APPENDIX A: INDIAN HEAD HATCHERY 2011 ENVIRONMENTAL REGISTRATION AND RELEASE

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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Environment and Conservation
January 27, 2011

Environmental Assessment Bulletin

The Honourable Ross Wiseman, Minister of Environment and Conservation, has announced the following events relative to Part 10 Environmental Assessment of the Environmental Protection Act.

UNDERTAKINGS RELEASED:

Garnish to Point Rosie All Terrain Vehicle (ATV) Trail
Proponent: Garnish-Point Rosie Trail Association Inc. (Reg. 1535)

Crown Districts 17 & 18 Five Year Operating Plan (2008-2012) Amendment
Proponent: Department of Natural Resources (Reg. 1541)

Stephenville Indian Head Salmon Hatchery Revised
Proponent: Northern Harvest Sea Farms Newfoundland Ltd. (Reg.1544)

The project is released from further environmental assessment subject to the following conditions:

- A satisfactory full scale hydrogeologic assessment of the proposed groundwater source is required and shall be carried out by a qualified hydrogeologic professional. The full extent of the influence of the proposed water use on the aquifer needs to be evaluated in this assessment in order to ensure that there are no long-term negative effects on water quality or quantity from this source. This hydrogeologic assessment is to be submitted and approved by the Minister of Environment and Conservation.

- A groundwater monitoring program must be implemented by Northern Harvest Sea Farms Newfoundland Ltd. to monitor water levels and water quality. The program must be approved by the Water Resources Management Division (WRMD). Water level data shall be collected continuously using a recording data logger, and selected water quality parameters will be collected weekly, with monthly and annual reports submitted to this department for review for a period of at least two years. The format, content and quality of all reports must be approved by WRMD. Extension of the monitoring and reporting beyond two years will be at the discretion of the Minister of Environment and Conservation.

- Northern Harvest Sea Farms Newfoundland Ltd. will be required to enter into a Memorandum of Understanding with the Department of Environment and Conservation for the installation of a real time water quality and quantity monitoring network to monitor water levels and selected quality parameters. The type, number and location of the stations required will depend on site conditions and final operation plans. The proponent is to bear all costs associated with the groundwater monitoring network and must install the required network prior to the start of operation.

- A health and safety plan is required if any excavation is going to take place in subsurface soil (below 1 metre depth) in the areas of identified or potential contamination. In addition, workers should be made aware of the contamination and be required to wear personnel protective equipment to minimize potential exposure to contaminants.

For further information on the environmental assessment process, please contact the Director of Environmental Assessment at (709) 729-4211 or toll-free: 1-800-563-6181 or by mail to:

Director, Environmental Assessment Division
Department of Environment and Conservation
West Block, Confederation Building
P.O. Box 8700, St. John's, NL, A1B 4J6

Environmental assessment information is on the department Web site at http://www.gov.nl.ca/env

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Media contact:
Melony O'Neill
Director of Communications
Department of Environment and Conservation
709-729-2575; 689-0928
moneill@gov.nl.ca

APPENDIX B: FRESHWATER AQUIFER TESTING

Please note that these reports were commissioned by MHAC prior to the purchase of NHS.

1. Assessing the Capacity of the Local Groundwater Aquifers 3113-003
2. Aquifer Well Testing 3113-006

Fracflow Consultants Inc.

Environmental, Hydrogeological and
Geotechnical Engineering Consultants

TECHNICAL MEMORANDUM

TO: Dean Guest, Marine Harvest Atlantic Canada FFC-NL-3113-003

FROM: Fracflow Consultants Inc.

DATE: January 17, 2018

SUBJECT: **Progress Report: Assessing the Capacity of the Local Groundwater Aquifers to Support the Long Term Water Supply Needs of a New Fish Hatchery – Stephenville, NL - Monitoring Wells, Water Table, Water Chemistry and RFP for Test Well.**

Background

In 2009, Fracflow conducted an initial hydrogeological assessment of an area adjacent to the Port of Stephenville (Port Harmon) to determine the potential for developing a water supply for a proposed fish hatchery (Northern Harvest Sea Farms) which was subsequently constructed. The 2009 assessment consisted of augering three (3) boreholes and constructing three (3) monitoring wells and drilling a 15-cm diameter, screened, test water well to determine the approximate groundwater yield from the aquifer. The aquifer was found to consist of sands and gravels to some unknown depth, greater than 60 m, and to have a high permeability. However, the vertical overburden column included a low permeability paleosurface surface, locally, at approximately 5 m to 6 m below ground surface which impedes local groundwater recharge and creates a perched water table. The actual water table is approximately15 m below the ground surface. Fracflow recommended that a 3D model should be constructed and used to simulate the groundwater system as a basis for assessing the long term groundwater yield for this area given the lack of detail on the aquifer thickness and distribution and the known areas of environmental impact from the US air force activities and the linerboard mill, in the form of old landfills and oil spills as defined by Fracflow's 2006 and 2009 Phase 1 and Phase 2 work for Abitibi in this area.

Existing Fish Hatchery Water Supply Wells

The 3D model work was never completed but the water supply wells for the fish hatchery were constructed (**Figure 1**) and have been in operation for a number of years. The details of the water well construction and pumping rates for two years (**Figure 2**) have been provided to Fracflow. However, the drawdowns and any long term changes in water levels in the production wells are not known but the owner has noted that the frequency settings on the variable frequency drives that control and operate the water supply pumps have had to be increased in recent months to maintain well yields. This may reflect a decrease in the overall water levels in the aquifer or

reduced well yield efficiency due to plugging of the well screens or a combination of both conditions. Monitoring of groundwater levels in the aquifer is limited to measuring water levels (**Figure 3**) on a monthly basis in one monitoring well that is located near the top of the raised plateau (MW5 in **Figure 4**) and this monitoring well has not shown any large changes in groundwater levels over the period of measurement.

3D Flow and Transport Model Boundaries

The 3D model that was constructed in 1999 for the Town of Stephenville was based on MODFLOW, a finite difference code and did not include the area of the existing fish hatchery well field or the potential sites of water supply wells for a new fish hatchery. A comprehensive groundwater flow model is being constructed to refine the watershed boundaries, and provide a basis for developing a well field protection plan for the existing and new well fields, that includes the simulation of different operational scenarios for the existing pumping wells, identifying the location of and simulating withdrawal from new production wells to establish a reasonable estimate of the long term well yields for the aquifer system in the fish hatchery area. This model is an update of the Stephenville-Kippens model and included extending the boundaries (**Figure 5**) of the existing model to the local drainage boundaries to the east to include Mine Pond and the old Abitibi landfills and part of their up-gradient drainage basins.

The model has been constructed using the finite element model FEFLOW which is a well-known commercial finite element flow and transport modeling software. Unlike the finite difference code, the finite element approach is more suited to simulate multiple production and observation wells because the mesh around the wells is refined locally resulting in a significantly smaller number of number of grid points and simulation time than the finite difference code. In addition, the model area in the revised model has been extended to a broader area to capture the more extensive watershed boundaries and to enable the assessment of how the different proposed well field locations and withdrawal rates may impact the yield from existing well fields or wells and the long-term yield from other water supply areas. Development of the larger aerial model allows the historical well field performance data from the existing well fields to be used to calibrate the model and to confirm whether or not the individual well fields interact and by doing so, provide an assessment of the overall groundwater capacity for the general area. Based on the calibrated flow model under the current condition of the groundwater system of the well fields, the impact of any potential contaminates such as the leachate from the abandoned and active landfills will be re-evaluated using the transport model by calculating travel time to the pumping wells.

Water Table Variations

The first step in assessing the local groundwater potential was to determine the nature of the recharge to the aquifer by determining the water table gradient. Given the lack of water table elevation data, three new monitoring wells were constructed (BH1, BH2 and BH3 in **Figure 4**). The logs for these three boreholes are provided in **Appendix A**. The water level in BH1 was 19.17 m bgs, 19.51 m bgs in BH2 and 11.95 m in BH3. The water table elevation, below the perched water table, was 12.275 m in BH1, 12.277 m in BH2 and 16.186 m in BH3. An additional 11 existing monitoring wells were surveyed by Enos Fudge Surveys and the water

table elevations were measured in those wells (**Figure 4**). These water table measurements show that there is a water table gradient of approximately 0.004, oriented NNE to SSW with the main recharge area located north of the main bog area. However, it is expected that while the bog and ponds constitute a perched water table system, there is some recharge from this perched water table to the deeper groundwater system.

Groundwater Chemistry

Groundwater samples were collected from the three new monitoring wells and from the two main water supply wells for the existing fish hatchery. The water was analyzed for general chemistry, total and dissolved metals and low level BTEX/TPH. The laboratory data are presented in **Appendix B**.

The ground water samples showed consistent water chemistry, typical TDS, fluid conductivity and pH values for the groundwater in this immediate area. The total iron levels in BH2 and BH3 are elevated which is consistent with the higher turbidity levels in these two monitoring wells. The dissolved iron levels are not elevated. It is expected that when a water supply well is full developed, the turbidity levels will decrease and the total metals iron levels will also decrease to an acceptable level.

Each sample was analyzed for BTEX/TPH using a low level detection approach and no detectable BTEX/TPH was reported. BH1 showed a Fluoride concentration that was 0.16 mg/L versus the Fresh Water Aquatic Guidelines of 0.12 mg/L. Since the laboratory measured value is very close to the detection level, Fracflow will resample this monitoring well to see if one can determine if the Fluoride is still present in the groundwater and if so the source of the Fluoride.

Aquifer Properties – Grain size distributions and Estimate Hydraulic Conductivities

Each borehole was completed using hollow stem augers and split spoon samples were collected at regular intervals. The aquifer material in those samples consists of fine sand, some silt or clay particles, gravel with some cobbles and occasional boulders. The split spoon samples that were collected from below the water table were analyzed and the grain size distribution determined. The grain size data are included in **Appendix C** and show that nearly all of overburden samples that were collected from below the water table had grain sizes such that 50% of the grain diameters were greater than 0.5 mm. The grain size data are used to determine the slot size for screened wells since the general approach is to allow for 50% of the aquifer particles to pass through the well screen during well development in order to develop a natural gravel pack around the well screen. Based on these grain size distributions, a slot 20 is a suitable slot size for a well screen when a natural gravel pack will be developed. If an artificial gravel pack is installed, using a #2 sand, then a slot 40 well screen can be utilized.

The grain size data were used to compute the hydraulic conductivity values for the split-spoon samples that were collected below the water table using the Hazen method (Fetter, 2001) as,

$$K = C(d_{10})^2$$

where K is hydraulic conductivity (cm/s), d_{10} is the effective grain size (cm), and C is a coefficient with a range as shown in **Table 1**. The method is generally applicable for sand with the effective grain size ranged from 0.01 cm to 0.3 cm. The effective grain size from the eleven (11) analyzed samples ranged from 0.007 cm to 0.012 cm and the computed hydraulic conductivity values ranged from 4.41E-03 to 1.44E-02 cm/s (**Table 1**).

Table 1 Hydraulic conductivities calculated from the grain size distribution data using the Hazen method.

Sample ID	d_{10}		d_{60}	$C^{(1)}$	K		C_{min}	C_{max}	K_{min}	K_{max}
	mm	cm	mm	--	cm/s	m/s	--	--	cm/s	cm/s
BH1-SS14	0.089	0.0089	0.6	90	7.13E-03	7.13E-05	80	120	6.34E-03	9.51E-03
BH1-SS15	0.094	0.0094	2	90	7.95E-03	7.95E-05	80	120	7.07E-03	1.06E-02
BH1-SS17	0.07	0.007	0.6	90	4.41E-03	4.41E-05	80	120	3.92E-03	5.88E-03
BH2-SS17	0.113	0.0113	0.675	100	1.28E-02	1.28E-04	80	120	1.02E-02	1.53E-02
BH2-SS18	0.088	0.0088	0.7	110	8.52E-03	8.52E-05	80	120	6.20E-03	9.29E-03
BH2-SS19	0.092	0.0092	0.95	90	7.62E-03	7.62E-05	80	120	6.77E-03	1.02E-02
BH2-SS20	0.105	0.0105	0.85	100	1.10E-02	1.10E-04	80	120	8.82E-03	1.32E-02
BH3-SS13	0.097	0.0097	0.35	90	8.47E-03	8.47E-05	80	120	7.53E-03	1.13E-02
BH3-SS15	0.12	0.012	0.63	100	1.44E-02	1.44E-04	80	120	1.15E-02	1.73E-02
BH3-SS18	0.092	0.0092	0.565	100	8.46E-03	8.46E-05	80	120	6.77E-03	1.02E-02
BH3-SS20	0.09	0.009	0.685	110	8.91E-03	8.91E-05	80	120	6.48E-03	9.72E-03

Slug tests (falling head test) were conducted in the three boreholes, BH1, BH2 and BH3 on November 27, 2017. The hydraulic conductivities were calculated using the Hvorslev method (Fetter, 2001) as,

$$K = \frac{r^2 \, ln(L_e/R)}{2 \, L_e \, T_0}$$

where K is hydraulic conductivity (L/T; m/s), r is the radius of the well casing (L; m), R is the radius of the well screen (L; m), L_e is the length of the well screen (L; m), and T_o is the time it takes for the water level to rise or fall to 37 percent of the initial change (T; sec). The above

formula applies when the length of the piezometer/well screen is more than eight (8) times the radius of the well screen ($L_e/R > 8$) and the ratio was greater than 300 for the three boreholes, BH1, BH2 and BH3. The time to fall to 37 percent (T_o) of the initial change ranged from 5 to 10 seconds for the three slug test, and the computed hydraulic conductivities ranged from 1.16E-02 cm/s to 2.10E-02 cm/s (**Table 2**).

Table 2 Hydraulic conductivities calculated from the slug tests using the Hvorslev method.

Borehole ID	***Hydraulic Conductivity (K)***	
	cm/s	***m/s***
BH1	2.10E-02	2.10E-04
BH2	1.49E-02	1.49E-04
BH3	1.16E-02	1.16E-04

Summary and Conclusions

1. A water table gradient of 0.004 with a NNE-SSW direction was mapped indicating that the main area of recharge to the aquifer is located north of the existing NHSF fish hatchery water supply wells.

2. The shape of the original NHSF aquifer test curves suggests that some recharge is taking place from the perched water table that underlies the bog/marshland area.

3. The water levels in the aquifer around the NHSF water supply wells based on the data from one monitoring well do not show any long term changes for the records that were available

4. Withdrawal rates for the NHSF water supply wells have averaged approximately 400 to 450 USGPM for most of the two year period for which we have records. For one five to six day period, the withdrawal rates were increased to approximately 1,000 USGPM with no long term impact on groundwater levels in the monitoring well.

5. The water level in one monitoring well that is located between the NHSF water supply wells and the harbour shoreline is several metres above sea level, demonstrating that withdrawals from the NHSF water supply wells have not reversed the hydraulic gradient and that groundwater is continuing to be discharged to the harbour.

6. The three new monitoring wells that were constructed to map the water table encountered sands with minor gravel and occasional boulders to depths of up to 40 m below ground surface. Hydraulic conductivity (K) values that range from 4.41E-05 m/s to 1.1E--04 m/s were computed from the grain size data.

7. Falling head tests in the three new monitoring wells gave K values that range from 7.88E-04 m/s to 1.01E-03 m/s.

8. The ground water samples showed a consistent water chemistry, typical TDS, fluid conductivity and pH values for the groundwater in this immediate area, with no detectable BTEX/TPH (low level), but BH1 showed a Fluoride concentration that was 0.16 mg/L versus the Fresh water Aquatic Guidelines of 0.12 mg/L. Since the laboratory measured value is very close to the detection level, Fracflow will resample this monitoring well to see if one can determine if the Fluoride is still present in the groundwater and if so the source of the Fluoride. The total iron levels in BH2 and BH3 are elevated which is consistent with the higher turbidity levels in these two monitoring wells. The dissolved iron levels are not elevated.

9. Based on the data obtained from the three new monitoring wells a 200 mm diameter test well has been designed, using a K-packer design, and a slot 20 well screen, with a potential depth of up to 80 m, depending on the depth to bedrock. Overburden samples will be collected as the borehole is advanced to confirm that the grain size data are consistent with the slot 20 well screens. The RFP for this test well is provided in **Appendix D**.

10. Depending on the depth to bedrock and the type of overburden near the bottom of the well, which determines both the available drawdown and the well yield, it is expected that each full size production well will produce approximately 500 USGPM or 2,000 litres per minute.

11. The 3D model boundaries have been defined with mesh refinement limited to the drainage basin in which the new water supply wells may be developed.

Reference

Fetter, C.W., 2001, *Applied Hydrogeology*. Fourth Edition, Prentice Hall.

Figure 1 Location of the existing production wells for the fish hatchery, Stephenville, NL

Project No.	Document Reference
3113	FFC-NL-3113-003
Location	**Date**
Stephenville, NL	December 2017

FFC

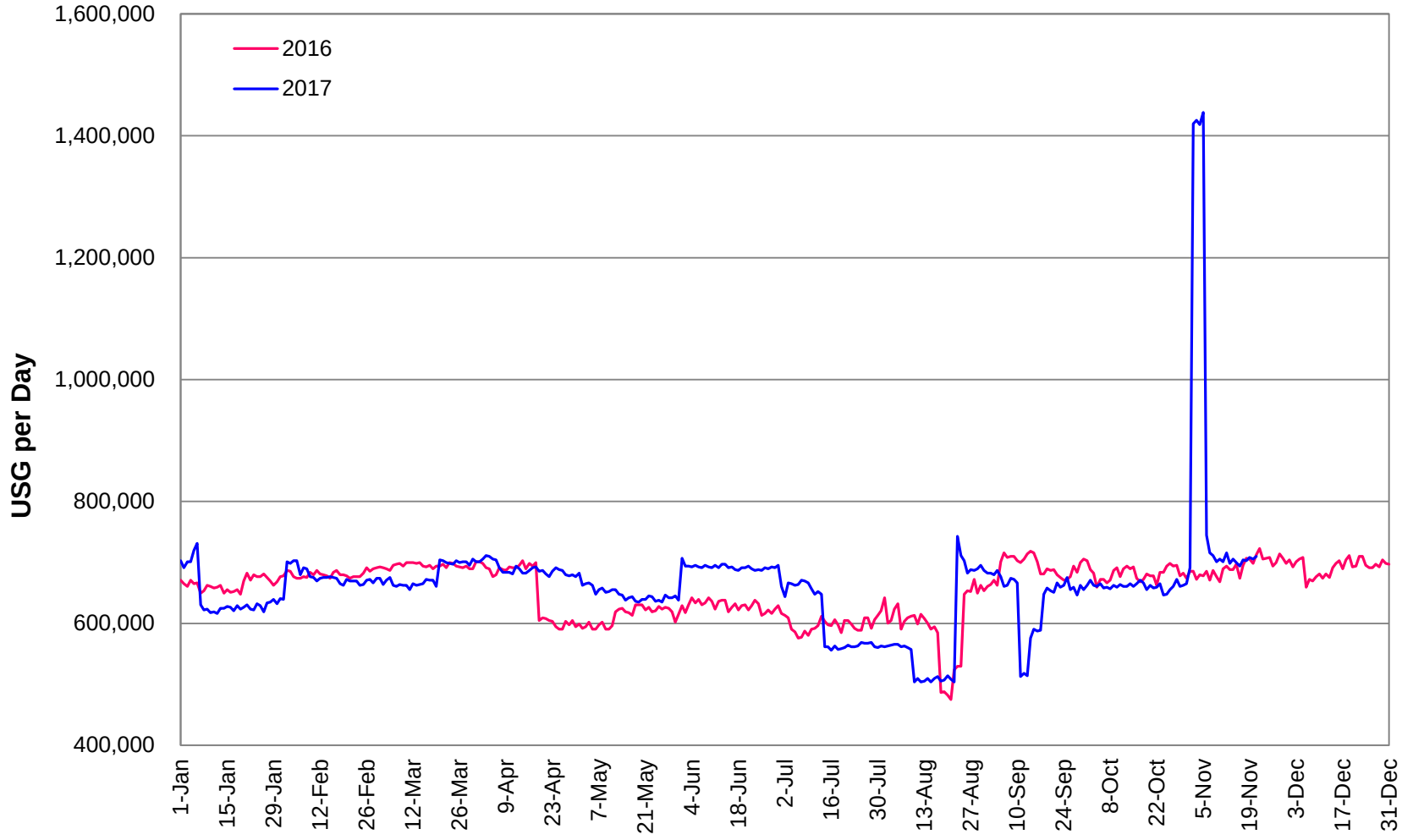

Figure 2 Northern Harvest Smolt overall daily water usage in 2016 and 2017.

Project No.	Document Reference
3113	FFC-NL-3113-003
Location	Date
Stephenville, NL	January 2018

FFC

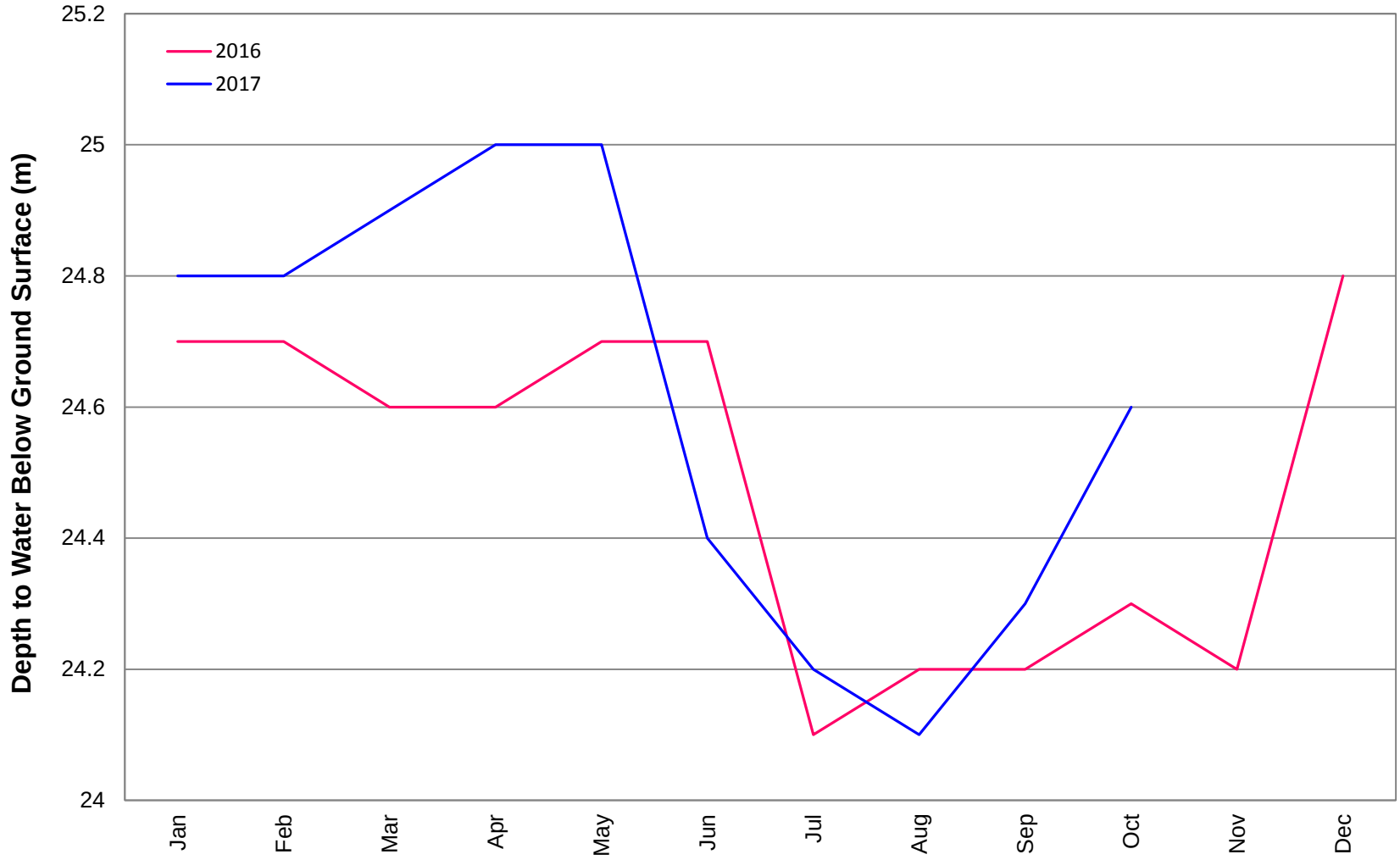

Figure 3 Northern Harvest Smolt depth to water below ground surface in 2016 and 2017.

