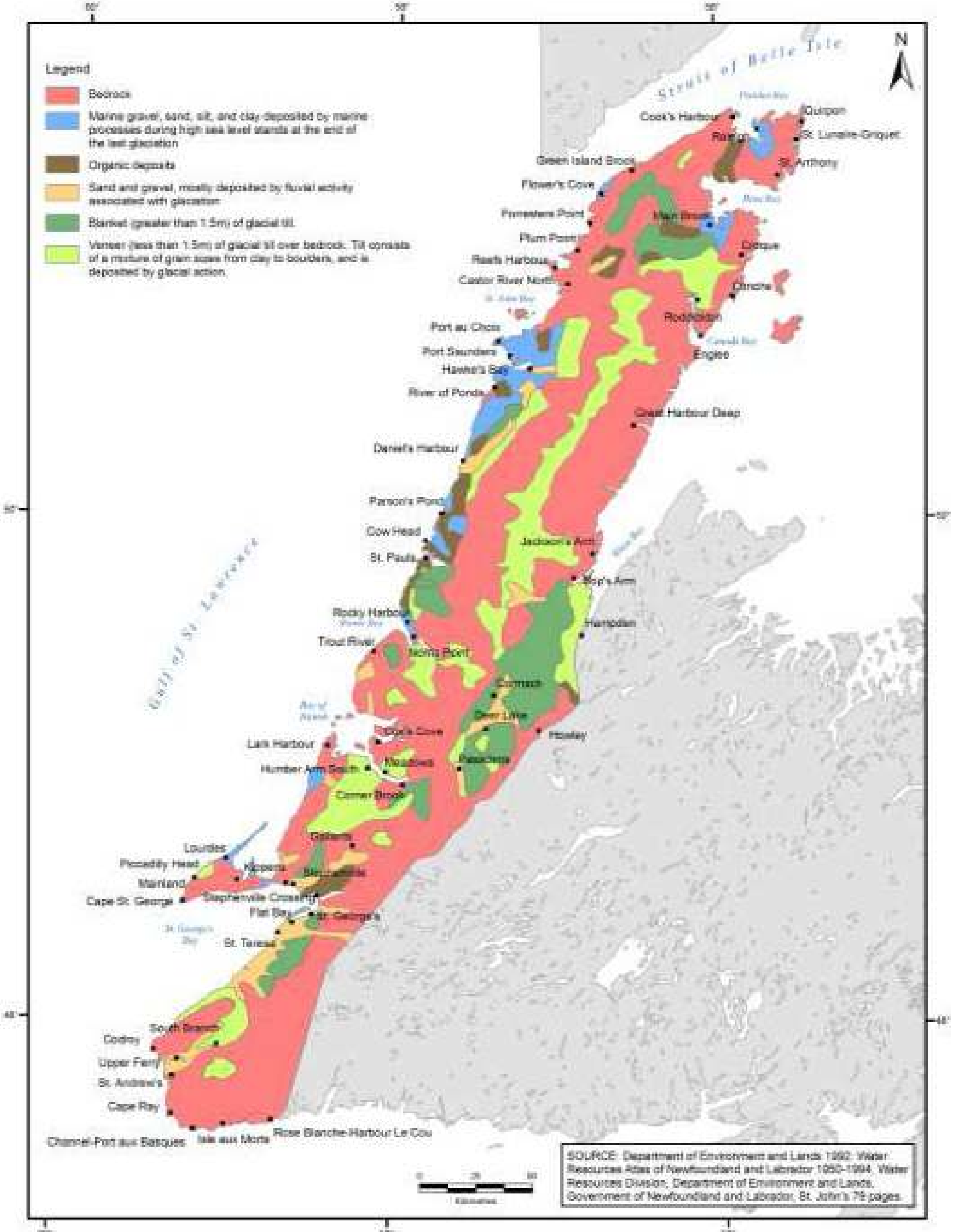


Figure 3.1: Generalized Surficial Geology of the Study Area

Figure 5.1: Drainage Divisions Covering the Study Area

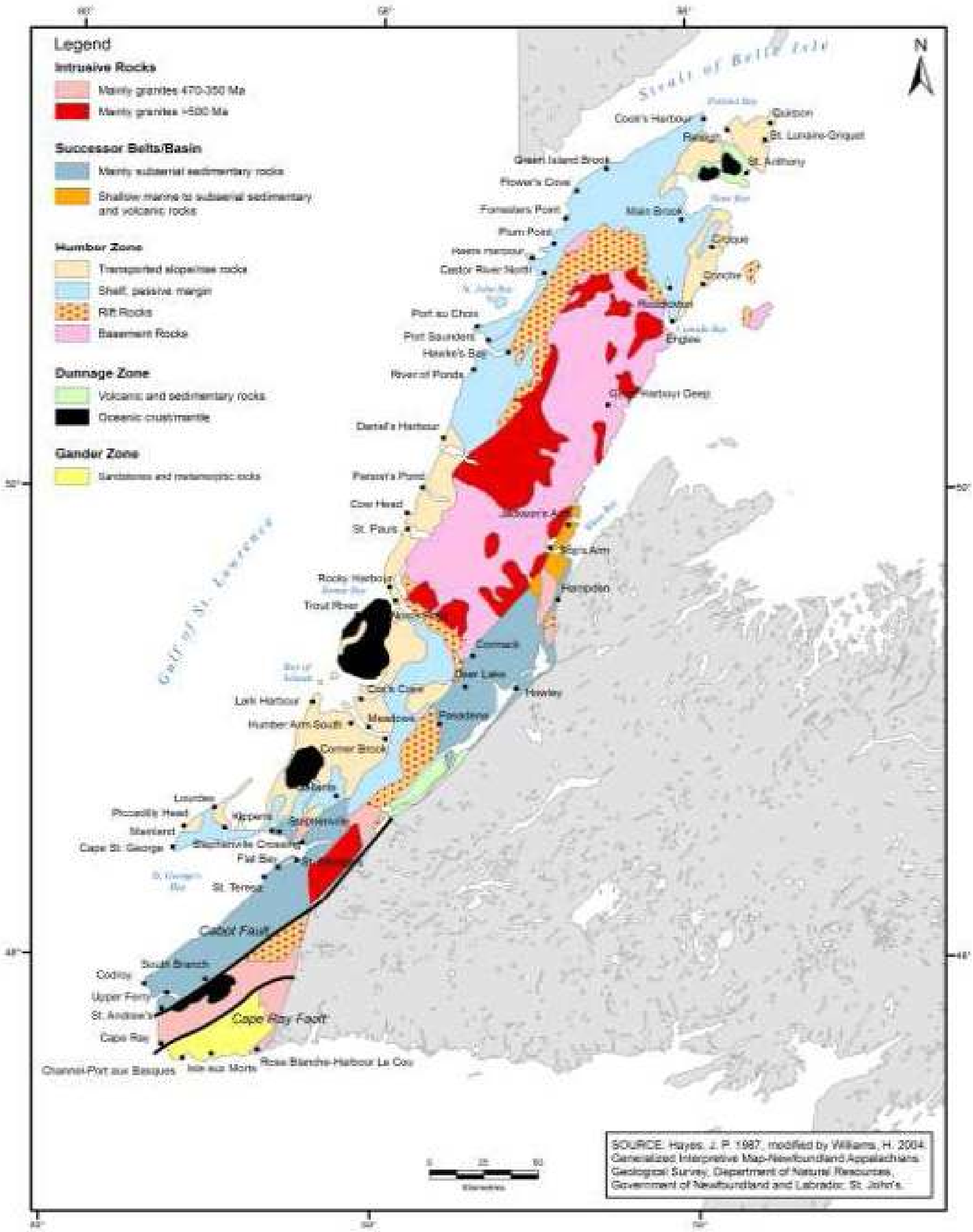
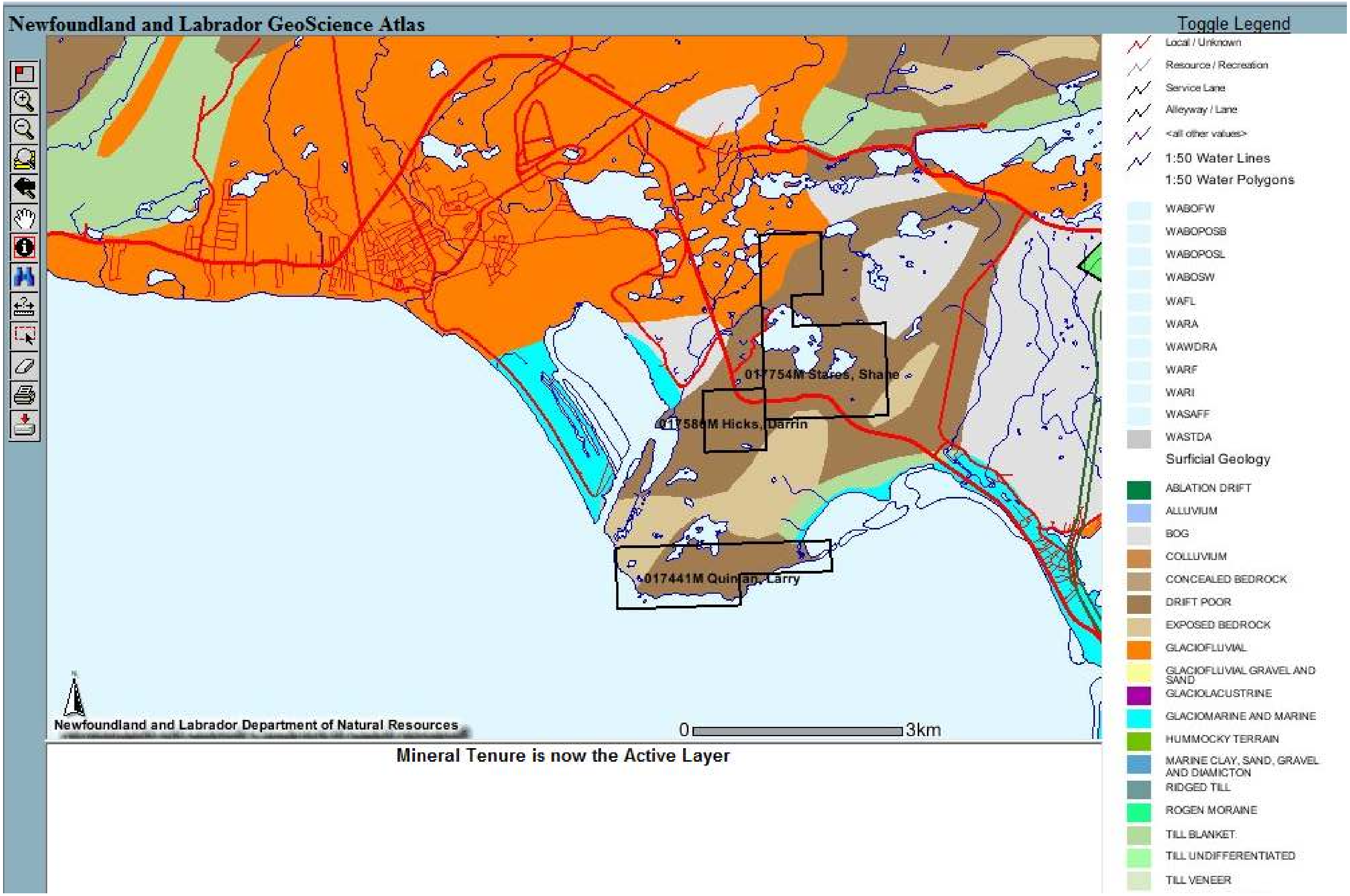


Figure 3.2: Generalized Bedrock Geology of the Study Area



Newfoundland and Labrador GeoScience Atlas
Toggle Legend
Local / Unknown
Resource / Recreation
Service Lane
Alleyway / Lane
<all other values>
1:50 Water Lines
1:50 Water Polygons
WABOFW
WABOPOSB
WABOPOSL
WABOSW
WAFL
WARA
WAWDRA
WARF
WARI
WASAFF
WASTDA
Surficial Geology
ABLATION DRIFT
ALLUVIUM
BOG
COLLUVIUM
CONCEALED BEDROCK
DRIFT POOR
EXPOSED BEDROCK
GLACIOFLUVIAL
GLACIOFLUVIAL GRAVEL AND SAND
GLACIOLACUSTRINE
GLACIOMARINE AND MARINE
HUMMOCKY TERRAIN
MARINE CLAY, SAND, GRAVEL AND DIAMICTON
RIDGED TILL
ROGEN MORAINE
TILL BLANKET
TILL UNDIFFERENTIATED
TILL VENEER
017441M Quinlan, Larry
Newfoundland and Labrador Department of Natural Resources
0
3km
Mineral Tenure is now the Active Layer