Project No.	Document Reference
3113	FFC-NL-3113-003
Location	Date
Stephenville, NL	January 2018

FFC

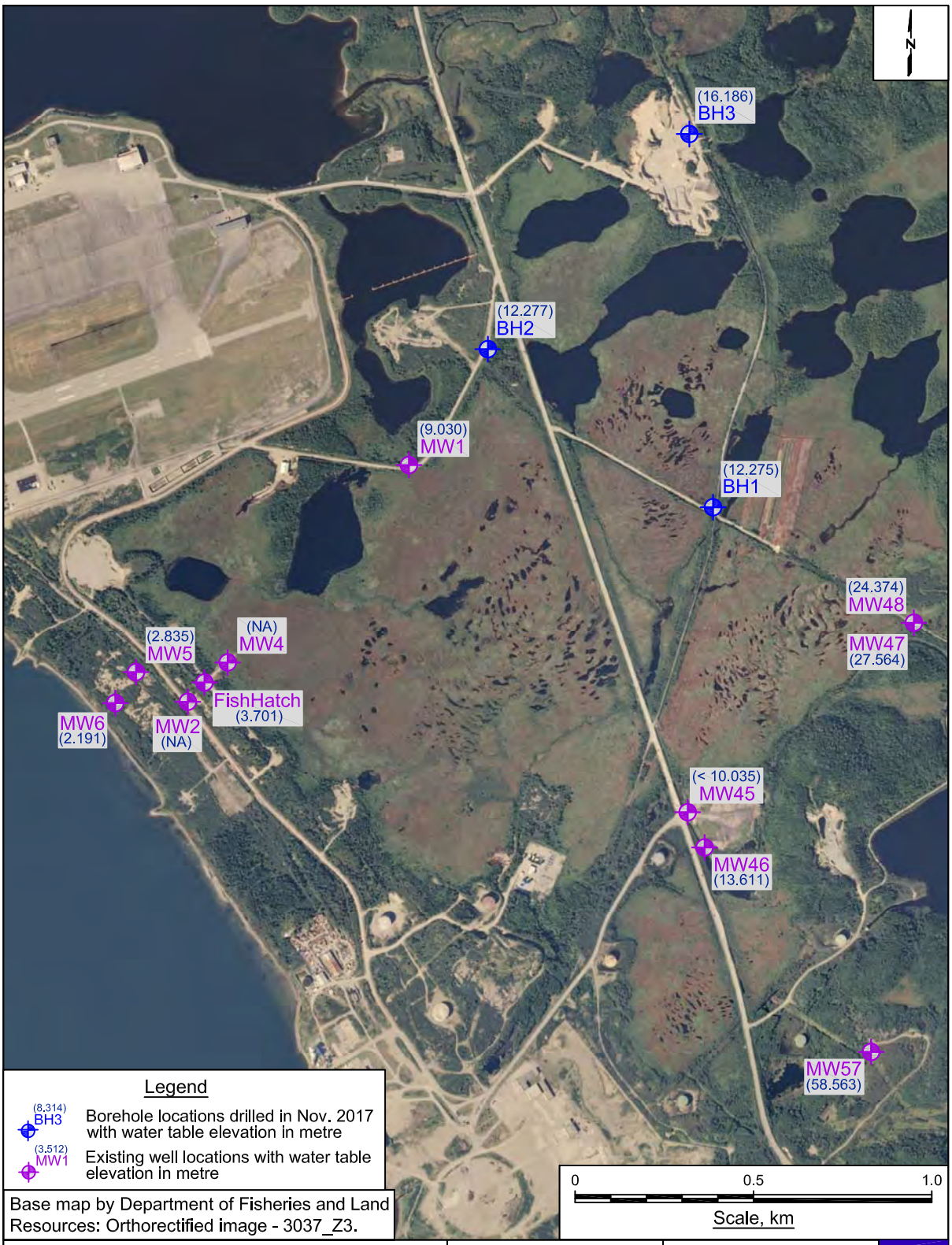

Figure 4 Location of the three boreholes drilled in Nov. 2017 and existing monitoring wells with water table elevations, Stephenville, NL

Project No.	Document Reference
3113	FFC-NL-3113-003
Location	Date
Stephenville, NL	December 2017

FFC

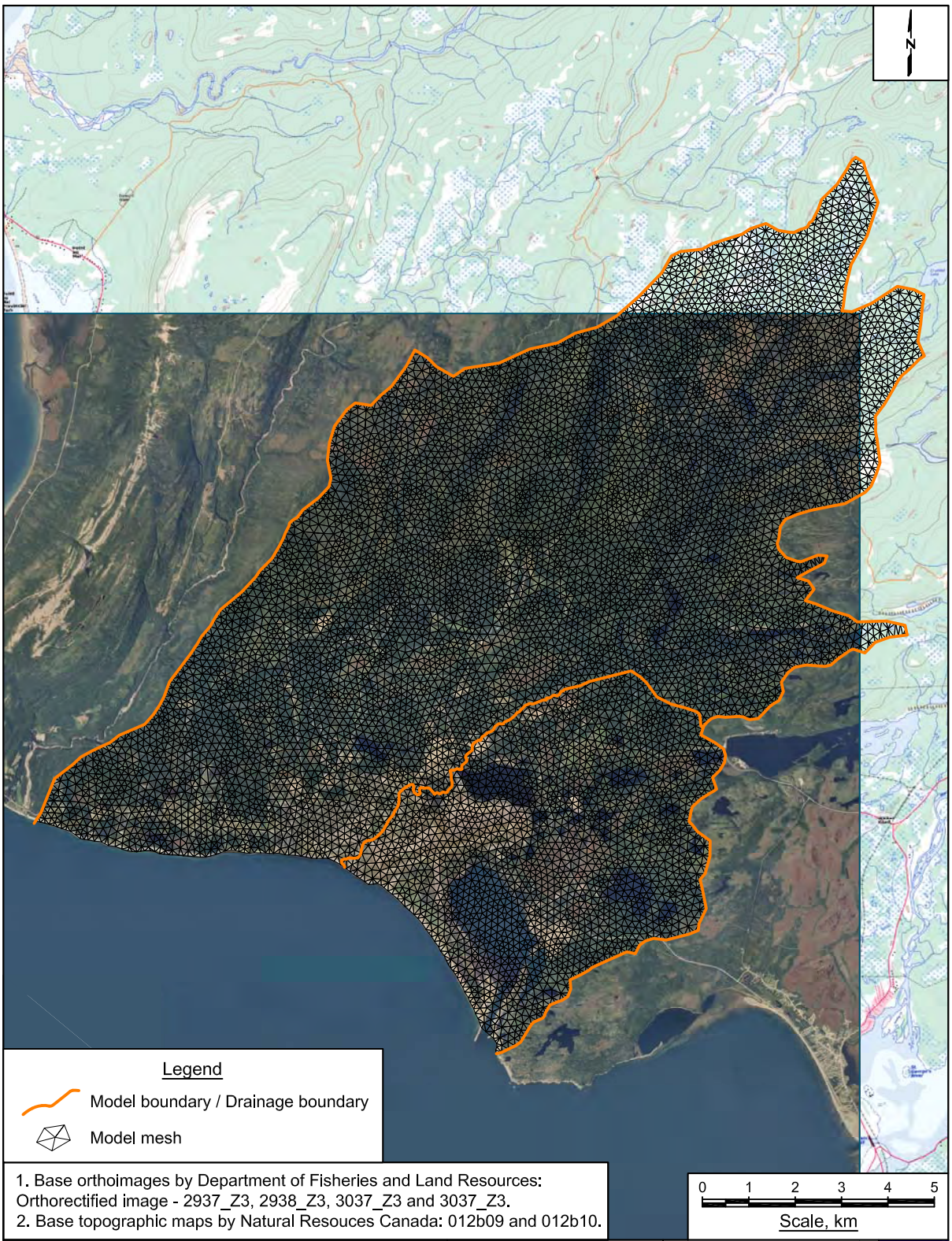

Figure 5 Drainage basin/model boundaries with coarse meshes for 3D hydrogeological model.

Project No.	Document Reference
3113	FFC-NL-3113-003
Location	**Date**
Stephenville, NL	January 2017

FFC

APPENDIX A

Borehole Logs

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Borehole: BH1

Project No: 3113

Date: November 16 - 19, 2017

SUBSURFACE PROFILE			SAMPLE							
Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data / Well Description
0 / 0		Ground Surface (GS)	31.4							Well head protection installed
1		Auger								Cement packing from 0.05 m to 0.46 m
2										Native sand packing from 0.46 m to 0.91 m
3 / 1										Bentonite packing from 0.91 m to 1.12 m
4			30							
5		SPT: 4 / 18 / 36 / 36 Wet, brown, medium sand		SS	1	54	31			
6 / 2			29.4							
7		Auger								0.05 m dia. riser from 0 m to 16.68 m
8										
9										
10 / 3			28.3							
11		SPT: 7 / 12 / 21 / 22 Damp, brown, medium sand with red and black particles		SS	2	33	52			
12			27.7							
13		Auger								
14 / 4										
15			26.9							Native sand packing from 1.12 m to 26.48 m
16		SPT: 13 / 16 / 19 /14 Damp,brown, medium sand		SS	3	35	25			
17 / 5			26.3							
18		Auger								
19										
20 / 6			25.4							
21		SPT: 10 / 39 / 27 / 16 No recovery		SS	4	66	0			
22			24.8							
23		Auger								

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Borehole: BH1

Project No: 3113

Date: November 16 - 19, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 / 60)	Well Data	Well Description
23											
24			23.9								
25		SPT: 7 / 25 / 53 / 53 Dry, brown, fine to medium sand with some rock fragments		SS	5	78	20				
26	8		23.3								
27		Auger									
28											
29											
30	9		22.4								0.05 m dia. riser from 0 m to 16.68 m
31		SPT: 43 / 52 for 0.03 m (Refusal) Brown and tan, fine sand with some rock fragments	22.2	SS	6	52	36				
32											
33	10	Auger									
34											
35			20.9								
36		SPT: 44 / 62 for 0.06 m (Refusal) Dry, grey and brown, fine sand with some rock fragments	20.6	SS	7	62	97				
37	11										Native sand packing from 1.12 m to 26.48 m
38		Auger									
39											
40	12		19.3								
41		SPT: 17 / 52 / 66 / 42 Dry, light grey to dark brown, fine sand with some coarse sand		SS	8	118	62				
42			18.7								
43	13	Auger									
44											
45			17.8								
46	14	SPT: 9 / 15 / 17 / 20 Dry, grey and some brown, fine sand with some rock fragments					41				

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Location: Stephenville, NL

Log of Borehole: BH1

Project No: 3113

Date: November 16 - 19, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 60)	Well Data	Well Description
46			17.2	SS	9	32	41				
47		Auger									
48											
49	15		16.2								Native sand packing from 1.12 m to 26.48 m
50		SPT: 10 / 12 / 15 / 13 Brown and grey, fine sand with some rock fragments		SS	10	27	54				
51			15.6								
52	16	Auger									
53			14.7								
54											
55		SPT: 9 / 17 / 17 / 16 Damp, brown, fine sand		SS	11	34	67				
56	17		14.1								0.05 m dia. screen from 16.68 m to 25.82 m
57		Auger									
58											
59	18		13.2								
60		SPT: 10 / 18 / 17 / 15 Dry, grey and brown, fine sand		SS	12	35	58				
61			12.6								
62	19	Auger									
63											19.17 m BGS (Nov. 27, 2017)
64			11.7								
65		SPT: 9 / 15 / 19 / 19 Wet, grey, very fine sand		SS	13	34	46				
66	20		11.1								
67		Auger									
68											
69	21										

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Log of Borehole: BH1

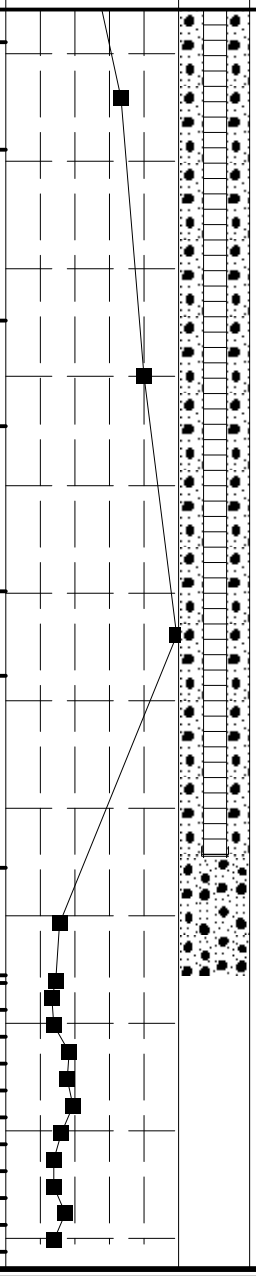
Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 16 - 19, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines
			10.3					
70		SPT: 12 / 28 / 39 / 18 CFEM: Sand, trace Gravel, trace Silt/Clay		SS	14	67	37	
71			9.65					
72	22	Auger						
73								
74			8.68					
75	23	SPT: 32 / 49 / 32 / 34 CFEM: Gravelly Sand, trace Silt/Clay		SS	15	81	33	
76			8.07					
77		Auger						
78								
79	24		7.14					
80		SPT: 29 / 54 / 67 / 52 for 0.03 m (Refusal) No recovery		SS	16	121	0	
81			6.66					
82	25	Auger						
83								
84			5.57					
85	26	SPT: 14 / 13 / 19 / 23 CFEM: Sand, some Silt/Clay, trace Gravel		SS	17	32	27	
86			4.97					
87		DCPT (Blow counts per 150 mm)		PC	--	27		
88				PC	--	28		
89	27			PC	--	37		
90				PC	--	36		
91				PC	--	39		
92	28			PC	--	33		
				PC	--	28		
				PC	--	28		
				PC	--	35		
				PC	--	28		



Well Description

0.05 m dia. screen from 16.68 m to 25.82 m

Native sand packing from 1.12 m to 26.48 m

Screw-on cap

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Driller: Formation Drilling Ltd.

Datum: Geodetic

Log of Borehole: BH1

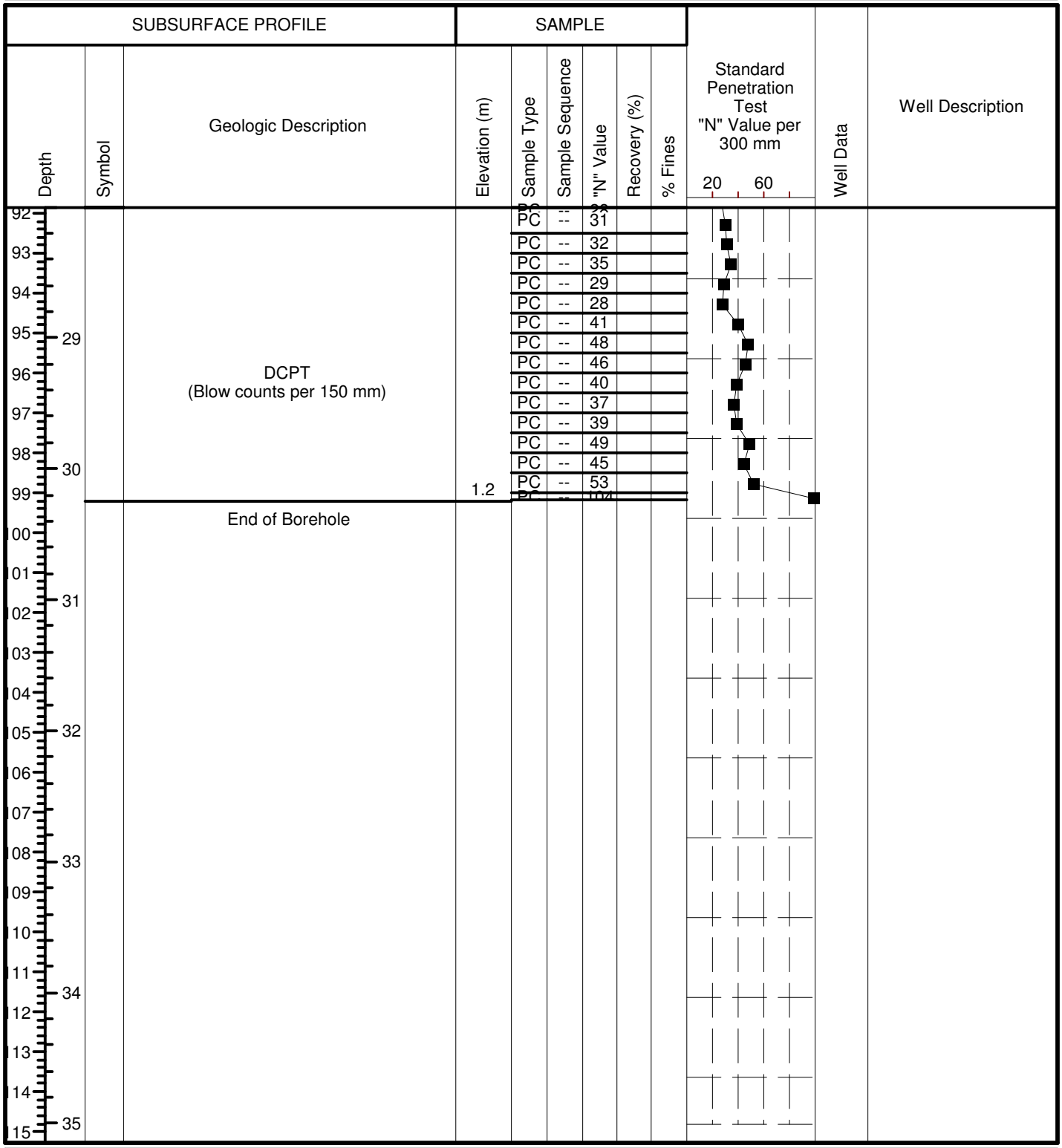
Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Project No: 3113

Date: November 16 - 19, 2017



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Sheet: 5 of 5

Log of Borehole: BH2

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Project No: 3113

Date: November 19 - 22, 2017

Depth (ft / m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Well Description
0 / 0		Ground Surface (GS)	31.8						Flush mount installed
		Auger	30.3						Cement packing from 0.1 m to 0.46 m
									Native sand packing from 0.46 m to 0.91 m
									Bentonite packing from 0.91 m to 1.52 m
5 / 1.5		SPT: 4 / 52 for 0.03 m (Refusal) Wet, dark brown coarse sand	30.1	SS	1	52	100		
		Auger	28.8						0.05 m dia. riser from 0 m to 15.76 m
10 / 3		SPT: 4 / 20 / 19 / 6 0 m - 0.31 m: damp, brown gravel with coarse sand with red and black particles 0.31 m - 0.56 m: wet, silt/clay	28.2	SS	2	39	92		
		Auger	27.3						Native sand packing from 1.52 m to 31.00 m
15 / 4.5		SPT: 5 / 6 / 6 / 5 Wet, brown 0 m - 0.15 m: medium sand 0.15 m - 0.25 m: silt/clay	26.7	SS	3	12	42		
		Auger	25.7						
20 / 6		SPT: 10 / 11 / 8 / 6 Wet, dark brown, medium sand with gravel	25.1	SS	4	19	23		
23 / 7									

Standard Penetration Test "N" Value per 300 mm (20 – 60)

Well Data

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Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 / 60)	Well Data	Well Description
23											
24		Auger	24.2								
25											
26	8	SPT: 11 / 18 / 19 / 10 Damp, light brown, medium sand	23.6	SS	5	37	8				
27											
28		Auger									
29			22.7								
30	9	SPT: 10 / 9 / 9 / 21 Damp, brown 0 m - 0.07 m: fine sand 0.07 m - 0.15 m: gravel with coarse sand		SS	6	18	25				0.05 m dia. riser from 0 m to 15.76 m
31			22.1								
32											
33	10	Auger									
34			21.2								
35											
36	11	SPT: 9 / 12 / 13 / 14 Damp, light brown, medium sand with red and black particles	20.6	SS	7	25	42				
37											
38		Auger									
39	12		19.6								Native sand packing from 1.52 m to 31.00 m
40											
41		SPT: 12 / 25 / 23 / 29 Damp, light brown, fine sand with gravel with red and black particles	19	SS	8	48	44				
42											
43	13	Auger									
44			18.1								
45											
46	14	SPT: 8 / 23 / 23 / 20 Dry, light brown, medium sand with red and black particles					56				

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Datum: Geodetic

Log of Borehole: BH2

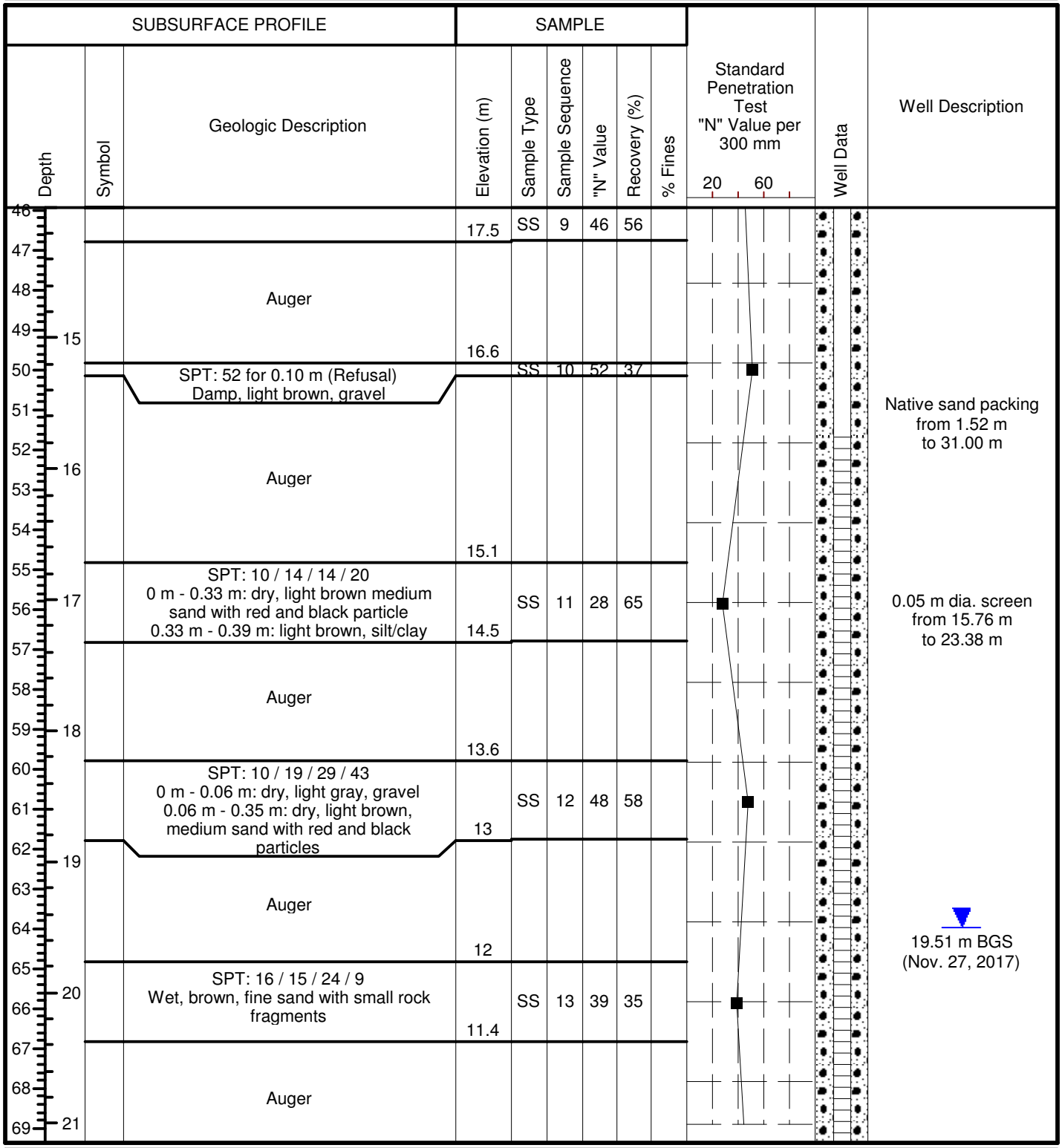
Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Project No: 3113

Date: November 19 - 22, 2017



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Date: November 19 - 22, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 / 60)	Well Data	Well Description
69			10.5								
70		SPT: 19 / 23 / 26 / 29 Wet, brown, fine sand with small rock fragments	9.87	SS	14	49	29				0.05 m dia. screen from 15.76 m to 23.38 m
72	22	Auger	8.98								
75	23	SPT: 31 / 19 / 24 / 33 Wet, brown, fine to medium sand	8.37	SS	15	43	46				Screw-on cap
77		Auger	7.44								
79	24	SPT: 15 / 20 / 39 / 50 Wet, brown, fine to medium sand with red and black particles	6.83	SS	16	59	42				
82	25	Auger	5.89								Native sand packing from 1.52 m to 31.00 m
85	26	SPT: 14 / 21 / 35 / 36 CFEM: Sand, trace Gravel, trace Silt/Clay	5.28	SS	17	56	42				
87		Auger	4.44								
90	27	SPT: 18 / 78 / 36 / 45 CFEM: Sand, trace Silt/Clay	3.84	SS	18	114	29				
92	28										

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Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 60)	Well Data	Well Description
92											
93		Auger									
94			2.9								
95	29	SPT: 35 / 38 / 34 / 27 CFEM: Sand, some Gravel, trace Silt/Clay		SS	19	72	23				
96			2.28								Native sand packing from 1.52 m to 31.00 m
97		Auger									
98	30		1.4								
99		SPT: 18 / 32 / 34 / 41 CFEM: Sand, trace Gravel, trace Silt/Clay		SS	20	66	46				
00			0.787								
01	31	DCPT (Blow counts per 150 mm)		PC	--	30					
02				PC	--	32					
03				PC	--	32					
04				PC	--	28					
05	32			PC	--	21					
06				PC	--	26					
07				PC	--	36					
08	33			PC	--	35					
09				PC	--	35					
10				PC	--	58					
11				PC	--	53					
12	34			PC	--	23					
13				PC	--	24					
14				PC	--	36					
15	35			PC	--	37					
				PC	--	31					
				PC	--	35					
				PC	--	44					
				PC	--	37					
				PC	--	38					
				PC	--	33					
				PC	--	36					
				PC	--	37					
				PC	--	46					
				PC	--	52					
				PC	--	50					
				PC	--	58					

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Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH2

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 19 - 22, 2017

SUBSURFACE PROFILE			SAMPLE								
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 60)	Well Data	Well Description
15				PC	--	58					
16				PC	--	53					
17				PC	--	43					
18	36			PC	--	48					
19				PC	--	57					
20				PC	--	40					
21				PC	--	38					
22	37	DCPT (Blow counts per 150 mm)		PC	--	57					
23				PC	--	56					
24				PC	--	71					
25	38			PC	--	57					
26				PC	--	58					
27				PC	--	62					
28	39			PC	--	57					
29				PC	--	61					
30				PC	--	57					
31	40			PC	--	60					
32				PC	--	56					
33				PC	--	62					
34				PC	--	79					
35	41			PC	--	103					
36			-6.52	PC	--	119					
37		End of Borehole									
42											

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Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd

Datum: Geodetic

Log of Borehole: BH3

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Project No: 3113

Date: November 23 - 26, 2017

Depth (ft)	Depth (m)	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 – 60)	Well Data	Well Description
0	0		Ground Surface (GS)	28.1								Well head protection Installed
			Auger	26.7								Cement packing from 0.05 m to 0.36 m Native sand packing from 0.36 m to 0.91 m Bentonite packing from 0.91 m to 1.52 m
6	2		SPT: 6 / 9 / 10 / 11 Dry, brown,coarse sand	26	SS	1	19	21				
			Auger	25.2								
10	3		SPT: 17 / 31 / 12 / 20 Medium to coarse sand with small rock fragments	24.6	SS	2	43	29				0.05 m dia. riser from 0 m to 12.21 m
			Auger	23.6								
15	5		SPT: 5 / 21 / 30 / 21 Dry, light brown gravel with coarse sand with red and black particles	23	SS	3	51	29				Native sand packing from 1.52 m to 32.71 m
			Auger	22.1								
20	6		SPT: 10 / 27 / 37 / 30 Dry, light brown, gravel with coarse sand	21.5	SS	4	64	27				
23												

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Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

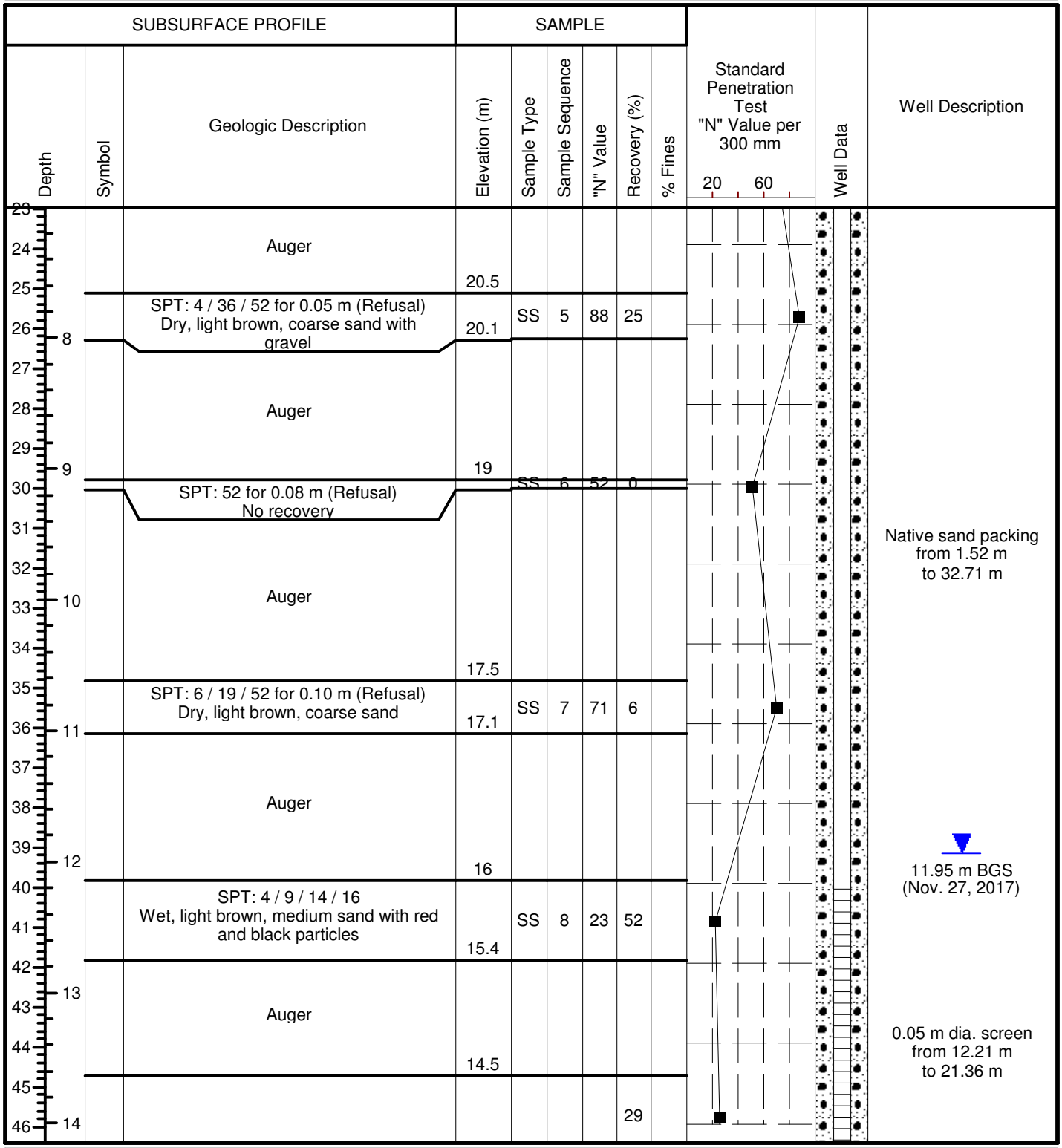
Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Borehole: BH3

Project No: 3113

Date: November 23 - 26, 2017



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Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 / 60)	Well Data	Well Description
46		SPT: 3 / 10 / 16 / 17 Wet, light brown with red and black particles 0 m - 0.05 m: fine to medium sand 0.05 m - 0.18 m: medium sand	13.9	SS	9	26	29				
47											
48											
49	15	Auger	12.9								
50											
51		SPT: 8 / 17 / 19 / 19 Wet, light brown with red and black particles 0 m - 0.18 m: fine sand 0.18 m - 0.23 m: medium sand	12.3	SS	10	36	37				Native sand packing from 1.52 m to 32.71 m
52	16										
53		Auger	11.5								
54											
55		SPT: 8 / 16 / 24 / 29 Wet, light brown, fine sand with red and black particles	10.8	SS	11	40	30				
56	17										
57		Auger	9.84								
58											
59	18										
60		SPT: 20 / 22 / 28 / 25 Wet, light brown, fine to medium sand with red and black particles	9.23	SS	12	50	67				0.05 m dia. screen from 12.21 m to 21.36 m
61											
62	19	Auger	8.46								
63											
64											
65		SPT: 7 / 15 / 21 / 16 CFEM: Sand, trace Silt/Clay	7.85	SS	13	36	54				
66	20										
67		Auger									
68											
69	21										

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL A1A 5A1
Phone: (709) 739-7270
Fax: (709) 753-5101

Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Log of Borehole: BH3

Project: Geotechnical Investigation

Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Project No: 3113

Date: November 23 - 26, 2017

Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 60)	Well Data	Well Description
69			6.88								
70		SPT: 3 / 10 / 13 / 17 Wet, light brown, fine to medium sand with red and white particles		SS	14	23	37				Screw-on cap
71			6.27								
72	22	Auger									
73											
74			5.44								
75		SPT: 6 / 12 / 18 / 25 CFEM: Sand, trace Silt/Clay		SS	15	30	33				
76	23		4.83								
77		Auger									
78											
79	24		3.84								
80		SPT: 2 / 8 / 13 / 14 Wet, brown, fine sand		SS	16	21	1				Native sand packing from 1.52 m to 32.71 m
81			3.23								
82	25	Auger									
83											
84			2.3								
85		SPT: 2 / 9 / 13 / 17 Brown, fine to medium sand with red and white particles		SS	17	22	29				
86	26		1.69								
87		Auger									
88											
89	27		0.809								
90		SPT: 15 / 15 / 20 / 27 CFEM: Sand, trace Silt/Clay, trace Gravel		SS	18	35	21				
91			0.199								
92	28										

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Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

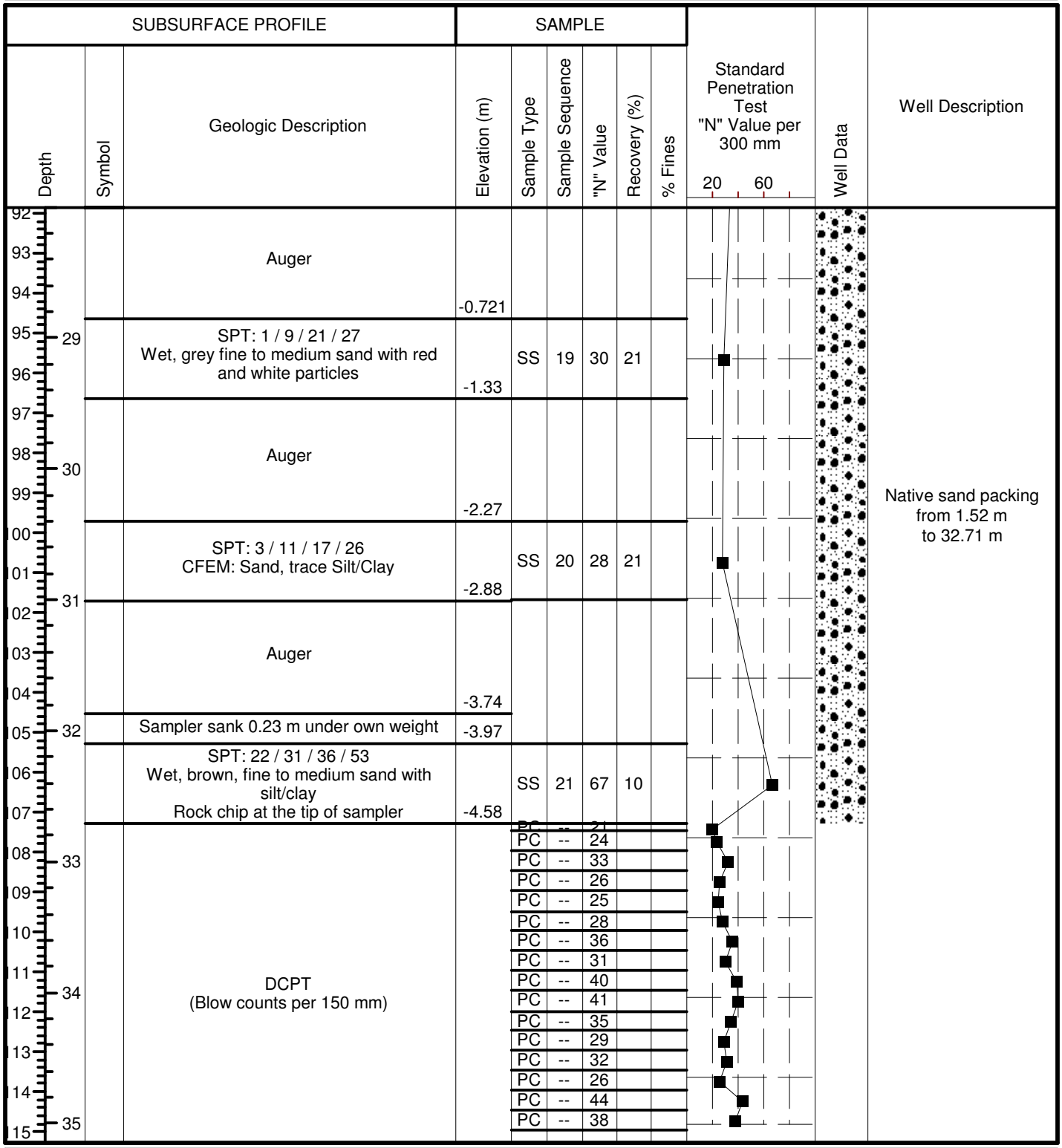
Client: Marine Harvest Atlantic Canada

Location: Stephenville, NL

Log of Borehole: BH3

Project No: 3113

Date: November 23 - 26, 2017



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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Marine Harvest Atlantic Canada

Project No: 3113

Location: Stephenville, NL

Date: November 23 - 26, 2017

SUBSURFACE PROFILE			SAMPLE								
Depth	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample Sequence	"N" Value	Recovery (%)	% Fines	Standard Penetration Test "N" Value per 300 mm (20 60)	Well Data	Well Description
15				PC	--	39					
16				PC	--	43					
17				PC	--	42					
18	36			PC	--	43					
19				PC	--	36					
20				PC	--	33					
21	37			PC	--	23					
22				PC	--	26					
23				PC	--	37					
24				PC	--	41					
25	38	DCPT (Blow counts per 150 mm)		PC	--	35					
26				PC	--	32					
27				PC	--	37					
28	39			PC	--	42					
29				PC	--	36					
30				PC	--	31					
31	40			PC	--	36					
32				PC	--	36					
33				PC	--	45					
34				PC	--	46					
35	41			PC	--	61					
36				PC	--	50					
37				PC	--	52					
38	42			PC	--	64					
				PC	--	53					
				PC	--	49					
				PC	--	47					
				PC	--	40					
				PC	--	50					
				PC	--	62					
				PC	--	59					
				PC	--	51					
				PC	--	64					
				PC	--	85					
				PC	--	78					
				PC	--	83					
				PC	--	127					
			-12.7	PC	--	153					
		End of Borehole									

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Drilling Method: Hollow Stem Augering
Dynamic Cone Penetration Test

Driller: Formation Drilling Ltd.

Datum: Geodetic

APPENDIX B

Laboratory Analyses

AGAT Laboratories

57 Old Pennywell Road, Unit I
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http://www.agatlabs.com

CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113 - Stephenville, NL

AGAT WORK ORDER: 17K288500

TRACE ORGANICS REVIEWED BY: Kelly Hogue, B.Sc, P.Chem, Operations Manager

WATER ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

DATE REPORTED: Dec 01, 2017

PAGES (INCLUDING COVER): 16

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level

DATE RECEIVED: 2017-11-27

DATE REPORTED: 2017-12-01

Parameter	Unit	G / S	RDL	3113-PUMP1-WS1 Water 2017-11-22 8936013	3113-PUMP2-WS1 Water 2017-11-22 8936090
Benzene	mg/L	0.370	0.001	<0.001	<0.001
Toluene	mg/L	0.002	0.001	<0.001	<0.001
Ethylbenzene	mg/L	0.09	0.001	<0.001	<0.001
Xylene (Total)	mg/L		0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	<0.01	<0.01
Modified TPH (Tier 1)	mg/L		0.1	<0.1	<0.1
Resemblance Comment				NR	NR
Return to Baseline at C32				Y	Y
Surrogate	**Unit**	**Acceptable Limits**			
Isobutylbenzene - EPH	%	70-130		104	104
Isobutylbenzene - VPH	%	70-130		77	77
n-Dotriacontane - EPH	%	70-130		113	108

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8936013-8936090 Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By: Kelly Hogue

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Certificate of Analysis

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2017-11-27

DATE REPORTED: 2017-12-01

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-PUMP1-WS1 SAMPLE TYPE: Water DATE SAMPLED: 2017-11-22 8936013	SAMPLE DESCRIPTION: 3113-PUMP2-WS1 SAMPLE TYPE: Water DATE SAMPLED: 2017-11-22 8936090
Dissolved Aluminum	ug/L	Variable	5	<5	<5
Dissolved Antimony	ug/L		2	<2	<2
Dissolved Arsenic	ug/L	5	2	<2	<2
Dissolved Barium	ug/L		5	36	38
Dissolved Beryllium	ug/L		2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2
Dissolved Boron	ug/L	29000,	5	7	7
Dissolved Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	2	2
Dissolved Cobalt	ug/L		1	<1	<1
Dissolved Copper	ug/L	Equation	2	<2	<2
Dissolved Iron	ug/L	300	50	<50	<50
Dissolved Lead	ug/L	Equation	0.5	<0.5	<0.5
Dissolved Manganese	ug/L		2	<2	<2
Dissolved Molybdenum	ug/L	73	2	<2	<2
Dissolved Nickel	ug/L	Equation	2	<2	<2
Dissolved Selenium	ug/L	1.0	1	<1	<1
Dissolved Silver	ug/L	0.25	0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	75	74
Dissolved Thallium	ug/L	0.8	0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2
Dissolved Uranium	ug/L	33, 15	0.1	0.3	0.3
Dissolved Vanadium	ug/L		2	<2	<2
Dissolved Zinc	ug/L	30	5	<5	8

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8936013-8936090 Analysis completed on a filtered sample.

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

MTL - TOC in Water

DATE RECEIVED: 2017-11-27

DATE REPORTED: 2017-12-01

				3113-PUMP1-WS1	3113-PUMP2-WS1
SAMPLE DESCRIPTION:					
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2017-11-22	2017-11-22
Parameter	Unit	G / S	RDL	8936013	8936090
Total Organic Carbon	mg/L		0.5	3.0	3.1

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8936013-8936090 TOC analysed at AGAT Montreal.

Certified By: Laura Baker

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2017-11-27

DATE REPORTED: 2017-12-01

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-PUMP1-WS1	SAMPLE DESCRIPTION: 3113-PUMP2-WS1
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2017-11-22	2017-11-22
pH		6.5-9.0		8.23	8.19
Reactive Silica as SiO2	mg/L		0.5	6.5	6.4
Chloride	mg/L	640, 120	1	26	17
Fluoride	mg/L	0.12	0.12	<0.12	<0.12
Sulphate	mg/L		2	7	5
Alkalinity	mg/L		5	145	142
True Color	TCU	Narrative	5	<5	8
Turbidity	NTU	Narrative	0.1	0.6	0.8
Electrical Conductivity	umho/cm		1	312	318
Nitrate + Nitrite as N	mg/L		0.05	0.21	0.38
Nitrate as N	mg/L	550, 13	0.05	0.21	0.38
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.05	0.06
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01
Total Sodium	mg/L		0.1	9.6	12.1
Total Potassium	mg/L		0.1	1.0	1.0
Total Calcium	mg/L		0.1	50.2	49.4
Total Magnesium	mg/L		0.1	8.3	7.4
Bicarb. Alkalinity (as CaCO3)	mg/L		5	145	142
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	190	179
Hardness	mg/L			160	154
Langelier Index (@20C)	NA			0.48	0.42
Langelier Index (@ 4C)	NA			0.16	0.10
Saturation pH (@ 20C)	NA			7.75	7.77
Saturation pH (@ 4C)	NA			8.07	8.09
Anion Sum	me/L			3.79	3.45
Cation sum	me/L			3.64	3.64

Certified By:

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2017-11-27

DATE REPORTED: 2017-12-01

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-PUMP1-WS1	SAMPLE DESCRIPTION: 3113-PUMP2-WS1
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2017-11-22	2017-11-22
% Difference/ Ion Balance (NS)	%			2.1	2.6
Total Aluminum	ug/L	Variable	5	<5	6
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2
Total Barium	ug/L		5	38	39
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L	29000,	5	8	7
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Total Chromium	ug/L		1	1	1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L	Equation	1	<1	<1
Total Iron	ug/L	300	50	61	77
Total Lead	ug/L	Equation	0.5	<0.5	<0.5
Total Manganese	ug/L		2	<2	<2
Total Molybdenum	ug/L	73	2	<2	<2
Total Nickel	ug/L	Equation	2	<2	<2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.02	0.02
Total Selenium	ug/L	1	1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1
Total Strontium	ug/L		5	89	86
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.3	0.3
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L	30	5	<5	<5

Certified By: Laura Baker

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2017-11-27

DATE REPORTED: 2017-12-01

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Certified By:

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 17K288500
PROJECT: 3113 - Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Trace Organics Analysis

RPT Date: Dec 01, 2017			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level															
Benzene	1	8923753	< 0.001	< 0.001	NA	< 0.001	77%	70%	130%	95%	70%	130%			
Toluene	1	8923753	< 0.001	< 0.001	NA	< 0.001	78%	70%	130%	93%	70%	130%			
Ethylbenzene	1	8923753	< 0.001	< 0.001	NA	< 0.001	81%	70%	130%	92%	70%	130%			
Xylene (Total)	1	8923753	< 0.001	< 0.001	NA	< 0.001	82%	70%	130%	101%	70%	130%			
C6-C10 (less BTEX)	1	8923753	< 0.01	< 0.01	NA	< 0.01	97%	70%	130%	102%	70%	130%	106%	70%	130%
>C10-C16 Hydrocarbons	1	8938408	< 0.05	< 0.05	NA	< 0.05	77%	70%	130%	89%	70%	130%	98%	70%	130%
>C16-C21 Hydrocarbons	1	8938408	< 0.05	< 0.05	NA	< 0.05	71%	70%	130%	89%	70%	130%	98%	70%	130%
>C21-C32 Hydrocarbons	1	8938408	< 0.01	< 0.01	NA	< 0.01	70%	70%	130%	89%	70%	130%	98%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By: Kelly Hogue

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 17K288500
PROJECT: 3113 - Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Water Analysis

RPT Date: Dec 01, 2017

PARAMETER	Batch	Sample Id	DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
			Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
MTL - TOC in Water															
Total Organic Carbon	8932683		35.0	35.8	2.3%	< 0.5	NA	80%	120%	120%	80%	120%	NA	80%	120%
Standard Water Analysis + Total Metals															
pH	8936119		7.89	7.92	0.4%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	8933976	2.2	3.5	NA	< 0.5	110%	80%	120%		80%	120%	80%	80%	120%
Chloride	8939186		7	8	2.6%	< 1	97%	80%	120%	NA	80%	120%	94%	80%	120%
Fluoride	8939186		<0.12	<0.12	NA	< 0.12	111%	80%	120%	NA	80%	120%	102%	80%	120%
Sulphate	8939186		11	11	3.0%	< 2	117%	80%	120%	NA	80%	120%	NA	80%	120%
Alkalinity	8936119		131	132	0.6%	< 5	98%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	8926699		<5	6	NA	< 5	110%	80%	120%	NA			NA		
Turbidity	8933973		3.3	3.0	8.2%	< 0.1	99%	80%	120%	NA			NA		
Electrical Conductivity	8936119		13400	13400	0.1%	< 1	101%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	8939186		<0.05	<0.05	NA	< 0.05	103%	80%	120%	NA	80%	120%	96%	80%	120%
Nitrite as N	8939186		<0.05	<0.05	NA	< 0.05	91%	80%	120%	NA	80%	120%	93%	80%	120%
Ammonia as N	1	8933973	0.05	0.02	NA	< 0.03	110%	80%	120%		80%	120%	104%	80%	120%
Ortho-Phosphate as P	1	8933973	<0.01	<0.01	NA	< 0.01	NA	80%	120%		80%	120%	100%	80%	120%
Total Sodium	8939189		3.5	3.4	1.2%	< 0.1	106%	80%	120%	107%	80%	120%	NA	70%	130%
Total Potassium	8939189		0.3	0.3	NA	< 0.1	106%	80%	120%	109%	80%	120%	101%	70%	130%
Total Calcium	8939189		11.6	12.0	3.8%	< 0.1	105%	80%	120%	108%	80%	120%	NA	70%	130%
Total Magnesium	8939189		0.9	0.9	3.4%	< 0.1	107%	80%	120%	110%	80%	120%	102%	80%	120%
Bicarb. Alkalinity (as CaCO3)	8936119		131	132	0.6%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	8936119		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	8936119		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	8939189		<5	<5	NA	< 5	103%	80%	120%	111%	80%	120%	96%	70%	130%
Total Antimony	8939189		<2	<2	NA	< 2	94%	80%	120%	105%	80%	120%	98%	70%	130%
Total Arsenic	8939189		<2	<2	NA	< 2	99%	80%	120%	99%	80%	120%	95%	70%	130%
Total Barium	8939189		<5	<5	NA	< 5	101%	80%	120%	104%	80%	120%	104%	70%	130%
Total Beryllium	8939189		<2	<2	NA	< 2	103%	80%	120%	108%	80%	120%	103%	70%	130%
Total Bismuth	8939189		<2	<2	NA	< 2	102%	80%	120%	109%	80%	120%	102%	70%	130%
Total Boron	8939189		<5	<5	NA	< 5	103%	80%	120%	106%	80%	120%	98%	70%	130%
Total Cadmium	8939189		<0.017	<0.017	NA	< 0.017	96%	80%	120%	99%	80%	120%	94%	70%	130%
Total Chromium	8939189		<1	<1	NA	< 1	95%	80%	120%	95%	80%	120%	102%	70%	130%
Total Cobalt	8939189		<1	<1	NA	< 1	96%	80%	120%	95%	80%	120%	101%	70%	130%
Total Copper	8939189		477	467	2.0%	< 1	99%	80%	120%	102%	80%	120%	NA	70%	130%
Total Iron	8939189		58	56	NA	< 50	99%	80%	120%	100%	80%	120%	102%	70%	130%
Total Lead	8939189		<0.5	<0.5	NA	< 0.5	104%	80%	120%	108%	80%	120%	101%	70%	130%
Total Manganese	8939189		3	<2	NA	< 2	98%	80%	120%	99%	80%	120%	75%	70%	130%
Total Molybdenum	8939189		<2	<2	NA	< 2	91%	80%	120%	94%	80%	120%	98%	70%	130%
Total Nickel	8939189		5	5	NA	< 2	96%	80%	120%	97%	80%	120%	100%	70%	130%

AGAT Laboratories
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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 17K288500
PROJECT: 3113 - Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Dec 01, 2017

PARAMETER	Batch	Sample Id	DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
			Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Phosphorous	8939189		0.04	0.03	NA	< 0.02	98%	80%	120%	105%	80%	120%	119%	70%	130%
Total Selenium	8939189		<1	<1	NA	< 1	96%	80%	120%	99%	80%	120%	82%	70%	130%
Total Silver	8939189		<0.1	<0.1	NA	< 0.1	93%	80%	120%	99%	80%	120%	94%	70%	130%
Total Strontium	8939189		31	31	1.6%	< 5	94%	80%	120%	98%	80%	120%	NA	70%	130%
Total Thallium	8939189		<0.1	<0.1	NA	< 0.1	102%	80%	120%	110%	80%	120%	105%	70%	130%
Total Tin	8939189		<2	<2	NA	< 2	97%	80%	120%	99%	80%	120%	103%	70%	130%
Total Titanium	8939189		<2	<2	NA	< 2	104%	80%	120%	107%	80%	120%	109%	70%	130%
Total Uranium	8939189		<0.1	<0.1	NA	< 0.1	100%	80%	120%	102%	80%	120%	100%	70%	130%
Total Vanadium	8939189		<2	<2	NA	< 2	91%	80%	120%	94%	80%	120%	95%	70%	130%
Total Zinc	8939189		56	56	0.1%	< 5	97%	80%	120%	102%	80%	120%	NA	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Dissolved Metals															
Dissolved Aluminum	8934102		<5	<5	NA	< 5	99%	80%	120%	96%	80%	120%	96%	70%	130%
Dissolved Antimony	8934102		<2	<2	NA	< 2	92%	80%	120%	99%	80%	120%	106%	70%	130%
Dissolved Arsenic	8934102		<2	<2	NA	< 2	94%	80%	120%	95%	80%	120%	101%	70%	130%
Dissolved Barium	8934102		5	5	NA	< 5	100%	80%	120%	102%	80%	120%	100%	70%	130%
Dissolved Beryllium	8934102		<2	<2	NA	< 2	101%	80%	120%	104%	80%	120%	117%	70%	130%
Dissolved Bismuth	8934102		<2	<2	NA	< 2	96%	80%	120%	103%	80%	120%	70%	70%	130%
Dissolved Boron	8934102		<5	<5	NA	< 5	97%	80%	120%	97%	80%	120%	112%	70%	130%
Dissolved Cadmium	8934102		<0.017	<0.017	NA	< 0.017	97%	80%	120%	97%	80%	120%	103%	70%	130%
Dissolved Chromium	8934102		<1	<1	NA	< 1	90%	80%	120%	90%	80%	120%	92%	70%	130%
Dissolved Cobalt	8934102		2	2	NA	< 1	93%	80%	120%	94%	80%	120%	100%	70%	130%
Dissolved Copper	8934102		<2	<2	NA	< 2	96%	80%	120%	98%	80%	120%	101%	70%	130%
Dissolved Iron	8934102		3000	2940	2.2%	< 50	90%	80%	120%	92%	80%	120%	NA	70%	130%
Dissolved Lead	8934102		21.3	21.3	0.1%	< 0.5	99%	80%	120%	101%	80%	120%	NA	70%	130%
Dissolved Manganese	8934102		156	152	2.3%	< 2	90%	80%	120%	91%	80%	120%	NA	70%	130%
Dissolved Molybdenum	8934102		<2	<2	NA	< 2	88%	80%	120%	91%	80%	120%	85%	70%	130%
Dissolved Nickel	8934102		<2	<2	NA	< 2	94%	80%	120%	95%	80%	120%	99%	70%	130%
Dissolved Selenium	8934102		<1	<1	NA	< 1	105%	80%	120%	97%	80%	120%	111%	70%	130%
Dissolved Silver	8934102		<0.1	<0.1	NA	< 0.1	90%	80%	120%	101%	80%	120%	96%	70%	130%
Dissolved Strontium	8934102		36	37	1.7%	< 5	86%	80%	120%	85%	80%	120%	NA	70%	130%
Dissolved Thallium	8934102		<0.1	<0.1	NA	< 0.1	100%	80%	120%	107%	80%	120%	105%	70%	130%
Dissolved Tin	8934102		<2	<2	NA	< 2	92%	80%	120%	96%	80%	120%	96%	70%	130%
Dissolved Titanium	8934102		<2	<2	NA	< 2	104%	80%	120%	105%	80%	120%	98%	70%	130%
Dissolved Uranium	8934102		<0.1	<0.1	NA	< 0.1	96%	80%	120%	100%	80%	120%	97%	70%	130%
Dissolved Vanadium	8934102		<2	<2	NA	< 2	89%	80%	120%	90%	80%	120%	94%	70%	130%
Dissolved Zinc	8934102		<5	<5	NA	< 5	91%	80%	120%	95%	80%	120%	113%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis (Continued)

RPT Date: Dec 01, 2017			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Certified By:

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

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SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
>C10-C16 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 17K288500
PROJECT: 3113 - Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Organic Carbon	INOR-101-6049F	MA.300-C1.0	DÉTECTION INFRAROUGE
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K288500

PROJECT: 3113 - Stephenville, NL

ATTENTION TO: John Gale

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS

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PROJECT: 3113 - Stephenville, NL

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PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Lead	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP-MS

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 4.0
Hold Time:
AGAT Job Number: 17R288500
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☑ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☑ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☑ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☑ Yes ☐ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3839

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment
3113-PUMP1-WS1	Nov. 22, 2017 / 12:20	Water	9	1x500, 3x150, 2x250, 3x40ml
				Field filtered - diss.metal
3113-PUMP2-WS1	Nov. 22, 2017 / 11:30	Water	9	1x500, 3x150, 2x250, 3x40ml
				Field filtered - diss.metal

Field Filtered/Preserved	Standard Water Analysis	Metals: ☑ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P2O5)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☑ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
	✓	✓								✓													
	✓	✓								✓													

Samples Relinquished By (Print Name): Eunjeong Seok
Date/Time: Nov. 27/17
Samples Relinquished By (Sign):
Date/Time: 13:00
Samples Received By (Print Name):
Date/Time: 2017/11/27
Samples Received By (Sign):
Date/Time: 1:00 pm

Pink Copy - Client
Yellow Copy - AGAT
White Copy - AGAT

Page 1 of 1
Nº: FFC-3113-COC-01

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CLIENT NAME: **FRACFLOW CONSULTANTS**
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: **John Gale**

PROJECT: **3113-Stephenville,NL**

AGAT WORK ORDER: **17K289906**

TRACE ORGANICS REVIEWED BY: **Kelly Hogue, B.Sc, P.Chem, Operations Manager**

WATER ANALYSIS REVIEWED BY: **Jason Coughtrey, Inorganics Supervisor**

DATE REPORTED: **Dec 08, 2017**

PAGES (INCLUDING COVER): **15**

VERSION*: **1**

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level

DATE RECEIVED: 2017-11-30

DATE REPORTED: 2017-12-06

		SAMPLE DESCRIPTION:		3113-BH1-WS1	3113-BH2-WS1	3113-BH3-WS1
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		2017-11-28	2017-11-28	2017-11-28
Parameter	**Unit**	**G / S**	**RDL**	**8944411**	**8944428**	**8944429**
Benzene	mg/L	0.370	0.001	<0.001	<0.001	<0.001
Toluene	mg/L	0.002	0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	0.09	0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L		0.001	<0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	<0.01	<0.01	<0.01
Modified TPH (Tier 1)	mg/L		0.1	<0.1	<0.1	<0.1
Resemblance Comment				NR	NR	NR
Return to Baseline at C32				Y	Y	Y
Surrogate	**Unit**	**Acceptable Limits**				
Isobutylbenzene - EPH	%	70-130		94	95	97
Isobutylbenzene - VPH	%	70-130		100	101	96
n-Dotriacontane - EPH	%	70-130		98	92	93

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8944411-8944429 Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By: Kelly Hogue

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Certificate of Analysis

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2017-11-30

DATE REPORTED: 2017-12-02

		SAMPLE DESCRIPTION:		3113-BH1-WS1	3113-BH2-WS1	3113-BH3-WS1
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		2017-11-28	2017-11-28	2017-11-28
Parameter	Unit	G / S	RDL	8944411	8944428	8944429
Dissolved Aluminum	ug/L	Variable	5	13	14	16
Dissolved Antimony	ug/L		2	<2	<2	<2
Dissolved Arsenic	ug/L	5	2	<2	<2	<2
Dissolved Barium	ug/L		5	26	42	44
Dissolved Beryllium	ug/L		2	<2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2	<2
Dissolved Boron	ug/L	29000,	5	10	7	8
Dissolved Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	3	4	4
Dissolved Cobalt	ug/L		1	<1	<1	<1
Dissolved Copper	ug/L	Equation	2	<2	<2	<2
Dissolved Iron	ug/L	300	50	<50	<50	<50
Dissolved Lead	ug/L	Equation	0.5	<0.5	<0.5	<0.5
Dissolved Manganese	ug/L		2	21	67	134
Dissolved Molybdenum	ug/L	73	2	<2	<2	<2
Dissolved Nickel	ug/L	Equation	2	<2	3	3
Dissolved Selenium	ug/L	1.0	1	<1	<1	<1
Dissolved Silver	ug/L	0.25	0.1	<0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	123	81	86
Dissolved Thallium	ug/L	0.8	0.1	<0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2	<2
Dissolved Uranium	ug/L	33, 15	0.1	0.4	0.4	0.3
Dissolved Vanadium	ug/L		2	<2	<2	<2
Dissolved Zinc	ug/L	30	5	7	16	16

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8944411-8944429 Analysis completed on a filtered sample.

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Certificate of Analysis

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2017-11-30

DATE REPORTED: 2017-12-06

Parameter	Unit	G / S	RDL	3113-BH1-WS1 Water 2017-11-28 8944411	3113-BH2-WS1 Water 2017-11-28 8944428	3113-BH3-WS1 Water 2017-11-28 8944429
pH		6.5-9.0		8.18	8.17	8.18
Reactive Silica as SiO2	mg/L		0.5	7.9	6.2	7.1
Chloride	mg/L	640, 120	1	27	17	11
Fluoride	mg/L	0.12	0.12	**0.16**	<0.12	<0.12
Sulphate	mg/L		2	6	5	2
Alkalinity	mg/L		5	128	145	170
True Color	TCU	Narrative	5	<5	6	9
Turbidity	NTU	Narrative	0.1	1.7	2.8	6.8
Electrical Conductivity	umho/cm		1	333	337	358
Nitrate + Nitrite as N	mg/L		0.05	0.14	0.37	0.15
Nitrate as N	mg/L	550, 13	0.05	0.14	0.37	0.15
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.03	<0.03	<0.03
Ortho-Phosphate as P	mg/L		0.01	<0.01	0.01	<0.01
Total Sodium	mg/L		0.1	15.6	9.3	7.5
Total Potassium	mg/L		0.1	2.1	1.7	2.2
Total Calcium	mg/L		0.1	44.4	51.2	57.8
Total Magnesium	mg/L		0.1	7.8	7.5	8.2
Bicarb. Alkalinity (as CaCO3)	mg/L		5	128	145	170
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10	<10
Hydroxide	mg/L		5	<5	<5	<5
Calculated TDS	mg/L		1	181	181	192
Hardness	mg/L			143	159	178
Langelier Index (@20C)	NA			0.32	0.43	0.56
Langelier Index (@ 4C)	NA			0	0.11	0.24
Saturation pH (@ 20C)	NA			7.86	7.74	7.62
Saturation pH (@ 4C)	NA			8.18	8.06	7.94
Anion Sum	me/L			3.46	3.51	3.76
Cation sum	me/L			3.62	3.67	4.00
% Difference/ Ion Balance (NS)	%			2.3	2.2	3.1

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2017-11-30

DATE REPORTED: 2017-12-06

		SAMPLE DESCRIPTION:		3113-BH1-WS1	3113-BH2-WS1	3113-BH3-WS1
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		2017-11-28	2017-11-28	2017-11-28
Parameter	Unit	G / S	RDL	8944411	8944428	8944429
Total Aluminum	ug/L	Variable	5	119	207	265
Total Antimony	ug/L		2	<2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2	<2
Total Barium	ug/L		5	27	43	46
Total Beryllium	ug/L		2	<2	<2	<2
Total Bismuth	ug/L		2	<2	<2	<2
Total Boron	ug/L	29000,	5	11	8	8
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017	<0.017
Total Chromium	ug/L		1	2	4	2
Total Cobalt	ug/L		1	<1	3	2
Total Copper	ug/L	Equation	1	<1	2	2
Total Iron	ug/L	300	50	258	**489**	**559**
Total Lead	ug/L	Equation	0.5	<0.5	<0.5	<0.5
Total Manganese	ug/L		2	32	96	171
Total Molybdenum	ug/L	73	2	2	<2	<2
Total Nickel	ug/L	Equation	2	4	5	4
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03	0.04
Total Selenium	ug/L	1	1	<1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1	<0.1
Total Strontium	ug/L		5	143	96	104
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2	<2
Total Titanium	ug/L		2	7	14	19
Total Uranium	ug/L	33, 15	0.1	0.5	0.4	0.4
Total Vanadium	ug/L		2	<2	<2	<2
Total Zinc	ug/L	30	5	6	16	8

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

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Certificate of Analysis

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis - TOC

DATE RECEIVED: 2017-11-30

DATE REPORTED: 2017-12-06

		SAMPLE DESCRIPTION:		3113-BH1-WS1	3113-BH2-WS1	3113-BH3-WS1
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		2017-11-28	2017-11-28	2017-11-28
Parameter	Unit	G / S	RDL	8944411	8944428	8944429
Total Organic Carbon	mg/L		0.5	0.9	0.9	1.4

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level															
Benzene	1	8950494	< 0.001	< 0.001	NA	< 0.001	92%	70%	130%	90%	70%	130%			
Toluene	1	8950494	< 0.001	< 0.001	NA	< 0.001	94%	70%	130%	98%	70%	130%			
Ethylbenzene	1	8950494	< 0.001	< 0.001	NA	< 0.001	94%	70%	130%	102%	70%	130%			
Xylene (Total)	1	8950494	< 0.001	< 0.001	NA	< 0.001	95%	70%	130%	104%	70%	130%			
C6-C10 (less BTEX)	1	8950494	< 0.01	< 0.01	NA	< 0.01	95%	70%	130%	107%	70%	130%	107%	70%	130%
>C10-C16 Hydrocarbons	1	8944411	< 0.05	< 0.05	NA	< 0.05	101%	70%	130%	106%	70%	130%	107%	70%	130%
>C16-C21 Hydrocarbons	1	8944411	< 0.05	< 0.05	NA	< 0.05	101%	70%	130%	106%	70%	130%	107%	70%	130%
>C21-C32 Hydrocarbons	1	8944411	<0.01	<0.01	NA	< 0.01	103%	70%	130%	106%	70%	130%	107%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By: Kelly Hogue

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Standard Water Analysis + Total Metals															
pH	8944411	8944411	8.18	8.20	0.2%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	8933041	4.3	5.2	18.9%	< 0.5	106%	80%	120%		80%	120%	98%	80%	120%
Chloride	8932992		36	35	1.0%	< 1	104%	80%	120%	NA	80%	120%	NA	80%	120%
Fluoride	8932992		<0.12	<0.12	NA	< 0.12	109%	80%	120%	NA	80%	120%	93%	80%	120%
Sulphate	8932992		5	5	NA	< 2	114%	80%	120%	NA	80%	120%	99%	80%	120%
Alkalinity	8944411	8944411	128	128	0.2%	< 5	98%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	8944411	8944411	<5	<5	NA	< 5	110%	80%	120%	NA			NA		
Turbidity	8942126		1.0	1.1	9.4%	< 0.1	99%	80%	120%	NA			NA		
Electrical Conductivity	8944411	8944411	333	337	1.2%	< 1	101%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	8932992		0.07	0.06	NA	< 0.05	103%	80%	120%	NA	80%	120%	104%	80%	120%
Nitrite as N	8932992		<0.05	<0.05	NA	< 0.05	88%	80%	120%	NA	80%	120%	95%	80%	120%
Ammonia as N	1	8943119	0.05	0.05	NA	< 0.03	101%	80%	120%		80%	120%	105%	80%	120%
Ortho-Phosphate as P	1	8933041	<0.01	<0.01	NA	< 0.01	114%	80%	120%		80%	120%	100%	80%	120%
Total Sodium	8947105		26.3	27.0	2.4%	< 0.1	102%	80%	120%	103%	80%	120%	NA	70%	130%
Total Potassium	8947105		1.1	1.2	2.9%	< 0.1	104%	80%	120%	105%	80%	120%	NA	70%	130%
Total Calcium	8947105		50.7	52.1	2.7%	< 0.1	105%	80%	120%	105%	80%	120%	NA	70%	130%
Total Magnesium	8947105		7.4	7.4	0.4%	< 0.1	103%	80%	120%	104%	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	8944411	8944411	128	128	0.2%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	8944411	8944411	<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	8944411	8944411	<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	8947105		<5	<5	NA	< 5	108%	80%	120%	111%	80%	120%	102%	70%	130%
Total Antimony	8947105		<2	<2	NA	< 2	93%	80%	120%	103%	80%	120%	100%	70%	130%
Total Arsenic	8947105		7	7	NA	< 2	94%	80%	120%	98%	80%	120%	NA	70%	130%
Total Barium	8947105		20	20	NA	< 5	100%	80%	120%	103%	80%	120%	104%	70%	130%
Total Beryllium	8947105		<2	<2	NA	< 2	113%	80%	120%	116%	80%	120%	103%	70%	130%
Total Bismuth	8947105		<2	<2	NA	< 2	107%	80%	120%	115%	80%	120%	97%	70%	130%
Total Boron	8947105		17	18	NA	< 5	113%	80%	120%	117%	80%	120%	107%	70%	130%
Total Cadmium	8947105		<0.017	<0.017	NA	< 0.017	98%	80%	120%	100%	80%	120%	94%	70%	130%
Total Chromium	8947105		<1	<1	NA	< 1	100%	80%	120%	103%	80%	120%	110%	70%	130%
Total Cobalt	8947105		<1	<1	NA	< 1	101%	80%	120%	106%	80%	120%	107%	70%	130%
Total Copper	8947105		10	11	9.5%	< 1	104%	80%	120%	109%	80%	120%	NA	70%	130%
Total Iron	8947105		529	551	4.0%	< 50	99%	80%	120%	101%	80%	120%	NA	70%	130%
Total Lead	8947105		<0.5	0.5	NA	< 0.5	99%	80%	120%	102%	80%	120%	92%	70%	130%
Total Manganese	8947105		795	813	2.2%	< 2	96%	80%	120%	99%	80%	120%	NA	70%	130%
Total Molybdenum	8947105		<2	<2	NA	< 2	98%	80%	120%	100%	80%	120%	110%	70%	130%
Total Nickel	8947105		2	2	NA	< 2	103%	80%	120%	104%	80%	120%	104%	70%	130%
Total Phosphorous	8947105		0.02	0.03	NA	< 0.02	110%	80%	120%	103%	80%	120%	96%	70%	130%
Total Selenium	8947105		<1	<1	NA	< 1	92%	80%	120%	100%	80%	120%	84%	70%	130%
Total Silver	8947105		<0.1	<0.1	NA	< 0.1	97%	80%	120%	107%	80%	120%	101%	70%	130%

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 17K289906
PROJECT: 3113-Stephenville,NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Water Analysis (Continued)

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Strontium	8947105		362	379	4.7%	< 5	91%	80%	120%	94%	80%	120%	NA	70%	130%
Total Thallium	8947105		<0.1	<0.1	NA	< 0.1	107%	80%	120%	113%	80%	120%	103%	70%	130%
Total Tin	8947105		<2	<2	NA	< 2	97%	80%	120%	98%	80%	120%	102%	70%	130%
Total Titanium	8947105		<2	<2	NA	< 2	106%	80%	120%	107%	80%	120%	97%	70%	130%
Total Uranium	8947105		0.1	0.1	NA	< 0.1	106%	80%	120%	109%	80%	120%	104%	70%	130%
Total Vanadium	8947105		<2	<2	NA	< 2	97%	80%	120%	100%	80%	120%	112%	70%	130%
Total Zinc	8947105		9	9	NA	< 5	105%	80%	120%	108%	80%	120%	96%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Dissolved Metals

Dissolved Aluminum	8943635		9	8	NA	< 5	109%	80%	120%	111%	80%	120%	100%	70%	130%
Dissolved Antimony	8943635		<2	<2	NA	< 2	99%	80%	120%	107%	80%	120%	111%	70%	130%
Dissolved Arsenic	8943635		<2	<2	NA	< 2	97%	80%	120%	102%	80%	120%	112%	70%	130%
Dissolved Barium	8943635		8	8	NA	< 5	100%	80%	120%	104%	80%	120%	107%	70%	130%
Dissolved Beryllium	8943635		<2	<2	NA	< 2	104%	80%	120%	111%	80%	120%	122%	70%	130%
Dissolved Bismuth	8943635		<2	<2	NA	< 2	108%	80%	120%	114%	80%	120%	83%	70%	130%
Dissolved Boron	8943635		<5	<5	NA	< 5	104%	80%	120%	107%	80%	120%	111%	70%	130%
Dissolved Cadmium	8943635		<0.017	<0.017	NA	< 0.017	98%	80%	120%	101%	80%	120%	112%	70%	130%
Dissolved Chromium	8943635		<1	<1	NA	< 1	100%	80%	120%	103%	80%	120%	90%	70%	130%
Dissolved Cobalt	8943635		<1	<1	NA	< 1	99%	80%	120%	103%	80%	120%	89%	70%	130%
Dissolved Copper	8943635		<2	<2	NA	< 2	102%	80%	120%	109%	80%	120%	94%	70%	130%
Dissolved Iron	8943635		<50	<50	NA	< 50	101%	80%	120%	109%	80%	120%	76%	70%	130%
Dissolved Lead	8943635		<0.5	<0.5	NA	< 0.5	103%	80%	120%	106%	80%	120%	99%	70%	130%
Dissolved Manganese	8943635		2	2	NA	< 2	101%	80%	120%	105%	80%	120%	91%	70%	130%
Dissolved Molybdenum	8943635		<2	<2	NA	< 2	96%	80%	120%	100%	80%	120%	78%	70%	130%
Dissolved Nickel	8943635		<2	<2	NA	< 2	100%	80%	120%	109%	80%	120%	94%	70%	130%
Dissolved Selenium	8943635		<1	<1	NA	< 1	96%	80%	120%	98%	80%	120%	119%	70%	130%
Dissolved Silver	8943635		<0.1	<0.1	NA	< 0.1	103%	80%	120%	101%	80%	120%	90%	70%	130%
Dissolved Strontium	8943635		16	16	NA	< 5	94%	80%	120%	96%	80%	120%	91%	70%	130%
Dissolved Thallium	8943635		<0.1	<0.1	NA	< 0.1	103%	80%	120%	111%	80%	120%	104%	70%	130%
Dissolved Tin	8943635		<2	<2	NA	< 2	97%	80%	120%	99%	80%	120%	100%	70%	130%
Dissolved Titanium	8943635		<2	<2	NA	< 2	105%	80%	120%	105%	80%	120%	98%	70%	130%
Dissolved Uranium	8943635		<0.1	<0.1	NA	< 0.1	101%	80%	120%	105%	80%	120%	97%	70%	130%
Dissolved Vanadium	8943635		<2	<2	NA	< 2	96%	80%	120%	101%	80%	120%	88%	70%	130%
Dissolved Zinc	8943635		<5	<5	NA	< 5	100%	80%	120%	107%	80%	120%	114%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Water Analysis - TOC

Total Organic Carbon	656	8930876	6	6	0.0%	< 1	110%	80%	120%						

AGAT Laboratories
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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis (Continued)

RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Comments: If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.

Certified By:

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
>C10-C16 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	VOL-120-5007	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS | **AGAT WORK ORDER: 17K289906**

PROJECT: 3113-Stephenville,NL | **ATTENTION TO: John Gale**

SAMPLING SITE: | **SAMPLED BY:**

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	SM 3125	ICP-MS

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Method Summary

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AGAT WORK ORDER: 17K289906

PROJECT: 3113-Stephenville,NL

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SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Lead	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Organic Carbon	INOR-171-6217	SM 5310 B	COMBUSTION

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 2.9
Hold Time:
AGAT Job Number: 17K289906
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113 - Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To
Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3841

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☑ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube

☑ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☑ FWAL ☐ Other
☐ Sediment

Drinking Water Sample: ☑ Yes ☐ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☑ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P2O5)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☑ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
3113-BH1-WS1	Nov. 28, 2017	Water	9	1x500, 3x100, 2x250, 3x40ml		✓	✓								✓												
	21:19			Field filtered - diss.metal																							
3113-BH2-WS1	Nov. 28, 2017	Water	9	1x500, 3x100, 2x250, 3x40ml		✓	✓								✓												
	13:05			Field filtered - diss.metal																							
3113-BH3-WS1	Nov. 28, 2017	Water	9	1x500, 3x100, 2x250, 3x40ml		✓	✓								✓												
	16:16			Field filtered - diss.metal																							

Samples Relinquished By (Print Name)	Date/Time	Samples Received By (Print Name)	Date/Time
Terry Crummey	Nov. 30/17	JK	Nov 30/17 11:30
Samples Relinquished By (Sign)	**Date/Time**	**Samples Received By (Sign)**	**Date/Time**
	12:13		12:30 pm

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

Nº: FFC-3113-COC-02

Document ID: DIV-13-0001.002
Date revised: January 2018

APPENDIX C

Grain Size Analysis Reports

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

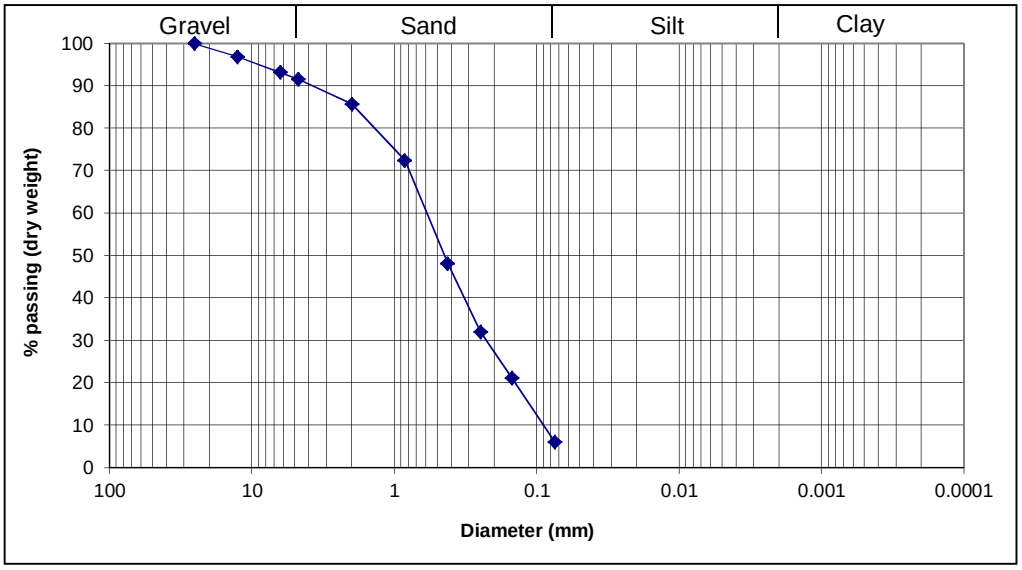
Sample No. : BH1-SS14

Depth below GS : 21.19 m - 21.80 m

Sieve Analysis

Dry weight of sample (g) = 526.39

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	16.39	3.11	3.11	96.89
1/4"	6.35	19.29	3.66	6.78	93.22
4	4.76	8.46	1.61	8.39	91.61
10	2.00	30.72	5.84	14.22	85.78
20	0.85	70.09	13.32	27.54	72.46
40	0.425	127.82	24.28	51.82	48.18
60	0.25	85.01	16.15	67.97	32.03
100	0.15	56.74	10.78	78.75	21.25
200	0.075	79.40	15.08	93.83	6.17
pan	---	32.47	6.17	100.00	---
		526.39			



D_{10} = 0.089

D_{30} = 0.23 Cu = 6.74

D_{60} = 0.6 Cc = 0.99

USCS: SP-SM (Poorly graded sand with silt) or SP-SC (Poorly graded sand with clay)

R_{200} = 93.83 % Gravel = 8.39

R_4 = 8.39 % Sand = 85.45

R_4/R_{200} = 0.09 % Silt & Clay = 6.17

SF = 85.45 % Clay = NA

GF = 8.39 **CFEM:** Sand, trace Gravel, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

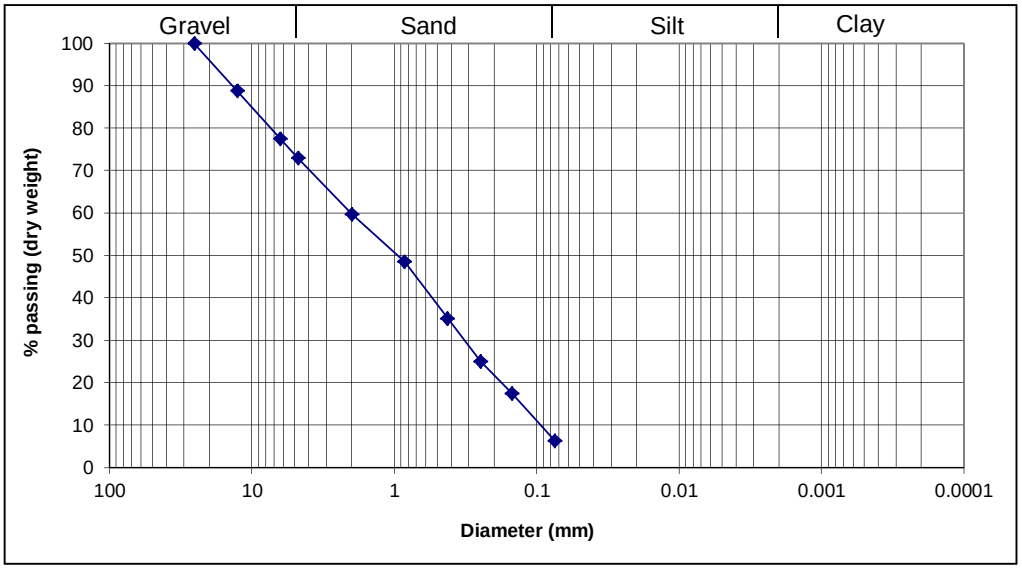
Sample No. : BH1-SS15

Depth below GS : 22.77 m - 23.22 m

Sieve Analysis

Dry weight of sample (g) = 547.48

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	61.18	11.17	11.17	88.83
1/4"	6.35	61.57	11.25	22.42	77.58
4	4.76	25.08	4.58	27.00	73.00
10	2.00	72.02	13.15	40.16	59.84
20	0.85	61.73	11.28	51.43	48.57
40	0.425	73.20	13.37	64.80	35.20
60	0.25	55.10	10.06	74.87	25.13
100	0.15	41.05	7.50	82.36	17.64
200	0.075	61.60	11.25	93.62	6.38
pan	---	34.95	6.38	100.00	---
		547.48			



D_{10} = 0.094

D_{30} = 0.325

D_{60} = 2

Cu = 21.28

Cc = 0.56

USCS: SP-SM (Poorly graded sand with silt and gravel) or SP-SC (Poorly graded sand with clay and gravel)

R_{200} = 93.62

R_4 = 27.00

R_4/R_{200} = 0.29

SF = 66.61

GF = 27.00

% Gravel = 27.00

% Sand = 66.61

% Silt & Clay = 6.38

% Clay = NA

CFEM: Gravelly Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

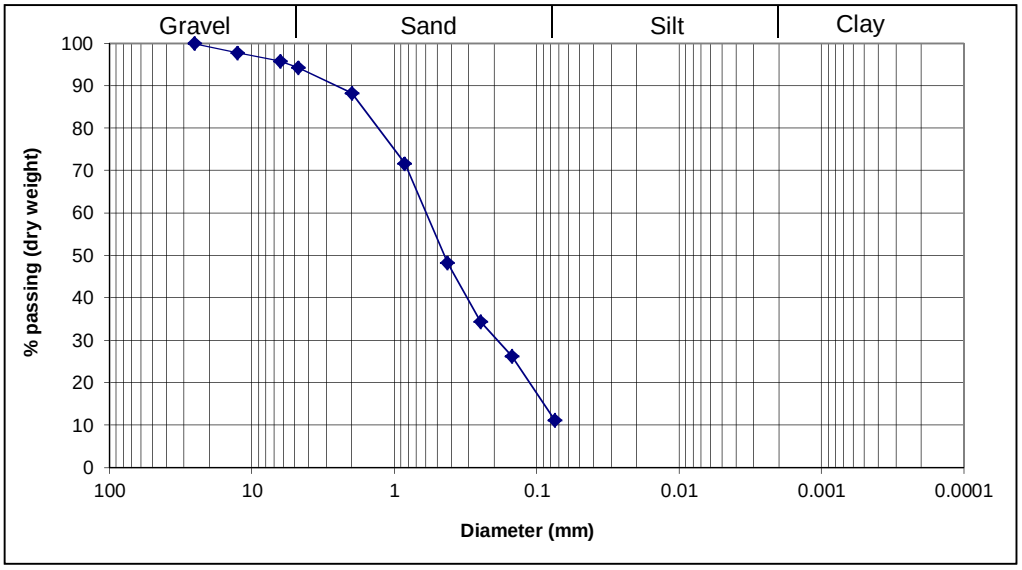
Sample No. : BH1-SS17

Depth below GS : 25.87 m - 26.48 m

Sieve Analysis

Dry weight of sample (g) = 282.04

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	6.10	2.16	2.16	97.84
1/4"	6.35	5.67	2.01	4.17	95.83
4	4.76	4.21	1.49	5.67	94.33
10	2.00	17.04	6.04	11.71	88.29
20	0.85	46.87	16.62	28.33	71.67
40	0.425	66.06	23.42	51.75	48.25
60	0.25	38.82	13.76	65.51	34.49
100	0.15	23.03	8.17	73.68	26.32
200	0.075	42.43	15.04	88.72	11.28
pan	---	31.81	11.28	100.00	---
		282.04			



D_{10} = 0.07

D_{30} = 0.19

D_{60} = 0.6

Cu = 8.57

Cc = 0.86

USCS: SP-SM (Poorly graded sand with silt) or SP-SC (Poorly graded sand with clay)

R_{200} = 88.72

R_4 = 5.67

R_4/R_{200} = 0.06

SF = 83.06

GF = 5.67

% Gravel = 5.67

% Sand = 83.06

% Silt & Clay = 11.28

% Clay = NA

CFEM: Sand, some Silt/Clay, trace Gravel

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

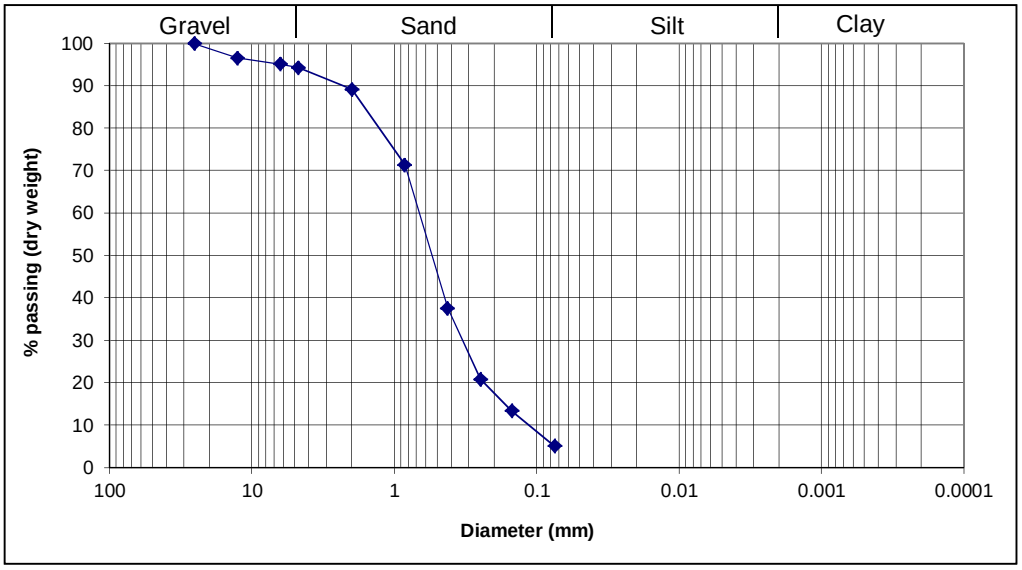
Sample No. : BH2-SS17

Depth below GS : 25.90 m - 26.51 m

Sieve Analysis

Dry weight of sample (g) = 484.43

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	16.57	3.42	3.42	96.58
1/4"	6.35	6.80	1.40	4.82	95.18
4	4.76	3.82	0.79	5.61	94.39
10	2.00	24.90	5.14	10.75	89.25
20	0.85	86.15	17.78	28.54	71.46
40	0.425	163.65	33.78	62.32	37.68
60	0.25	81.60	16.84	79.16	20.84
100	0.15	35.89	7.41	86.57	13.43
200	0.075	40.21	8.30	94.87	5.13
pan	---	24.84	5.13	100.00	---
		484.43			



D_{10} = 0.113

D_{30} = 0.335 Cu = 5.97

D_{60} = 0.675 Cc = 1.47

USCS: SP-SM (Poorly graded sand with silt) or SP-SC (Poorly graded sand with clay)

R_{200} = 94.87 % Gravel = 5.61

R_4 = 5.61 % Sand = 89.26

R_4/R_{200} = 0.06 % Silt & Clay = 5.13

SF = 89.26 % Clay = NA

GF = 5.61 **CFEM:** Sand, trace Gravel, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

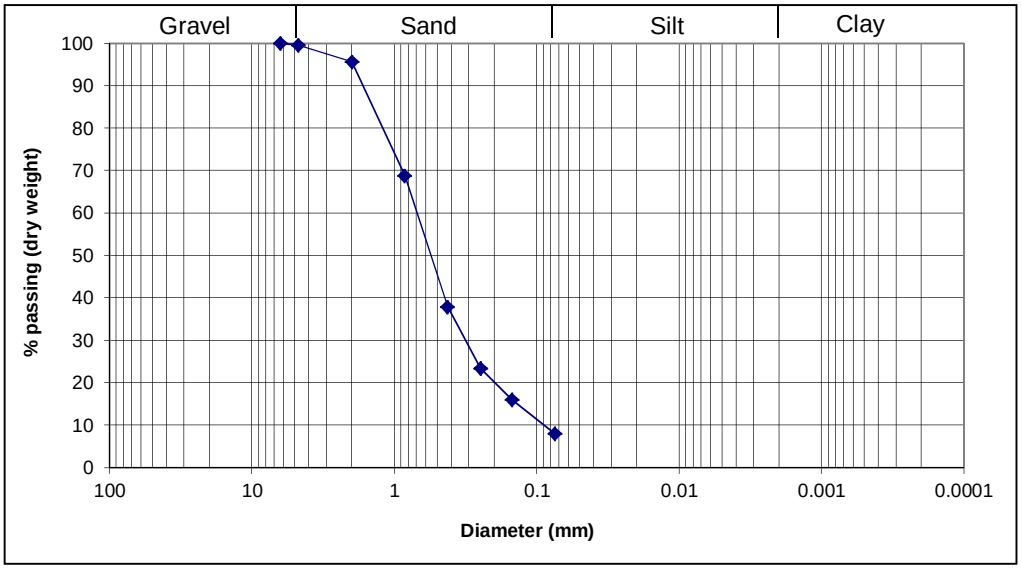
Sample No. : BH2-SS18

Depth below GS : 27.34 m - 27.95 m

Sieve Analysis

Dry weight of sample (g) = 374.75

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	1.32	0.35	0.35	99.65
10	2.00	15.01	4.01	4.36	95.64
20	0.85	100.27	26.76	31.11	68.89
40	0.425	116.06	30.97	62.08	37.92
60	0.25	54.30	14.49	76.57	23.43
100	0.15	27.40	7.31	83.89	16.11
200	0.075	30.29	8.08	91.97	8.03
pan	---	30.10	8.03	100.00	---
		374.75			



D_{10} = 0.088

D_{30} = 0.32 Cu = 7.95

D_{60} = 0.7 Cc = 1.66

USCS: SW-SM (Well-graded sand with silt) or SW-SC (Well-graded sand with clay)

R_{200} = 91.97 % Gravel = 0.35

R_4 = 0.35 % Sand = 91.62

R_4/R_{200} = 0.00 % Silt & Clay = 8.03

SF = 91.62 % Clay = NA

GF = 0.35 **CFEM:** Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephnville, NL

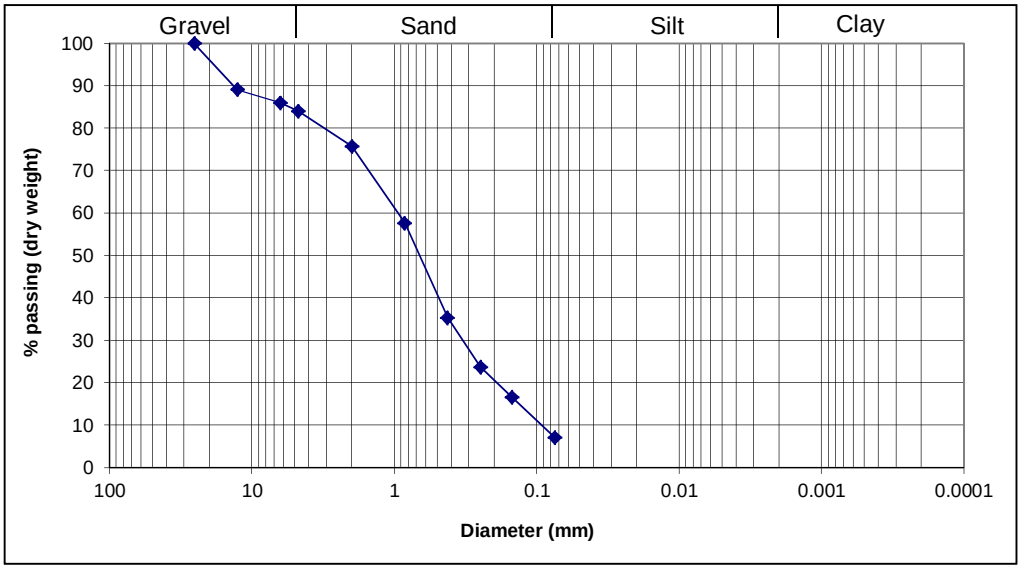
Sample No. : BH2-SS19

Depth below GS : 28.89 m - 29.50 m

Sieve Analysis

Dry weight of sample (g) = 469.82

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	50.99	10.85	10.85	89.15
1/4"	6.35	14.73	3.14	13.99	86.01
4	4.76	8.91	1.90	15.88	84.12
10	2.00	38.99	8.30	24.18	75.82
20	0.85	85.27	18.15	42.33	57.67
40	0.425	104.51	22.24	64.58	35.42
60	0.25	54.93	11.69	76.27	23.73
100	0.15	33.35	7.10	83.37	16.63
200	0.075	44.63	9.50	92.87	7.13
pan	---	33.51	7.13	100.00	---
		469.82			



D_{10} = 0.092

D_{30} = 0.335

D_{60} = 0.95

Cu = 10.33

Cc = 1.28

USCS: SW-SM (Well-graded sand with silt and gravel) or SW-SC (Well-graded sand with clay and gravel)

R_{200} = 92.87

R_4 = 15.88

R_4/R_{200} = 0.17

SF = 76.98

GF = 15.88

% Gravel = 15.88

% Sand = 76.98

% Silt & Clay = 7.13

% Clay = NA

CFEM: Sand, some Gravel, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

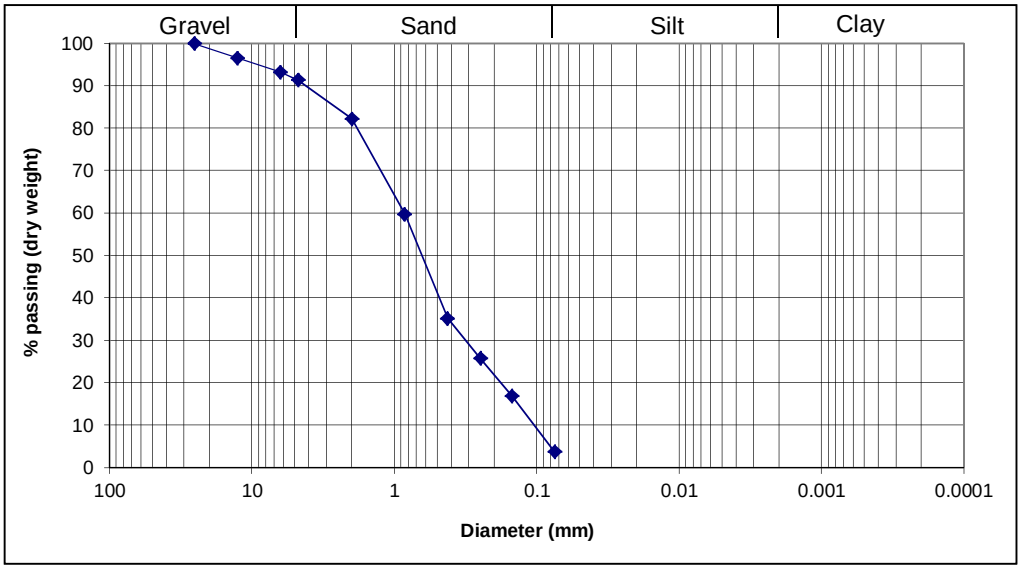
Sample No. : BH2-SS20

Depth below GS : 30.39 m - 31.00 m

Sieve Analysis

Dry weight of sample (g) = 686.68

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	23.67	3.45	3.45	96.55
1/4"	6.35	22.46	3.27	6.72	93.28
4	4.76	12.96	1.89	8.61	91.39
10	2.00	62.38	9.08	17.69	82.31
20	0.85	154.88	22.55	40.24	59.76
40	0.425	168.68	24.56	64.81	35.19
60	0.25	64.46	9.39	74.20	25.80
100	0.15	60.68	8.84	83.03	16.97
200	0.075	90.50	13.18	96.21	3.79
pan	---	26.01	3.79	100.00	---
		686.68			



D_{10} = 0.105

D_{30} = 0.32

D_{60} = 0.85

Cu = 8.10

Cc = 1.15

USCS: SW (Well-graded sand)

R_{200} = 96.21

R_4 = 8.61

R_4/R_{200} = 0.09

SF = 87.61

GF = 8.61

% Gravel = 8.61

% Sand = 87.61

% Silt & Clay = 3.79

% Clay = NA

CFEM: Sand, trace Gravel, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

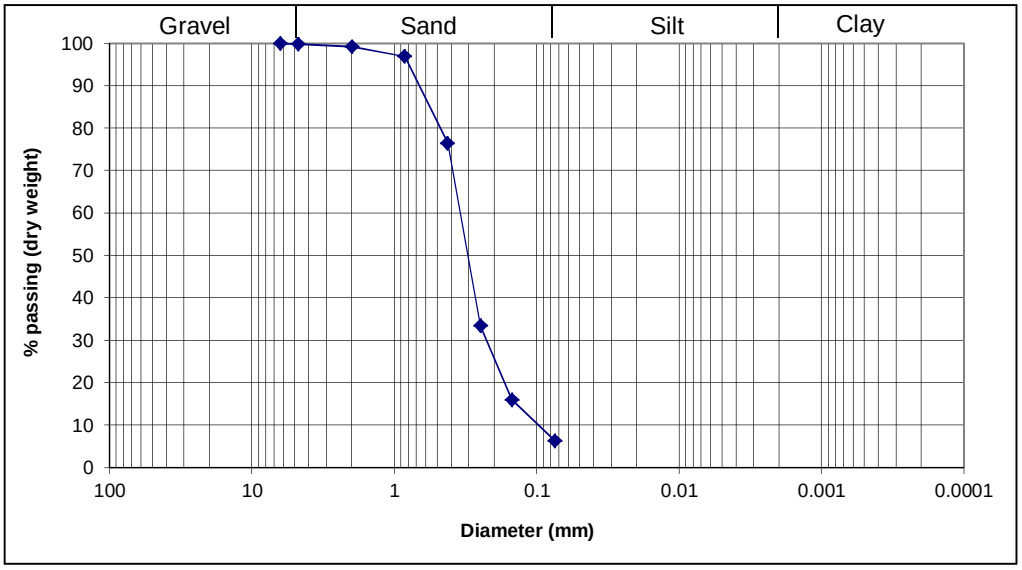
Sample No. : BH3-SS13

Depth below GS : 19.56 m - 20.17 m

Sieve Analysis

Dry weight of sample (g) = 739.60

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	1.13	0.15	0.15	99.85
10	2.00	4.66	0.63	0.78	99.22
20	0.85	16.44	2.22	3.01	96.99
40	0.425	151.00	20.42	23.42	76.58
60	0.25	318.70	43.09	66.51	33.49
100	0.15	128.40	17.36	83.87	16.13
200	0.075	71.74	9.70	93.57	6.43
pan	---	47.53	6.43	100.00	---
		739.60			



D_{10} = 0.097

D_{30} = 0.23 Cu = 3.61

D_{60} = 0.35 Cc = 1.56

USCS: SP-SM (Poorly graded sand with silt) or SP-SC (Poorly graded sand with clay)

R_{200} = 93.57 % Gravel = 0.15

R_4 = 0.15 % Sand = 93.42

R_4/R_{200} = 0.00 % Silt & Clay = 6.43

SF = 93.42 % Clay = NA

GF = 0.15 **CFEM:** Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

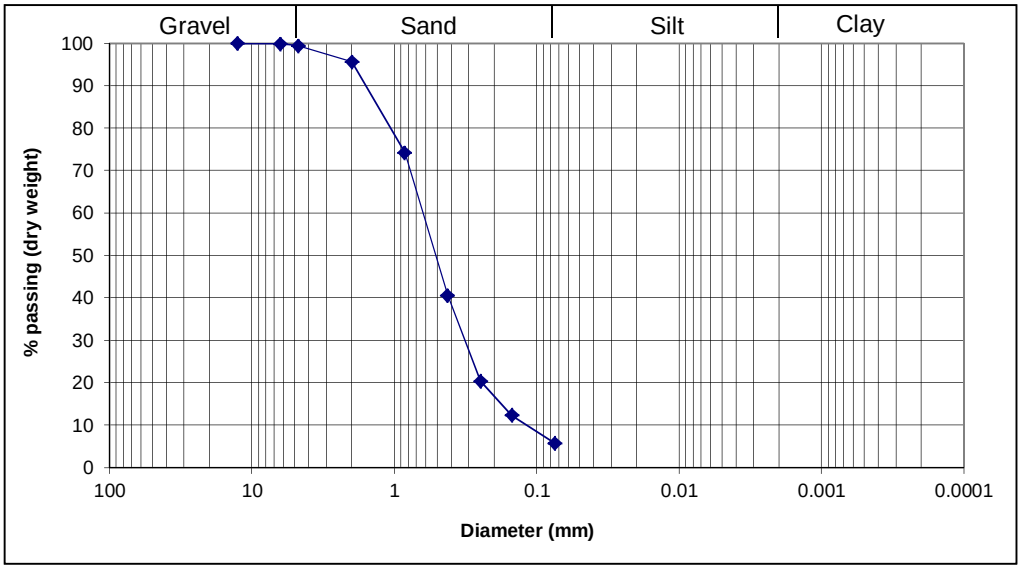
Sample No. : BH3-SS15

Depth below GS : 22.70 m - 23.31 m

Sieve Analysis

Dry weight of sample (g) = 524.73

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	0.45	0.09	0.09	99.91
4	4.76	2.14	0.41	0.49	99.51
10	2.00	19.90	3.79	4.29	95.71
20	0.85	112.31	21.40	25.69	74.31
40	0.425	176.52	33.64	59.33	40.67
60	0.25	105.97	20.20	79.52	20.48
100	0.15	42.57	8.11	87.64	12.36
200	0.075	34.08	6.49	94.13	5.87
pan	---	30.79	5.87	100.00	---
		524.73			



D_{10} = 0.12

D_{30} = 0.325

D_{60} = 0.63

Cu = 5.25

Cc = 1.40

USCS: SP-SM (Poorly graded sand with silt) or SP-SC (Poorly graded sand with clay)

R_{200} = 94.13

R_4 = 0.49

R_4/R_{200} = 0.01

SF = 93.64

GF = 0.49

% Gravel = 0.49

% Sand = 93.64

% Silt & Clay = 5.87

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

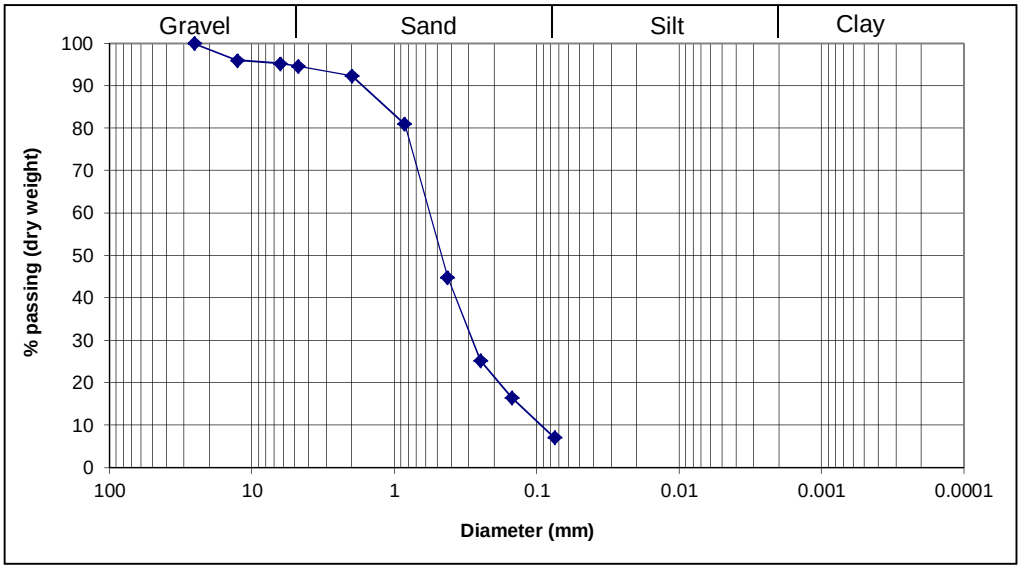
Sample No. : BH3-SS18

Depth below GS : 27.32 m - 27.93 m

Sieve Analysis

Dry weight of sample (g) = 410.99

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	--	--		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	16.31	3.97	3.97	96.03
1/4"	6.35	3.04	0.74	4.71	95.29
4	4.76	2.75	0.67	5.38	94.62
10	2.00	9.02	2.19	7.57	92.43
20	0.85	47.08	11.46	19.03	80.97
40	0.425	148.17	36.05	55.08	44.92
60	0.25	80.72	19.64	74.72	25.28
100	0.15	35.86	8.73	83.44	16.56
200	0.075	38.88	9.46	92.90	7.10
pan	---	29.16	7.10	100.00	---
		410.99			



D_{10} = 0.092

D_{30} = 0.285

D_{60} = 0.565

Cu = 6.14

Cc = 1.56

USCS: SP-SM (Well-graded sand with silt) or SP-SC (Well-graded sand with clay)

R_{200} = 92.90

R_4 = 5.38

R_4/R_{200} = 0.06

SF = 87.53

GF = 5.38

% Gravel = 5.38

% Sand = 87.53

% Silt & Clay = 7.10

% Clay = NA

CFEM: Sand, trace Silt/Clay, trace Gravel

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

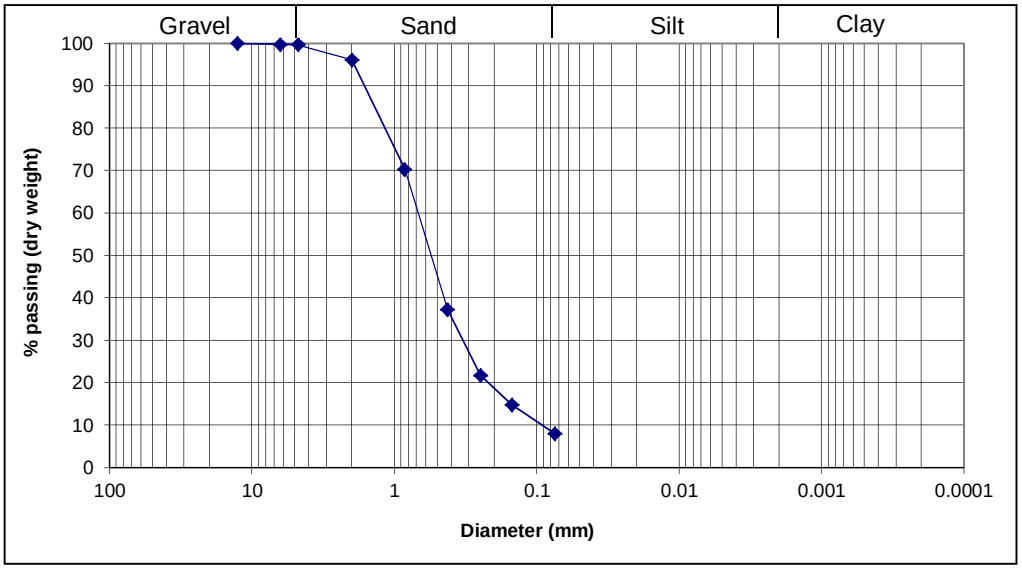
Sample No. : BH3-SS20

Depth below GS : 30.40 m - 31.01 m

Sieve Analysis

Dry weight of sample (g) = 320.68

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	0.68	0.21	0.21	99.79
4	4.76	0.37	0.12	0.33	99.67
10	2.00	11.33	3.53	3.86	96.14
20	0.85	82.82	25.83	29.69	70.31
40	0.425	106.04	33.07	62.75	37.25
60	0.25	49.53	15.45	78.20	21.80
100	0.15	22.19	6.92	85.12	14.88
200	0.075	21.63	6.75	91.86	8.14
pan	---	26.09	8.14	100.00	---
		320.68			



D_{10} = 0.09

D_{30} = 0.335

D_{60} = 0.685

Cu = 7.61

Cc = 1.82

USCS: SW-SM (Well-graded sand with silt) or SW-SC (Well-graded sand with clay)

R_{200} = 91.86

R_4 = 0.33

R_4/R_{200} = 0.00

SF = 91.54

GF = 0.33

% Gravel = 0.33

% Sand = 91.54

% Silt & Clay = 8.14

% Clay = NA

CFEM: Sand, trace Silt/Clay

APPENDIX D

Test Well Request for Pricing

Fracflow Consultants Inc.

Environmental, Hydrogeological and
Geotechnical Engineering Consultants

Request for pricing for a nominal 200 mm diameter test and production well.

General Description of the Work

1. The proposed well is expected to extend to 80 m or more of depth and be completed using a stainless steel well screen with a 1 m sand trap at the bottom and a K-packer at the top of the well screen with a 2 to 3 m section of stainless steel riser or casing between the well screen and the K-packer. The K-Packer has to be sized to fit within the nominal 200 mm well casing. The well screens are to be slot 20 stainless steel wire wrapped Johnson Well screens or an equivalent that is acceptable to Fracflow Consultants. The sand trap, riser and K-packer will be stainless steel to match the stainless steel in the well screens. The sand trap is to have a pump-down valve attached to the bottom of the sand trap to permit final adjustments in the position of the well screen and K-Packer.

2. The ground is expected to consist of an upper organic layer that may be up to 5 m thick, sands, gravels, cobbles and occasional boulders in the upper 20 m of the borehole. Below 20 m the aquifer is expected to consist primarily of sands, gravels and cobbles. Bedrock may be encountered at depths below 40 m. Samples, approximately 2 kg in weight, of the overburden are to be collected at 5 m intervals and placed in fabric sample bags.

3. The well will be constructed by driving the 200 mm casing with a casing shoe attached with removal of the material from inside the casing as the casing is advanced to within no more than 1 m of the casing shoe to minimize up-coning of the sand into the casing except at the bottom of the hole.

4. The proposed well site is located in the Stephenville area and site access for drill trucks and service vehicles will be prepared by the Engineer and any snow clearing services that may be required will be arranged by the Engineer.

5. This well is being constructed to determine if sufficient volumes of ground water can be obtained from the aquifer to supply water for a proposed commercial enterprise in the Stephenville area. Based on the results obtained from this test/production well, an additional two production wells may be constructed in the general area in the near future.

6. Well drilling is expected to commence, based on the submitted prices, within four weeks of the date for submission of prices subject to the availability of equipment and materials and approval of the proposed well site and issuance of the well construction permit by DMAE - the Regulator.

7. Prices are to be submitted by the selected Newfoundland and Labrador licensed well drillers on or before 5:00 pm, December 21, 2017.

154 Major's Path, St. John's, Newfoundland and Labrador, Canada A1A 5A1
Tel: (709) 739-7270 Fax: (709) 753-5101 E-Mail: ffc_nf@nfld.net Web: www.fracflow.com

8. The work will be conducted under a Purchase Order/contract from Fracflow Consultants Inc. on behalf of its Client.

9. Please complete the equipment and personnel sheet that is attached as Appendix A and submit prices using the attached bid sheet, Appendix B.

To discuss any technical aspects of this project, contact:

John Gale, Ph.D., P.Eng., P.Geo., Fracflow Consultants Inc.
Telephone: (709) 739-7270 Facsimile: (709) 753-5101 Email: john_ffc@nfld.net
Cellular: (709) 685-0721

APPENDIX A - CONTRACTOR INFORMATION

GENERAL

Name: _____ Owner: _____

Address: _____ Address: _____

_____ _____

_____ _____

Telephone: _____ Telephone: _____

Facsimile: _____ Facsimile: _____

Email: _____ Email: _____

Water Well Contractor's Licenses and Certifications for:_____

_____

Schedule and startbtime proposed by the contractor;

_____

PERSONNEL

(List only those likely to work on this Contract. Additional records of experience for individuals listed may be required.)

		Years with Contractor	**Total Years in Related Work**
Field Superintendent			
Drillers			
Helpers			
Other Personnel			

EQUIPMENT

(List equipment to be used on this Contract)

Drilling Rig:

Manufacturer: _____

Model No. or Size: _____

Model Year or Age: _____

Drill Pipe Size: _____

Collar Size: _____

Compressor Size: _____

Additional: Information _____

_____

_____

Other Equipment:

_____

_____

_____

_____

_____

APPENDIX B - SCHEDULE OF QUANTITIES AND PRICES (One well)

Section	Description	Unit	Estimated Quantity per Well	Unit Price	Total
	1) Mobilization to and demobilization from Site between January and March 2018, inclusive of all materials, equipment, supplies and personnel costs, including all required permits and licenses for the driller. Site access preparation will be provided by the Engineer, including snow clearing if required. Note that the application for the construction of a non-domestic well permit will be submitted and paid for by and held by the Engineer.	Lump Sum	1		
	2) Supply nominal 200 mm diameter mild steel casing with a minimum 9 mm wall thickness a) Blank Casing, 200 mm diameter casing.	Metre	80		
	b) Supply and install Drive Shoe.	Each	1		
	c) Supply stainless steel K-Packer that fits and seals inside the nominal 200 mm diameter blank casing.	Each	1		
	d) Supply stainless steel well screen (20 slot), in 3 m or 10 ft sections, sized to fit inside the 200 mm casing and matches the ID and OD of the bottom of the K-Packer. The well screen should have a nominal inside diameter of no less 150 mm.	Metre	15		
	e) Supply nominal 150 mm inside diameter stainless steel blank casing to match the ID and OD of the well screen and the bottom of the K-Packer. One metre for the sand trap and 3 metres for the connection between the K-Packer and the well screen.	Metre	4		
	f) Pump-down valve for the bottom of the sand trap, including the plate for the bottom of the sand trap.	Each	1		
	g) Supply separate nominal 150 mm stainless steel weld rings for welding the well screen sections and the K-Packer. Note that all welding of the stainless steel materials must use stainless steel welding rods.	Each	5		
	3) Drive/drill minimum 200 mm diameter surface casing to a depth of 80 m or as directed by the Engineer. Drill and/or extract sediment from within the 200 mm diameter casing as the casing is advanced to one metre above the bottom of the casing shoe in the well, except at the bottom of the well. Collect nominal 2 kg weight overburden samples from inside the blank casing at 5 m intervals. Payment for completed wells only.	Metre	80		
	4) Assemble and Install the sand trap with the pump down valve, the well screen and the K-packer inside the 200 mm blank casing at the depth specified by the engineer. Payment for completed well only.	Hour	12		
	5) Retract the 200 mm casing approximately 17 m such that the K-Packer seal is approximately 2.5 m above the bottom of the 200 mm blank casing and casing shoe and ensure that the K-Packer string is not pulled up the hole with the blank casing. Confirm to the satisfaction of the Engineer the depth of the K-packer seal relative to the bottom of the blank casing. If necessary, use the pump-down valve to position the K-Packer and screen at the required depth and location. Payment for completed well only.	Hour	8		
	6) N/A				

APPENDIX B - SCHEDULE OF QUANTITIES AND PRICES (One well)

Section	Description	Unit	Estimated Quantity per Well	Unit Price	Total
	7) N/A				
	8) Standby Time as approved by the engineer.				
	a) Rig and crew	Hour	8		
	b) Rig only	Hour	8		
	9) Well Disinfection	Each	1		
	10) Well cap	Each	1		
			Sub-Total		
			HST 15%		
			Grand Total		

Note: all unit rates are inclusive of fuel, vehicles, per diems and hotel costs. No separate additional charge will be accepted for per diems and hotel costs.

Optional items, if identified, are those items that the owner reserves the right to conduct using its own resources or the resources of the Engineer.

Estimated quantities and hours are provided for bid comparison purposes. The client reserves the right to select the bidder whose prices, equipment, schedule and personnel that provides the best overall value for the work and not necessarily the lowest price.

Fracflow Consultants Inc.

Environmental, Hydrogeological and
Geotechnical Engineering Consultants

TECHNICAL MEMORANDUM

TO: Marine Harvest Atlantic Canada FFC-NL-3113-006

FROM: Fracflow Consultants Inc.

DATE: April 19, 2018

SUBJECT: Construction and Aquifer Testing - Test Well, MHPW1- 2018

1.0 INTRODUCTION

A Test Well (MHPW1) was sited (**Figure 1**) and drilled for Marine Harvest Atlantic Canada (MHAC) to evaluate the aquifer potential and water chemistry as a source water for a proposed fish hatchery/aquaculture operation in Stephenville, NL. The Test Well was drilled between February 8 and 11, 2018. Aquifer tests, consisting of a step-drawdown test, a 72-hour constant discharge test followed by monitoring of the recovery of the water level in the Test Well and monitoring wells, were completed between March 19 and 22, 2018. Five potable water samples, three bacteriological samples, and additional water samples for low-level BTEX/TPH hydrocarbon analysis, were collected during the 72-hour aquifer test. The scope of work, field methods, data collected, and the aquifer test results are presented in this report.

1.1 Scope of Work

The scope of work included 1) preparation of a water well design, obtaining a water well drilling permit, issuing two different Requests for Prices to five different drillers, and preparing a contract for the driller's services, 2) siting the borehole location and retaining a contractor to construct a drill pad for the large truck mounted DR12 drill rig, 3) supervising and directing the driller to construct the well, collecting drill cuttings at 1.5 m intervals, 4) selecting the interval for the placement of the well screens based on the drill cuttings, 5) completing grain size analysis on selected drill cutting samples and computing the hydraulic conductivity values for those grain size distribution curves, 6) conducting the aquifer tests and collecting water samples, followed by 7) analyzing the aquifer test data and the water sample laboratory data, and

8) preparation of this report. The Test Well was also designed to determine the nature of the underlying material and if bedrock existed at depth or at least at or above 80 m below ground surface. The design, size, and depth of the well was dictated by the cost and the uncertainty with respect to the depth to bedrock and nature of the overburden materials in the depth range of interest.

2.0 DRILLING AND WELL CONSTRUCTION

2.1 Preparation of the Drill Pad

Prior to mobilizing the drill rig to the proposed Test Well location, the drill pad was prepared by using an excavator to place a culvert and fill in the roadside ditch and to clear the surface bog material and brush to provide access for the drill rig. A drainage ditch was also constructed to permit drainage of the surface water as well as the well development water. As part of the overall hydrogeolgical assessment of the aquifer system and the recharge areas, a monitoring well (BH2) had been constructed near the proposed Test Well location to serve as an observation/monitoring well for the aquifer test.

2.2 Borehole Drilling

Fracflow retained Brewster Drilling and Piling (Brewster) from Mount Uniacke, Nova Scotia, to supply the well materials and to drill and construct the well. Brewster mobilized a DR12 drill rig with supporting equipment to the site on February 7, 2018. A 200 mm diameter casing was advanced in 1.5 m increments to approximately 80 m below ground surface. A surface casing was not installed for this water well but will have to be installed if this well is converted to a water supply production well. The driller's log is presented in Appendix A.

The overburden from approximately 3 m below ground surface (bgs) to approximately 66.25 m of depth consisted of fine to medium sand with some gravel. A thin clay layer (from 66.25 to 66.30 m) was encountered at approximately 66 m of depth followed by a 6 m thick zone of fine sand and then approximately 8 m of coarse conglomerate or coarse gravel in a clay matrix to 80 m bgs. The coarse gravel like drill cuttings consisted of pieces of quartz, granitic and metamorphic rock fragments with carbonate/dolomite rock fragments. The borehole was terminated when the design depth of 80 m bgs was reached. The borehole/well construction log is presented in **Figure 2**. The grain size data for selected samples, from what was identified as the preferred producing zone, for this water well, are presented in **Appendix B**.

The grain size data were used to compute the hydraulic conductivity values for the selected soil samples using the Hazen method (Fetter, 2001) as,

$$K = C(d_{10})^2$$

where *K* is hydraulic conductivity (cm/s), d_{10} is the effective grain size (cm), and *C* is a coefficient based on the table shown in **Table 1**. The method is generally applicable for sand with the effective grain size ranged from 0.01 cm to 0.3 cm. The effective grain sizes (d_{10} values) from the eleven (11) analyzed samples ranged from 0.0087 cm to 0.027 cm and the computed hydraulic conductivity values ranged from 6.06 E-03 cm/s to 7.29 E-02 cm/s with the selected Hazen coefficients.

2.3 Well Construction

Construction of the well assembly was proceeded by pulling the 200 mm regular steel casing back to approximately 66.25 m bgs to avoid the layer of fine sand and the thin clay layer at about 66.25 m bgs. The exposed borehole did not completely collapse below the bottom of the casing and crushed stone (fill) had to be added to the open borehole to fill the borehole up to the bottom of the casing or to 66.52 m bgs.

The water well was constructed using a K-Packer assembly, consisting of a 1.5 m bottom section of tight wound screen (0.005 slot) to serve as a sand trap. A 15 m section of 20 slot screen was then attached to the sand trap with a three metre section of tight wound screen (0.005 slot) between the well screen and the K-Packer. Once the well screen and K-Packer assembly had been lowered into place inside the 200 mm casing, the casing was pulled back approximately 15 m such that the bottom of the casing and the casing shoe were approximately 1.0 m above the top of the slot 20 well screen. The K-Packer and screen assembly sank under its own weight another 0.5 m such that the bottom of the sand trap was located at approximately 66.52 m bgs. The borehole and well construction log are provided in **Figure 2.**

2.4 Well Development

The well was developed on February 11, 2018, for a period of approximately one hour by air lifting within the well screen using a series of on and off air-lifting cycles to surge the well and to remove the fines from around the well screen. The discharge water was free of fines after a few minutes within each surging cycle. Due to the large volume of water (approximately 500 to

600 USgpm) that was being produced by air lifting and the limited space for water discharge, the planned procedure of well development using a surge block with simultaneous air-lifting could not be used on this well in the cold weather that was experienced at the time of the well construction and/or during the period before the aquifer test. This well can be expected to continue to develop with continued pumping especially with on and off pump cycles that will surge the water in the well, removing fines, with a corresponding increase in the permeability of the material that is adjacent to the well screen.

3.0 AQUIFER TESTING

3.1 Equipment Setup

The aquifer test equipment was installed on March 17 and 18, 2018. A 40 hp pump controlled by a variable frequency drive (VFD) was lowered into the well using a winch and tripod system with a safety rope and steel cable attached. The pump was powered using a mobile 85 KVA 3-phase generator.

The pump riser consisted of 100 mm diameter Aqua-Pipe sections that were connected to an electronic turbine flowmeter at the surface, a sampling port for collecting water samples and a valve to control the pump discharge. The discharge pipe at the surface consisted of approximately 90 m of 100 mm diameter lay-flat hose that extended to a down slope area such that the discharge water flowed down the slope over frozen ground to a nearby pond.

Two leveloggers were installed in the pumping well using the same 25 mm diameter stilling tube and the water level changes and groundwater temperatures before, during and after the aquifer test were monitored and recorded using direct read cables attached to the leveloggers.

Leveloggers were also installed in three nearby monitoring wells (**Figure 1**) that served as monitoring or observation wells for this aquifer test. A baralogger was placed within the trailer at the Test Well location to provide the data needed to correct the measured levelogger data on water levels for barometric pressure changes during the aquifer test. It is important to note that the screened sections of the monitoring wells did not extend to the depth in the aquifer in which the Test Well was screened.

3.2 Step-Drawdown Test

A step-drawdown test was completed on Test Well MHPW1 using the pump assembly described above to determine what pumping or discharge rate should be used to conduct the 72-hour aquifer test.

Four (4) steps were completed (**Figure 3**) with the initial static water level at 18.92 m below the top of the casing. The initial step was set at a flow rate of 344 Lpm for a period of approximately 19 minutes with the drawdown stabilizing at approximately 0.75 m. The second step was set at a flow rate of about 623 Lpm, the third step was set at 1,204 Lpm and the fourth and final step was set at 2,167 Lpm that produced a drawdown of about 5.13 m. All four steps, conducted over a 116 minute period, reached steady state within a few minutes with the fourth step showing a slight increase in drawdown with time.

Using the data from the step-drawdown test, an estimate of the optimum pumping rate for a well can be obtained by plotting the drawdown divided by pumping rate versus pumping rate for each step (**Figure 4**). The slope and intercept of a regression line fitted to these four (4) data points give the coefficients of the equation that describes the flow regime components that affect drawdown in a pumping well, such that;

$$dd = BQ + CQ^2$$

where: dd = drawdown;
Q = pumping rate;
B = coefficient for laminar component of drawdown (intercept); and
C = coefficient for turbulent component of drawdown (slope).

The slope of the line also gives an indication of the efficiency of the well (**Figure 4**). The smaller the slope of the line, the greater the well efficiency. For this Test Well, MHPW1, **Figure 4** shows that with a regression line slope of 1E-07, the well is very efficient at the measured pumping rates. Based on the step-drawdown test data, a pumping rate 1,820 Lpm was selected as the long term pumping rate for the 72-hour aquifer test since the maximum capacity of the pump with the 100 mm diameter discharge line was approximately 2,300 Lpm.

3.3 Aquifer Test Data and Safe Well Yield

The pump, riser and flow meter assembly (aquifer test equipment) used in the step-drawdown test was then used to conduct the 72-hour aquifer test. Once the water levels in the pumping well had returned to their original static water levels, the 72-hour aquifer test started on Monday, March 19, 2018, at 5:40 pm and ended 4,320 minutes later on Thursday, March 22, 2018, at 5:40 pm. The average pumping rate during the test was 1,820 Lpm. The water level dropped from an initial static level of 18.97 m to a near steady-state pumping level of 23.50 m below the top of the casing (i.e., the difference between these two readings equals a total drawdown of 4.53 m). The recorded data are provided in **Appendix C**.

The drawdown versus time data for the 72-hour aquifer test are plotted on a log-log diagram in **Figure 5**. The water well responded immediately to the imposed pumping rate and reached essentially a stable drawdown within 90 seconds with only a small increase in the drawdown in the first 100 minutes of pumping followed by a small but steady increase in drawdown until the pump was shut down. When the pump was shut down, the water level in the well recovered the first four metres of the drawdown in the first 20 seconds followed by a small but steady recovery of the water levels over the next 1,000 minutes.

Monitoring well, BH2 (**Figure 1**) is located 100 m northwest of the Test Well, with a monitoring well screen placed at 15.76 m to 23.38 m bgs but approximately 27.6 m above the top of the well screen in the Test Well. The water level in BH2 started to respond to the Test Well pumping within one minute (**Figure 6**) demonstrating that the vertical permeability of this section of the aquifer is similar to the horizontal permeability and that the producing zone of the aquifer for this Test Well responds more as an unconfined aquifer than a very leaky confined aquifer. The linear nature of the measured drawdown in this monitoring well, after the first five minutes of the aquifer test, reflects the vertical position of the monitoring well screen relative to the screened interval in the Test Well. A 3-D model will be used to compare the simulated drawdowns for the model nodes at the position within the aquifer that matches the monitoring well screen position to further define the hydraulic conductivity of the aquifer in the area of the Test Well.

The early time aquifer test data do not fit the Theis curve (Fetter, 2001) very well although the aquifer could be classified as a very leaky semi-confined aquifer. Based on the shape of the measured drawdown curve, the Neuman type curves (Fetter, 2001) were used to compute a range of hydraulic conductivity (K) values for this aquifer. Fitting the later time drawdowns to the Neuman unconfined aquifer type curves (**Figure 7**) produces a K value of 5.52×10^{-5} m/s for an assumed aquifer thickness of 50 m. Fitting the early time data to the Neuman type curves (**Figure 8**) produces a K value of 1.63×10^{-5} m/s. The slight increase in the drawdown that started

after 100 minutes of pumping is indicative of the response that is provided by pumping a well in an unconfined aquifer. For comparison purposes, the pumping well data were also analyzed using the Cooper-Jacob semi-log or time drawdown plot (**Figure 9)**, which is used to analyze Test Well well data in a confined aquifer, with the analysis based on the later time data producing a K value of 8.51×10^{-4} m/s.

The drawdown data from monitoring well, BH2 (**Figure 10**) were analyzed using the Cooper-Jacob time drawdown procedure (generally referred to as the straight-line procedure) with the computed K value being based on the later time drawdown data. This approach produced a K value of 7.11×10^{-4} m/s and a storativity of 0.0948, which is consistent with the storativity values that are expected for either an unconfined aquifer or a very leaky semi-confined aquifer. A 3-D flow model will be used to compared the K values that have been computed using the type curve approach and the grain size Hazen method, to the model parameters that are required to match the measured and modeled drawdowns at the same points in the aquifer.

The water level recovery data for the pumping well (**Figure 11**) did not produce useable data for type curve analysis due to the rapid response of the water levels immediately after the pump was turned off at the end of the 72-hour aquifer test. The water levels in the monitoring well (**Figure 12**) showed a more gradual response with the water levels in the monitoring well still recovering approximately one day after the pump was turned off.

Estimating the long term or safe well yield from this Test Well is referenced to the drawdown of approximately 4.5 m for a flowrate of 1,820 litres per minute. Based on the results of this aquifer test, the data indicate that the short term specific capacity will be approximately 400 litres per minute per metre of drawdown. This specific capacity is expected to decrease with increasing drawdown due to well losses from entrance/velocity effects and the accumulation of fines in the aquifer material around the well screen over time. The available drawdown for the pump system that was used is approximately 20 m to 22 m. For this well, the safe well yield is more determined by the size of the well screen and the well casing than by the available drawdown. The estimated safe yield, if a 125 mm (5 inch) pump discharge pipe or riser is used, is 2,100 Lpm to 2,200 Lpm. The well, if the pump is sized to deliver more water, can yield 2,500 Lpm for periods of up to 24 hours on an infrequent basis. Ultimately, the safe yield from a well depends on the aquifer geometry and characteristics since a 72-hour aquifer test does not provide a measure of the long term yield, especially if other production wells are extracting water from the same aquifer.

3.3.1 Groundwater Chemistry

Water samples were collected for pH, fluid electrical conductivity, and turbidity measurements during the three day aquifer test. Five (5) suites of water samples were collected during the three day period, for standard water analysis, total metals, and dissolved metals along with two (2) water samples for low level BTEX/TPH - hydrocarbon analysis. The laboratory analysis included pH and fluid conductivity measurements. Water temperatures were recorded along with water levels by the leveloggers. There were no measurable changes in pH and fluid conductivity during the three day test even though approximately eight million litres of water were pumped from the aquifer.

The laboratory reports are provided in **Appendix D**. The basic chemical data for general chemistry, total metals and dissolved metals are tabulated for ease of reference in **Tables 2, 3 and 4**. Based on the five standard water samples, the pH varied from 8.11 to 8.14 and fluid electrical conductivity varied from 310 umho/cm to 323 umho/cm. Mercury was below detection levels in all five laboratory samples. Copper and lead concentrations both decreased with increase in pumping times. The zinc concentration in the first water sample was above guideline but decreased to below guideline in all of the next four water samples. TDS and hardness are typical of groundwater and did not change significantly during the three day test, indicating limited or no contact with surface waters in close proximity to the Test Well screened section.

Table 5 provides the low-level BTEX/TPH analysis of two of the last three water samples that were collected during this aquifer test. All of the hydrocarbon components were below detection levels.

Water samples were also collected and submitted for bacteriological analysis (**Appendix D**). All of the submitted samples were free of any colliform impacts.

4.0 DISCUSSION AND RECOMMENDATIONS

The aquifer at the location of the Test Well consists primarily of medium sand with some gravel and scattered boulders or cobbles to approximately 67 m bgs, followed by a thin clay layer, that overlies a 6 m thick layer of fine sand that grades into a conglomeratic bedrock or a layer of gravel embedded in a clay matrix to the end of the borehole at 80 m bgs. The computed hydraulic conductivities varies from 5.52 E-05 m/s to 8.51E-04 m/s with the hydraulic conductivities that were computed from the grain size data falling within this range.

The aquifer test data indicate that this aquifer is responding as an unconfined aquifer or a very leaky confined aquifer. A 3-D model has to be used to match the measured drawdowns and screened sections in the monitoring well and the pumping well within the aquifer to the computed drawdowns at the same locations within at the model.

The safe yield of this well is controlled in part by the size of the well screen and with a specific capacity of approximately 400 litres per metre of drawdown and an available drawdown of 22 m for the pump configuration used in this aquifer test, the estimated safe yield of this well is 2,300 Lpm.

The general chemistry, total metals and dissolved metals laboratory data indicate that this Test Well water is suitable for aquaculture usage. Also, the low-level BTEX/TPH laboratory data for two (2) water samples that were collected during the aquifer test show no evidence of any hydrocarbon impacts in the immediate area of the Test Well.

Based on the yield obtained from this Test Well, it is recommended that future production wells be constructed using a 250 mm (10 inch) diameter well screen with a straight well assembly. In addition, each well design should be adapted to the aquifer materials that are encountered during the borehole drilling. To further evaluate the aquifer system and to provide additional data for aquifer test evaluation of future production wells, a 15 cm diameter casing should be driven within 30 m of the production well location to approximately 90 m of depth, into obvious bedrock, and the borehole instrumented with three 50 mm diameter monitoring wells, with screens at 85 m to 90 m, 55 m to 65 m and at 30 m to 35 m of depth, as the casing is withdrawn. This multi-level piezometer or monitoring well will enable collection of water samples from the bedrock, and the measured hydraulic heads will show the direction of groundwater movement during aquifer tests.

5.0 REFERENCE

Fetter, C.W., 2001, *Applied Hydrogeology*. Fourth Edition, Prentice Hall.

Tables

Table 1 Hydraulic conductivity values computed from grain size data using Hazen method. The sample ID includes the depth in feet below the ground surface

Sample ID	d_{10} mm	d_{10} cm	$C^{(1)}$ --	K cm/s	K m/s	C_{min} --	C_{max} --	K_{min} cm/s	K_{max} cm/s
MHPW1-160-165	0.16	0.016	80	**2.05E-02**	**2.05E-04**	70	90	1.79E-02	2.30E-02
MHPW1-165-170	0.16	0.016	80	**2.05E-02**	**2.05E-04**	70	90	1.79E-02	2.30E-02
MHPW1-170-175	0.17	0.017	90	**2.60E-02**	**2.60E-04**	80	100	2.31E-02	2.89E-02
MHPW1-175-180	0.16	0.016	90	**2.30E-02**	**2.30E-04**	80	100	2.05E-02	2.56E-02
MHPW1-180-185	0.1	0.01	80	**8.00E-03**	**8.00E-05**	70	90	7.00E-03	9.00E-03
MHPW1-185-190	0.095	0.0095	80	**7.22E-03**	**7.22E-05**	70	90	6.32E-03	8.12E-03
MHPW1-190-195	0.087	0.0087	80	**6.06E-03**	**6.06E-05**	70	90	5.30E-03	6.81E-03
MHPW1-195-200	0.12	0.012	90	**1.30E-02**	**1.30E-04**	80	100	1.15E-02	1.44E-02
MHPW1-200-205	0.265	0.0265	100	**7.02E-02**	**7.02E-04**	90	110	6.32E-02	7.72E-02
MHPW1-205-210	0.27	0.027	100	**7.29E-02**	**7.29E-04**	90	110	6.56E-02	8.02E-02
MHPW1-210-215	0.26	0.026	100	**6.76E-02**	**6.76E-04**	90	110	6.08E-02	7.44E-02

Note: (1) Table for coefficient ***C*** by *Hazen* (1911).

40 - 80 Very fine sand, poorly sorted
40 - 80 Fine sand with appreciable fines
80 - 120 Medium sand, well sorted
80 - 120 Coarse sand, poorly sorted
120 - 150 Coarse sand, well sorted, clean

Table 2 Analytical results of standard water analysis in water samples for Test Well, MHPW1, Stephenville, NL.

Project 3113 - Aquifer Test Sampling Program								
Fracflow Sample ID	**Units**	**G / S**	**RDL**	**3113-MHPW1-WS1**	**3113-MHPW1-WS2**	**3113-MHPW1-WS3**	**3113-MHPW1-WS4**	**3113-MHPW1-WS5**
Sampling Date				3/19/2018	3/20/2018	3/21/2018	3/22/2018	3/22/2018
AGAT ID				9144904	9144904	9149300	9149305	9149302
Standard Water Analysis + Additional Parameters								
pH		6.5-9.0		8.11	8.11	8.14	8.13	8.13
Reactive Silica as SiO2	mg/L		0.5	10.9	7.4	6	5.7	5.7
Chloride	mg/L	640, 120	1	13	12	12	12	12
Fluoride	mg/L	0.12	0.12	<0.12	<0.12	<0.12	<0.12	<0.12
Sulphate	mg/L		2	5	4	4	4	4
Alkalinity	mg/L		5	142	142	143	143	143
True Color	TCU	Narrative	5	13	14	<5	<5	<5
Turbidity	NTU	Narrative	0.1	0.8	1.1	0.5	0.9	0.7
Electrical Conductivity	umho/cm		1	310	313	321	323	322
Nitrate + Nitrite as N	mg/L		0.05	0.43	0.37	0.36	0.39	0.37
Nitrate as N	mg/L	550, 13	0.05	0.43	0.37	0.36	0.39	0.37
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.03	0.05	0.04	0.04	<0.03
Total Organic Carbon	mg/L		0.5	<0.5	<0.5	<0.5	0.7	1.7
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01	0.08	0.07	0.08
Total Sodium	mg/L		0.1	8.2	8.1	8.2	8.3	8.2
Total Potassium	mg/L		0.1	1	0.9	0.9	0.9	0.9
Total Calcium	mg/L		0.1	50.3	47	50	47.3	49.7
Total Magnesium	mg/L		0.1	6.9	6.9	7.2	7.1	6.8
Bicarb. Alkalinity (as CaCO3)	mg/L		5	142	142	143	143	143
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10	<10	<10	<10
Hydroxide	mg/L		5	<5	<5	<5	<5	<5
Calculated TDS	mg/L		1	172	166	170	167	169
Hardness	mg/L			154	146	154	147	152
Langelier Index (@20C)	NA			0.35	0.33	0.38	0.35	0.37
Langelier Index (@ 4C)	NA			0.03	0.01	0.06	0.03	0.05
Saturation pH (@ 20C)	NA			7.76	7.78	7.76	7.78	7.76
Saturation pH (@ 4C)	NA			8.08	8.1	8.08	8.1	8.08
Anion Sum	me/L			3.34	3.29	3.31	3.31	3.31
Cation sum	me/L			3.47	3.3	3.48	3.34	3.42
% Difference/ Ion Balance (NS	%			1.9	0.2	2.5	0.4	1.7
Dissolved Organic Carbon	mg/L		0.5	<0.5				<0.5
Mercury	ug/L	0.026	0.026	<0.026				<0.026
Mercury Digest				y				y
Total Kjeldahl Nitrogen as N	mg/L		0.4	0.5				<0.4
Bromide	mg/L		0.05	<0.05				<0.05

Comments: - **Bold/Shaded** - Exceeds Guideline/Standard
- RDL - Reported Detection Limit;
- G / S - Guideline / Standard

Table 3 Analytical results of total metals in water samples for Test Well, MHPW1, Stephenville, NL.

Project 3113 - Aquifer Test Sampling Program								
Fracflow Sample ID	**Units**	**G / S**	**RDL**	**3113-MHPW1-WS1**	**3113-MHPW1-WS2**	**3113-MHPW1-WS3**	**3113-MHPW1-WS4**	**3113-MHPW1-WS5**
Sampling Date				3/19/2018	3/20/2018	3/21/2018	3/22/2018	3/22/2018
AGAT ID				9144903	9144904	9149300	9149305	9149302
Total Metals								
Total Aluminum	ug/L	Variable	5	8	7	<5	<5	<5
Total Antimony	ug/L		2	<2	<2	<2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2	<2	<2	<2
Total Barium	ug/L		5	39	39	39	39	39
Total Beryllium	ug/L		2	<2	<2	<2	<2	<2
Total Bismuth	ug/L		2	<2	<2	<2	<2	<2
Total Boron	ug/L	29000, 1500	5	12	6	7	7	6
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017	<0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1	<1	<1	<1
Total Cobalt	ug/L		1	<1	<1	<1	<1	<1
Total Copper	ug/L	Equation	1	44	13	4	1	1
Total Iron	ug/L	300	50	89	65	65	68	63
Total Lead	ug/L	Equation	0.5	4.5	1.8	0.6	0.6	<0.5
Total Manganese	ug/L		2	4	3	3	3	3
Total Molybdenum	ug/L	73	2	<2	<2	<2	<2	<2
Total Nickel	ug/L	Equation	2	2	<2	2	2	2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03	0.03	0.03	0.02
Total Selenium	ug/L	1	1	<1	<1	<1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium	ug/L		5	84	86	86	88	87
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2	<2	<2	<2
Total Titanium	ug/L		2	<2	<2	<2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.4	0.4	0.4	0.4	0.3
Total Vanadium	ug/L		2	<2	<2	<2	<2	<2
Total Zinc	ug/L	30	5	**82**	23	26	15	22

Comments: - **Bold/Shaded** - Exceeds Guideline/Standard
- RDL - Reported Detection Limit;
- G / S - Guideline / Standard

Table 4 Analytical results of dissolved metals in water samples for Test Well, MHPW1, Stephenville, NL.

Project 3113 - Aquifer Test Sampling Program						
Fracflow Sample ID	**Units**	**G / S**	**RDL**	**3113-MHPW1-WS1**	**3113-MHPW1-WS3**	**3113-MHPW1-WS5**
Sampling Date				3/19/2018	3/21/2018	3/22/2018
AGAT ID				9144903	9149300	9149302
Dissolved Metals						
Dissolved Aluminum	ug/L	Variable	5	<5	<5	<5
Dissolved Antimony	ug/L		2	<2	<2	<2
Dissolved Arsenic	ug/L	5	2	<2	<2	<2
Dissolved Barium	ug/L		5	41	40	39
Dissolved Beryllium	ug/L		2	<2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2	<2
Dissolved Boron	ug/L	29000, 1500	5	21	7	7
Dissolved Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	2	2	2
Dissolved Cobalt	ug/L		1	<1	<1	<1
Dissolved Copper	ug/L	Equation	2	4	<2	<2
Dissolved Iron	ug/L	300	50	<50	<50	<50
Dissolved Lead	ug/L	Equation	0.5	0.8	<0.5	<0.5
Dissolved Manganese	ug/L		2	3	2	<2
Dissolved Molybdenum	ug/L	73	2	<2	<2	<2
Dissolved Nickel	ug/L	Equation	2	<2	6	<2
Dissolved Selenium	ug/L	1	1	<1	<1	<1
Dissolved Silver	ug/L	0.25	0.1	<0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	84	83	83
Dissolved Thallium	ug/L	0.8	0.1	<0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2	<2
Dissolved Uranium	ug/L	33, 15	0.1	0.4	0.3	0.3
Dissolved Vanadium	ug/L		2	<2	<2	<2
Dissolved Zinc	ug/L	30	5	**81**	28	29

Comments: - **Bold/Shaded** - Exceeds Guideline/Standard
- RDL - Reported Detection Limit;
- G / S - Guideline / Standard
- Analysis completed on a filtered sample.

Table 5 Analytical results of low level BTEX/TPH of selected water samples from Test Well, MHPW1, Stephenville, NL.

Project 3113 - Aquifer Test Sampling Program					
Fracflow Sample ID	**Units**	**Tier I**	**RDL**	**3113-MHPW1-WS3**	**3113-MHPW1-WS5**
Sampling Date				3/21/2018	3/22/2018
AGAT ID				9149300	9149302
Petroleum Hydrocarbons					
Benzene	mg/L		0.001	<0.001	<0.001
Toluene	mg/L		0.001	<0.001	<0.001
Ethylbenzene	mg/L		0.001	<0.001	<0.001
Xylene (Total)	mg/L		0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	<0.01	<0.01
Modified TPH (Tier 1)	mg/L		0.1	<0.1	<0.1
Resemblance Comment				NR	NR
Return to Baseline at C32				Y	Y
Surrogate Recovery (%)					
Isobutylbenzene - EPH	%			111	119
Isobutylbenzene - VPH	%			89	94
n-Dotriacontane - EPH	%			112	122

Comments:
- Tier I - Atlantic RBCA Version 3 Minimum requirements and reference guidelines for environmental assessments of petroleum impacted sites in Atlantic Canada (Non-potable
- **Bold/Shaded** - Exceeds Tier I Criteria.
- RDL - Reported Detection Limit;
- G / S - Guideline / Standard
- Results are based on the dry weight of the soil.
- Resemblance Comment Key:

FOF - Fuel Oil Fraction
FR - Product in Fuel Oil Range
GF - Gasoline Fraction
GR - Product in Gasoline Range
LOF - Lube Oil Fraction
LR - Lube Range
NA - Not Applicable
NR - No Resemblance

Figures

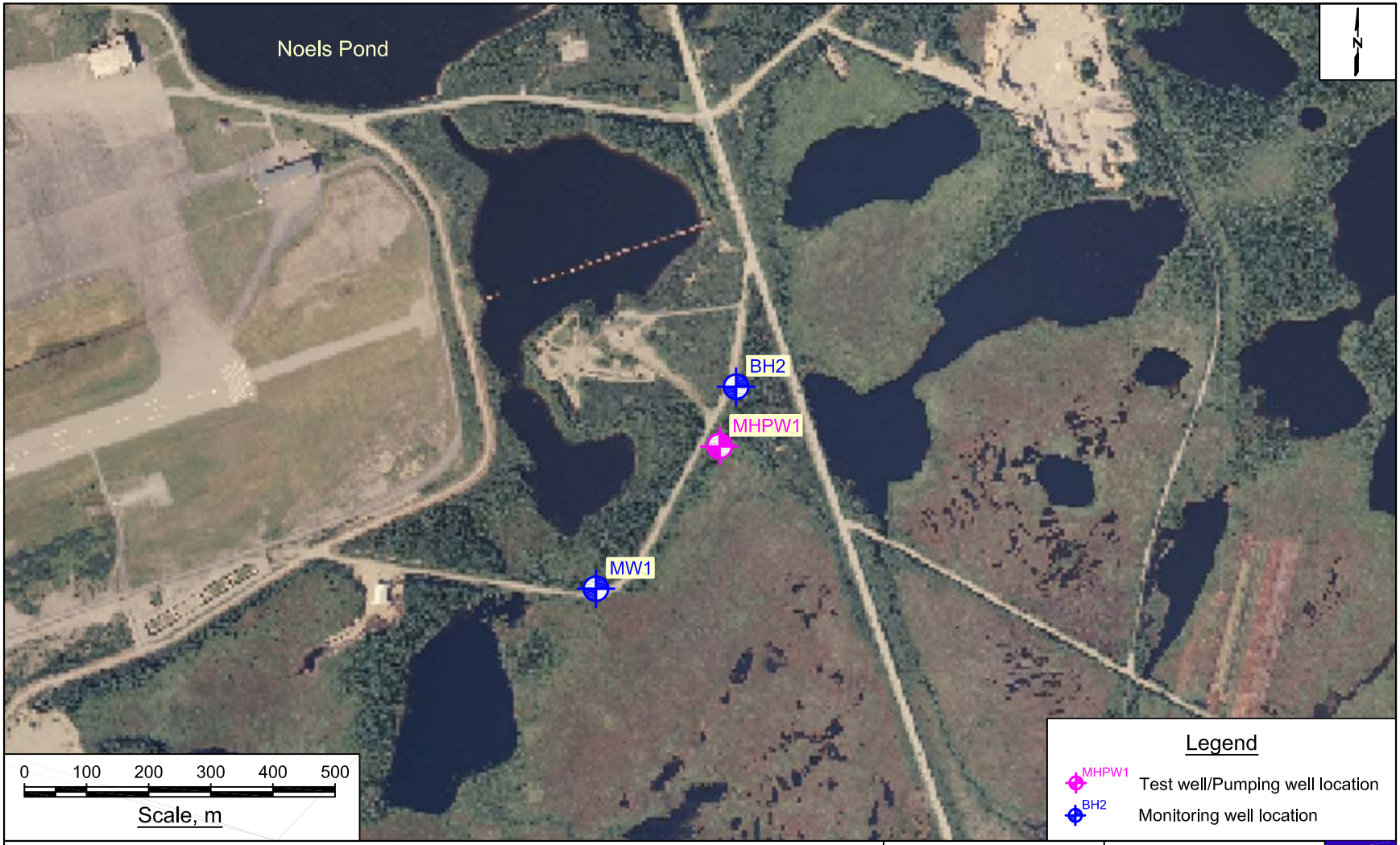


Figure 1 Borehole location map for the Test Well, MHPW1 and two monitoring wells, BH2 and MW1.

Project No. 3113E	Document Reference FFC-NL-3113-006
Location Stephenville, NL	Date April 2018

FFC

Project: Water Suppy Well - Test Well
Location: Stephenville, NL
Client: Marine Harvest Atlantic Canada
Drilling Supervisor: Kevin Gale

Well Log: MHPW1

Project No: 3113
Date: February 8 - 11, 2018

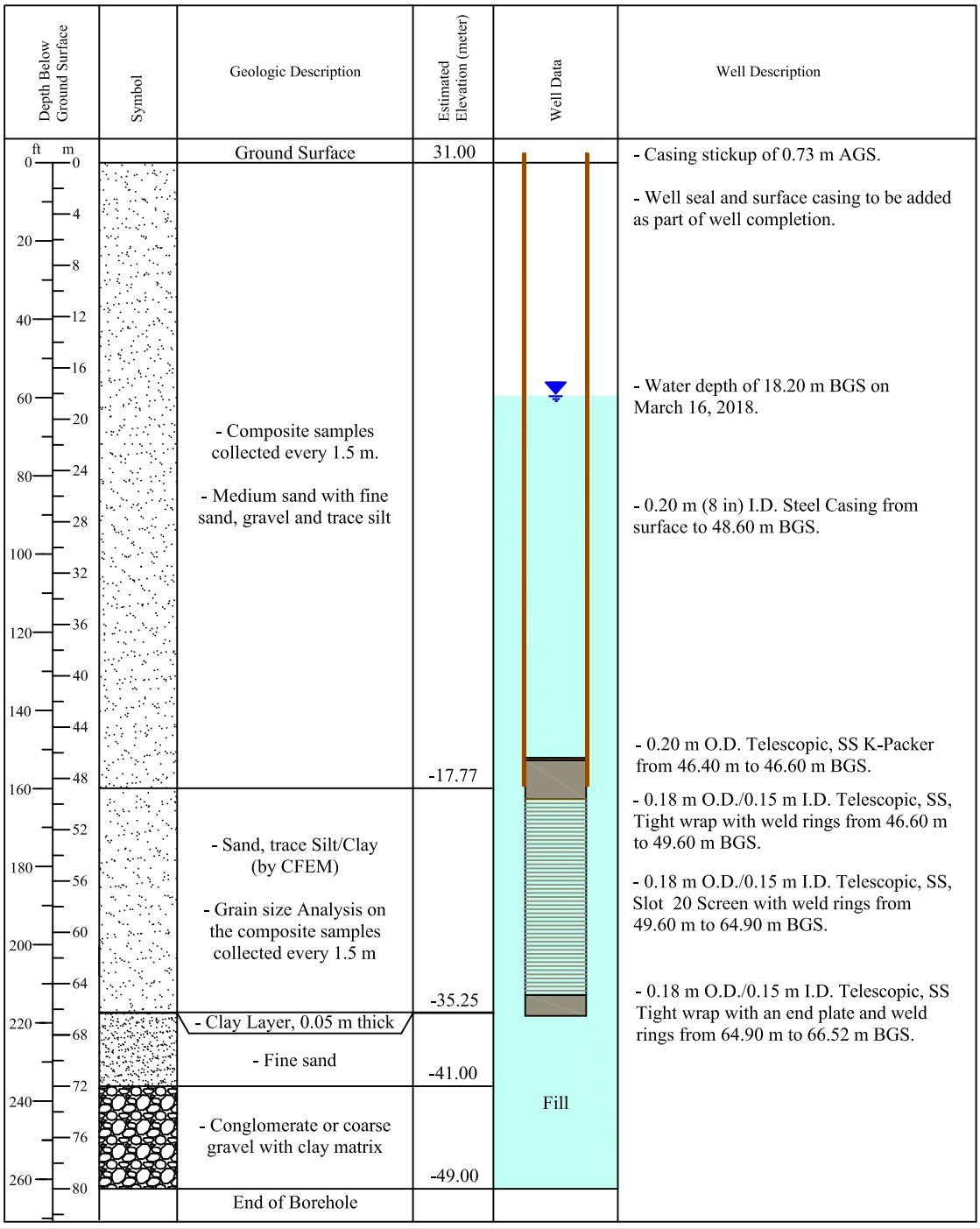


Figure 2 Borehole and well construction log.

Project No.	Document No.
3113	FFC-NL3113-006
Location	Date
Stephenville	April 2018

FFC

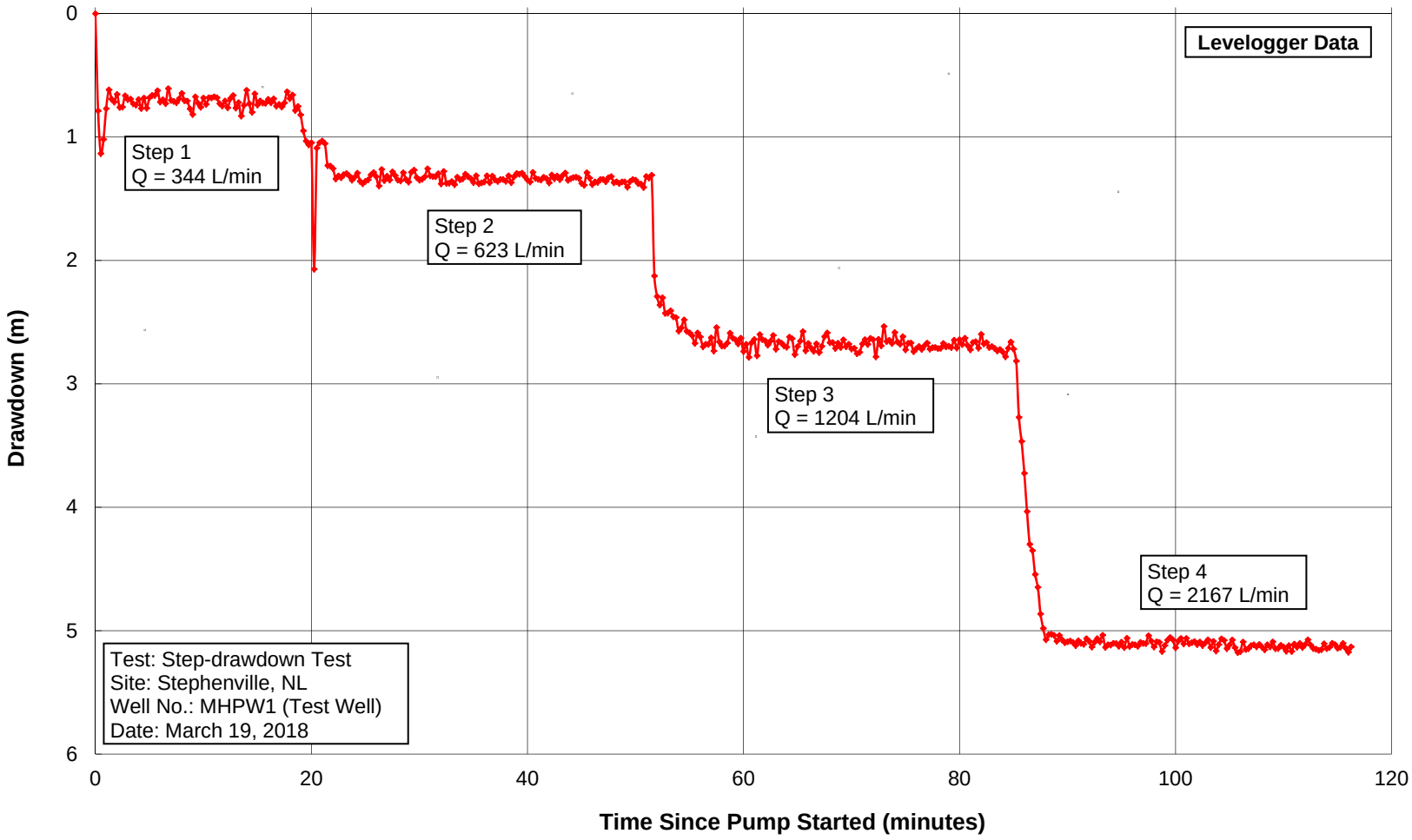


Figure 3 Plot of drawdown versus time for the step-drawdown test.

Project No.	Document Reference
3113E	FFC-NL-3113
Location	Date
Stephenville, NL	April 2018

FFC

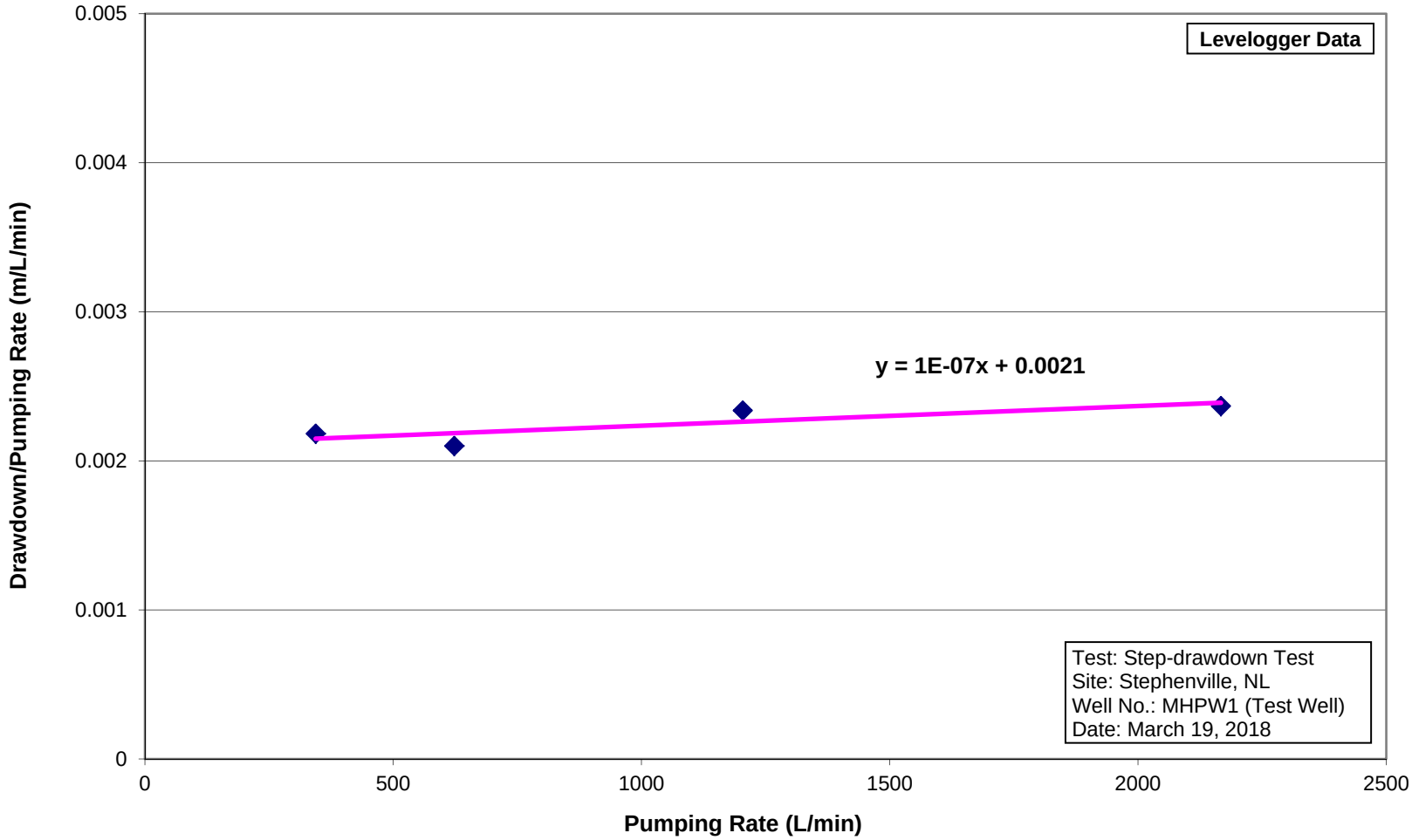


Figure 4 Plot of drawdown divided by the pumping rate versus the pumping rate for the step-drawdown test.

Project No.	Document Reference
3113E	FFC-NL-3113
Location	Date
Stephenville, NL	April 2018

FFC

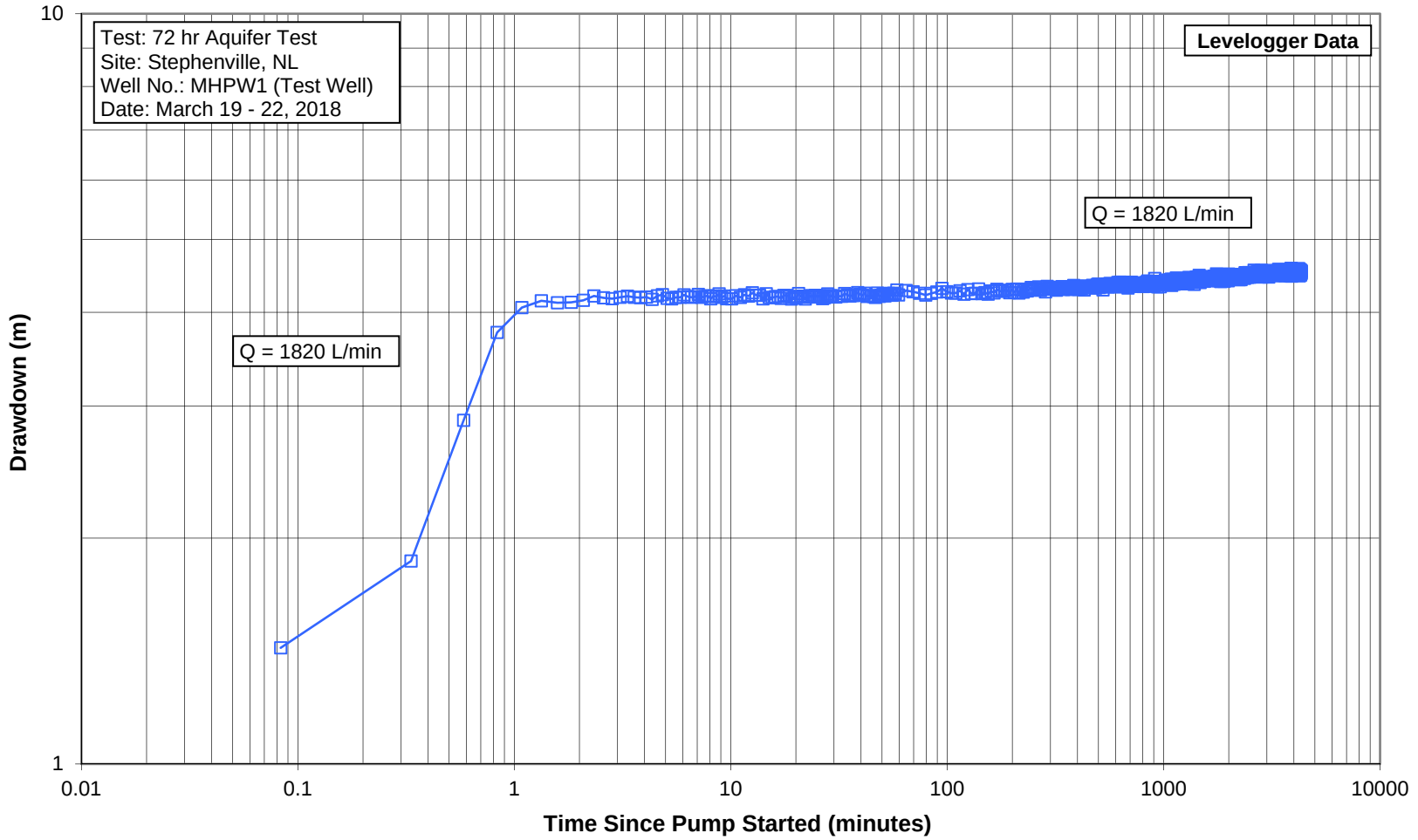


Figure 5 Log-log plot of drawdown versus time for the pumping well during the aquifer test.

Project No.	Document Reference
3113E	FFC-NL-3113
Location	Date
Stephenville, NL	April 2018

FFC

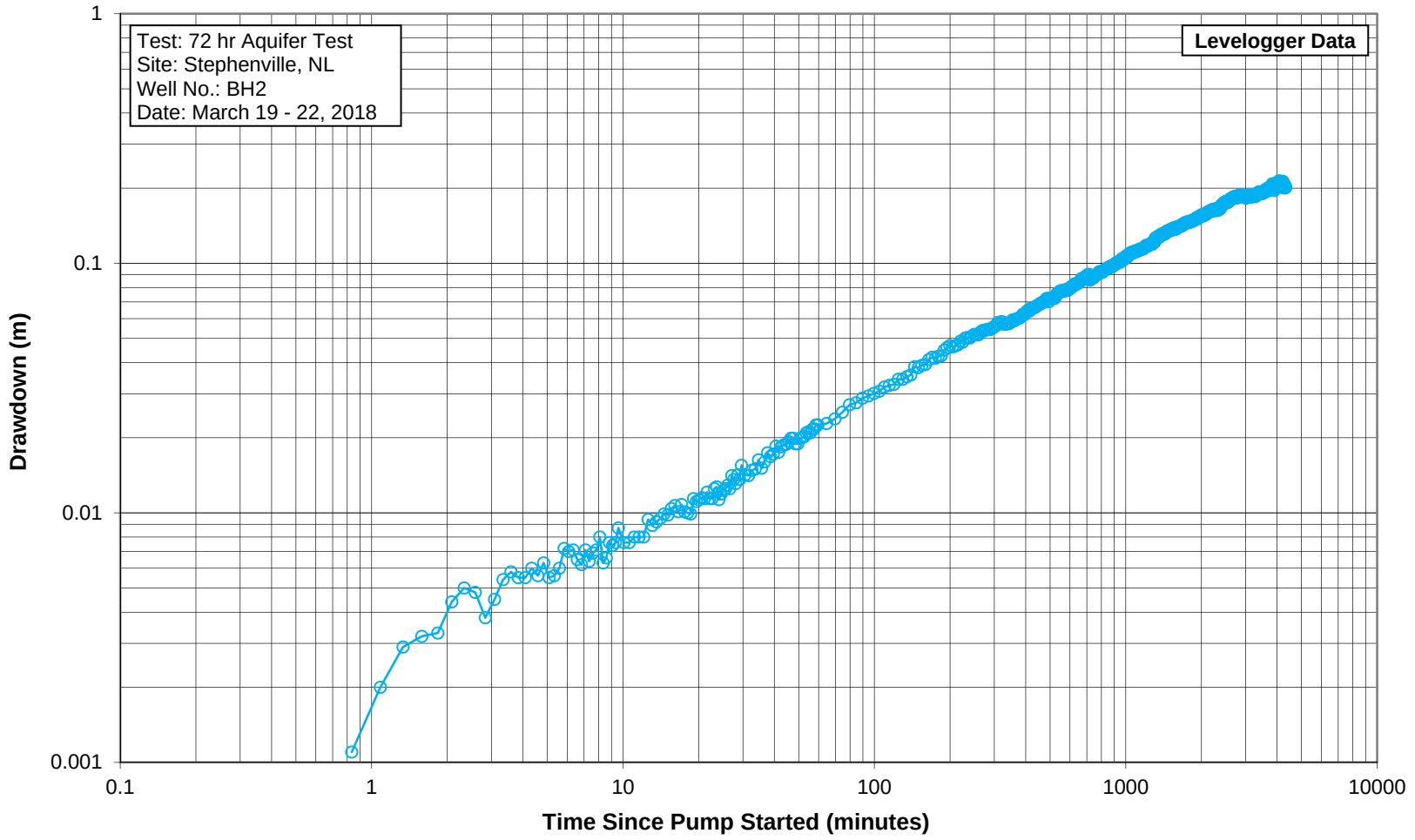


Figure 6 Log-log plot of drawdown versus time for the monitoring well, BH2, during the 72 hour aquifer test on MHPW1 (Test Well).

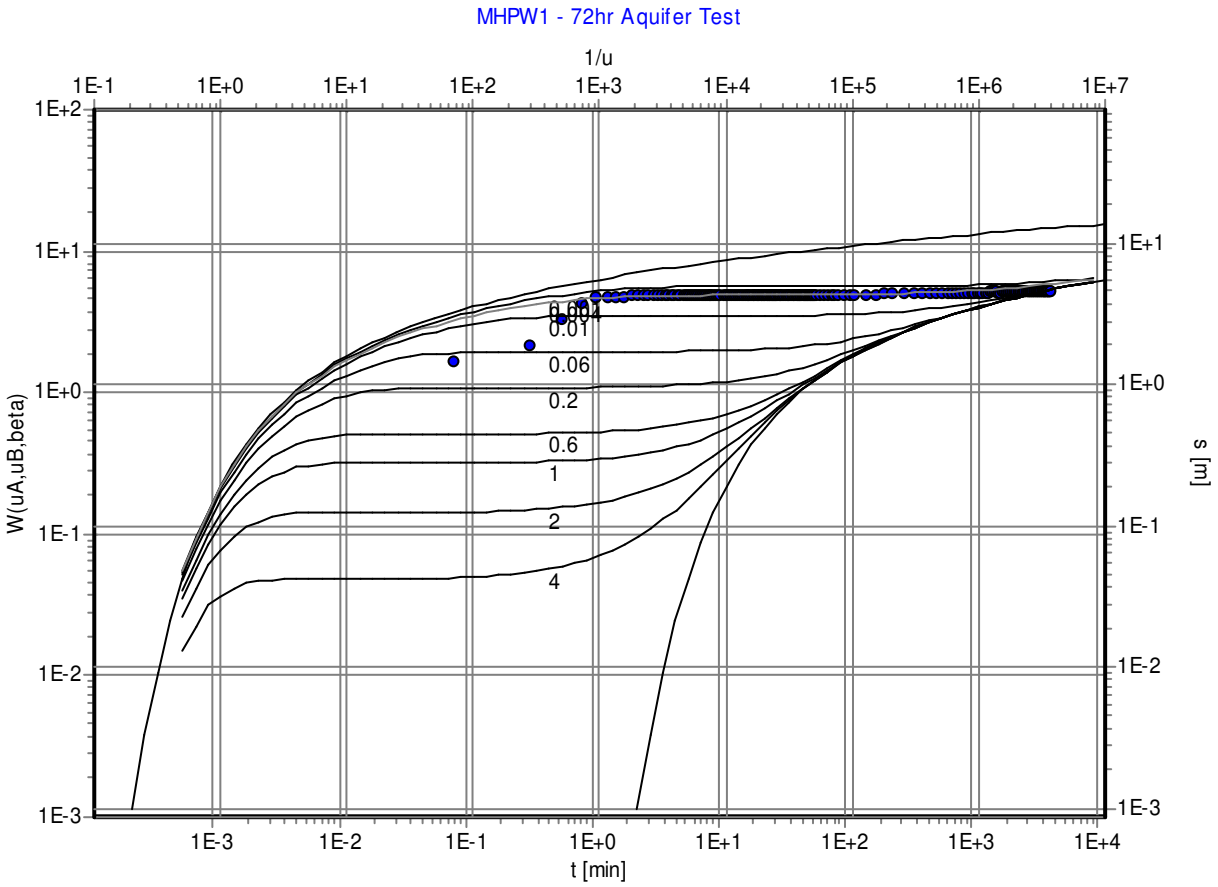
Project No.	Document Reference
3113E	FFC-NL-3113
Location	Date
Stephenville, NL	April 2018

FFC

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL Canada
Phone: +1 709-739-7270

Pumping Test Analysis Report

Project:	3113-AquiferTest
No:	3113
Client:	Marine Harvest Atlantic Canada



Test name: **MHPW1-72hr**

Analysis method: **Neuman**

Analysis results:	Transmissivity:	2.76E-3 [m²/s]	Conductivity:	5.52E-5 [m/s]

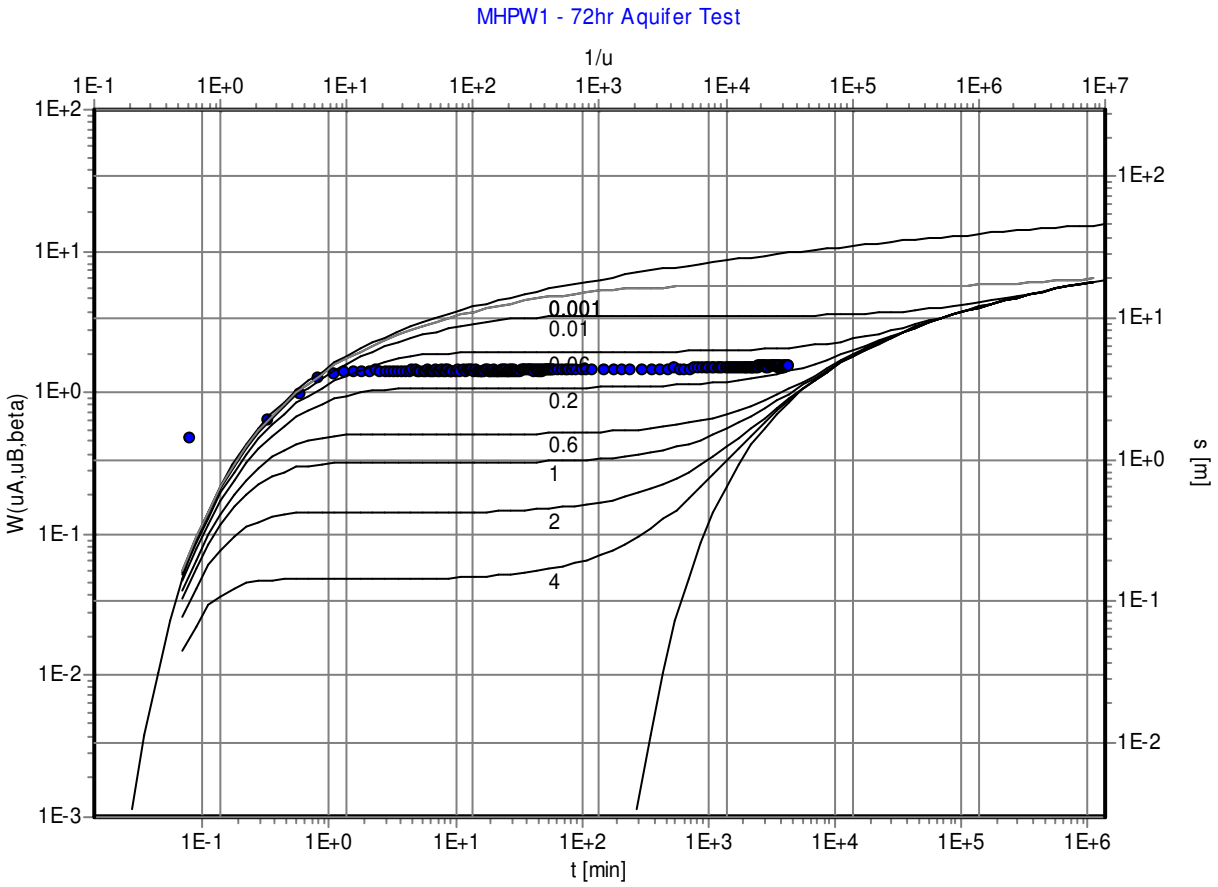
Test parameters:				
	Pumping well:	MHPW1	Aquifer thickness:	50 [m]
	Casing radius:	0.1016 [m]		
	Screen length:	15 [m]		
	Screen radius:	0.0762 [m]		
	Discharge rate:	30.33 [l/s]		

Figure 7 Analysis of the 72-hour aquifer test on the Test Well, MHPW1, using the Neuman method on a log-log plot for the later drawdowns.

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL Canada
Phone: +1 709-739-7270

Pumping Test Analysis Report

Project:	3113-AquiferTest
No:	3113
Client:	Marine Harvest Atlantic Canada



Test name: **MHPW1-72hr**

Analysis method: **Neuman**

Analysis results:	Transmissivity:	8.14E-4 [m²/s]	Conductivity:	1.63E-5 [m/s]

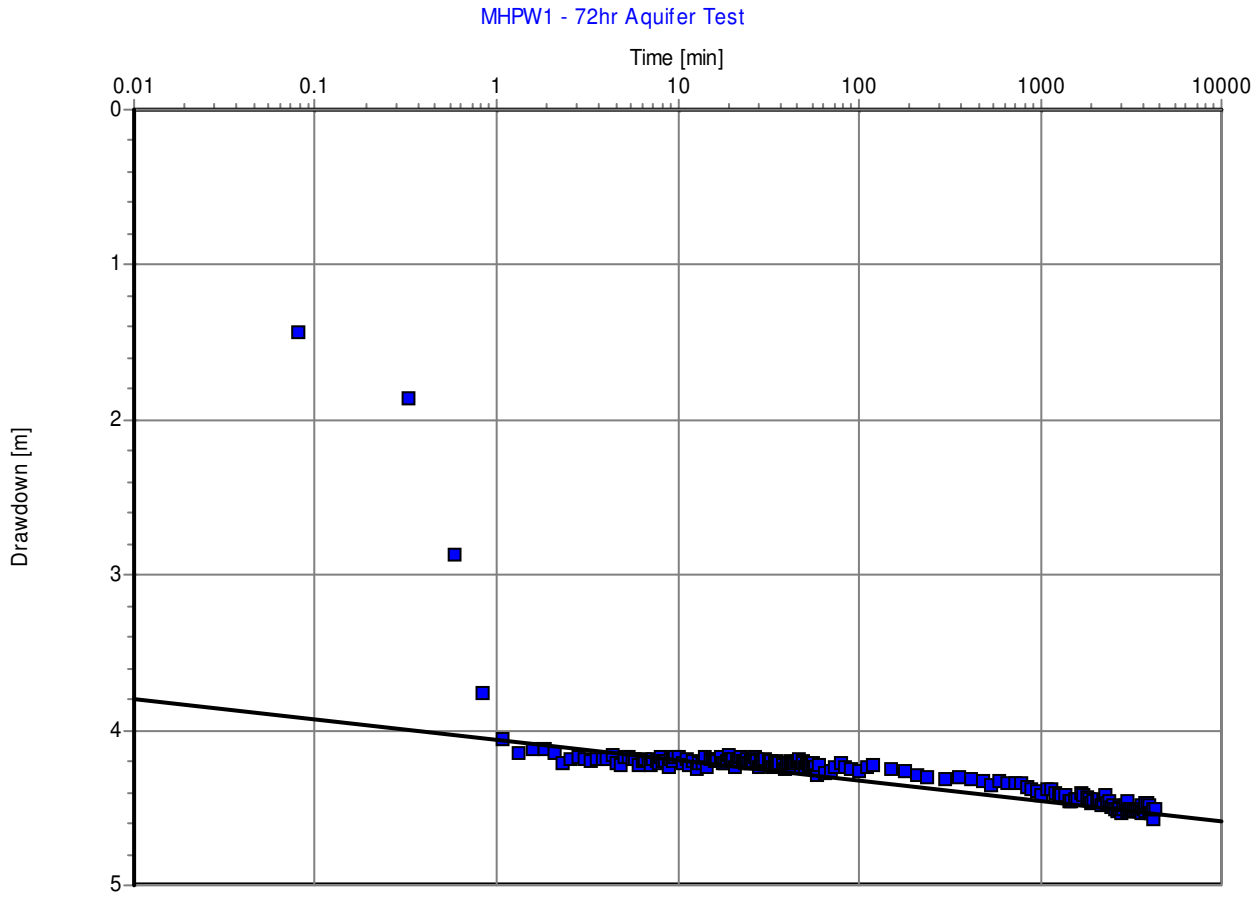
Test parameters:				
	Pumping well:	MHPW1	Aquifer thickness:	50 [m]
	Casing radius:	0.1016 [m]		
	Screen length:	15 [m]		
	Screen radius:	0.0762 [m]		
	Discharge rate:	30.33 [l/s]		

Figure 8 Analysis of the 72-hour aquifer test on the Test Well, MHPW1, using the Neuman method on a log-log plot for the early drawdowns.

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL Canada
Phone: +1 709-739-7270

Pumping Test Analysis Report

Project:	3113-AquiferTest
No:	3113
Client:	Marine Harvest Atlantic Canada



Test name: **MHPW1-72hr**

Analysis method: **Cooper-Jacob Time-Drawdown**

Analysis results:	Transmissivity:	4.24E-2 [m²/s]	Conductivity:	8.48E-4 [m/s]

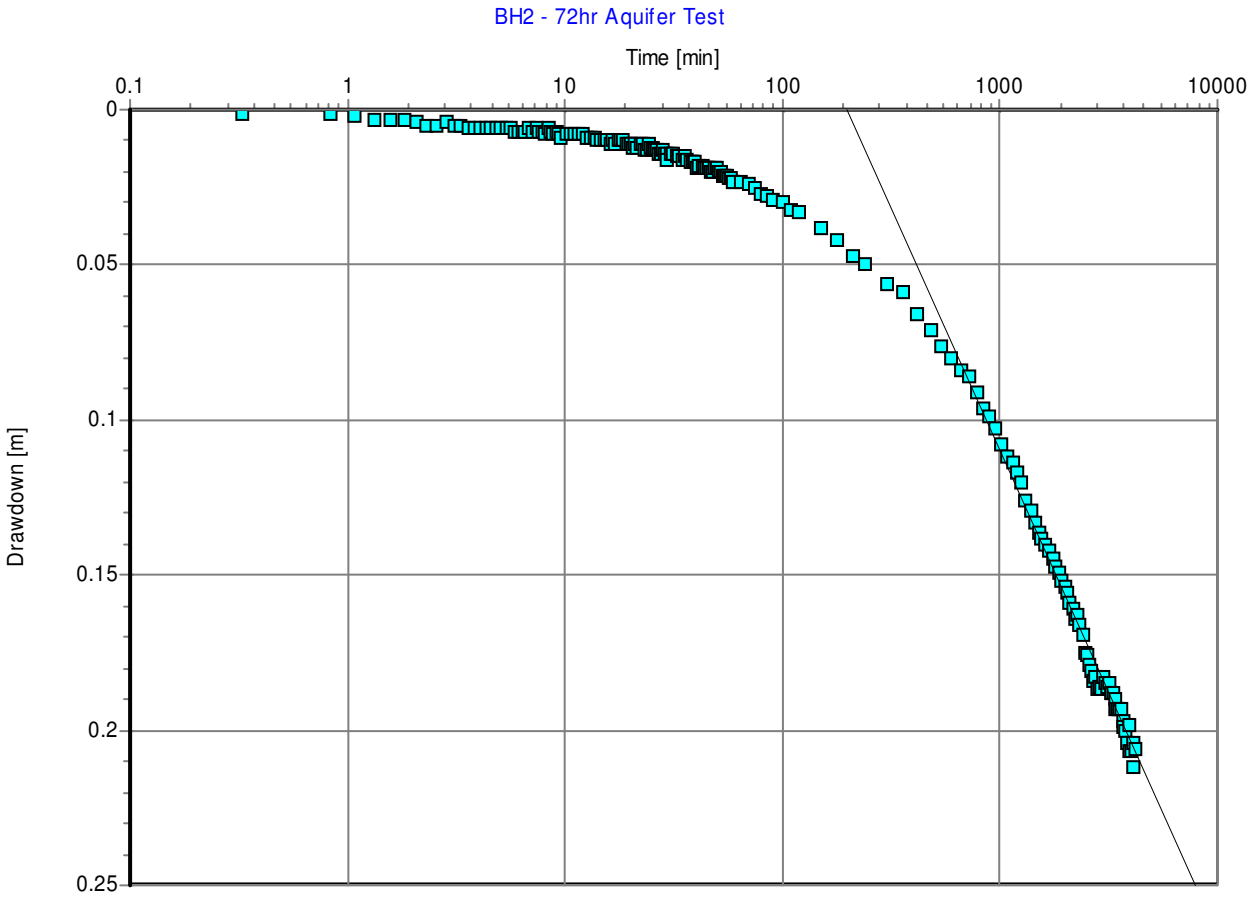
Test parameters:	Pumping well:	MHPW1	Aquifer thickness:	50 [m]
	Casing radius:	0.1016 [m]		
	Screen length:	15 [m]		
	Screen radius:	0.0762 [m]		
	Discharge rate:	30.33 [l/s]		

Figure 9 Analysis of the 72-hour aquifer test on the Test Well, MHPW1, using the Cooper-Jacob straight line method on a semi-log plot.

Fracflow Consultants Inc.
154 Major's Path
St. John's, NL Canada
Phone: +1 709-739-7270

Pumping Test Analysis Report

Project:	3113-AquiferTest
No:	3113
Client:	Marine Harvest Atlantic Canada



Test name: **BH2-72hr**

Analysis method: **Cooper-Jacob Time-Drawdown**

Analysis results:	Transmissivity:	3.55E-2 [m²/s]	Conductivity:	7.11E-4 [m/s]
	Storativity:	9.48E-2		
Test parameters:	Pumping well:	MHPW1	Aquifer thickness:	50 [m]
	Casing radius:	0.1016 [m]		
	Screen length:	15 [m]		
	Screen radius:	0.0762 [m]		
	Discharge rate:	30.33 [l/s]		

Figure 10 Analysis of aquifer test on the monitoring well, BH2, using the Cooper-Jacob straight line method on a semi-log plot during the 72-hour aquifer test on the production well, MHPW1.

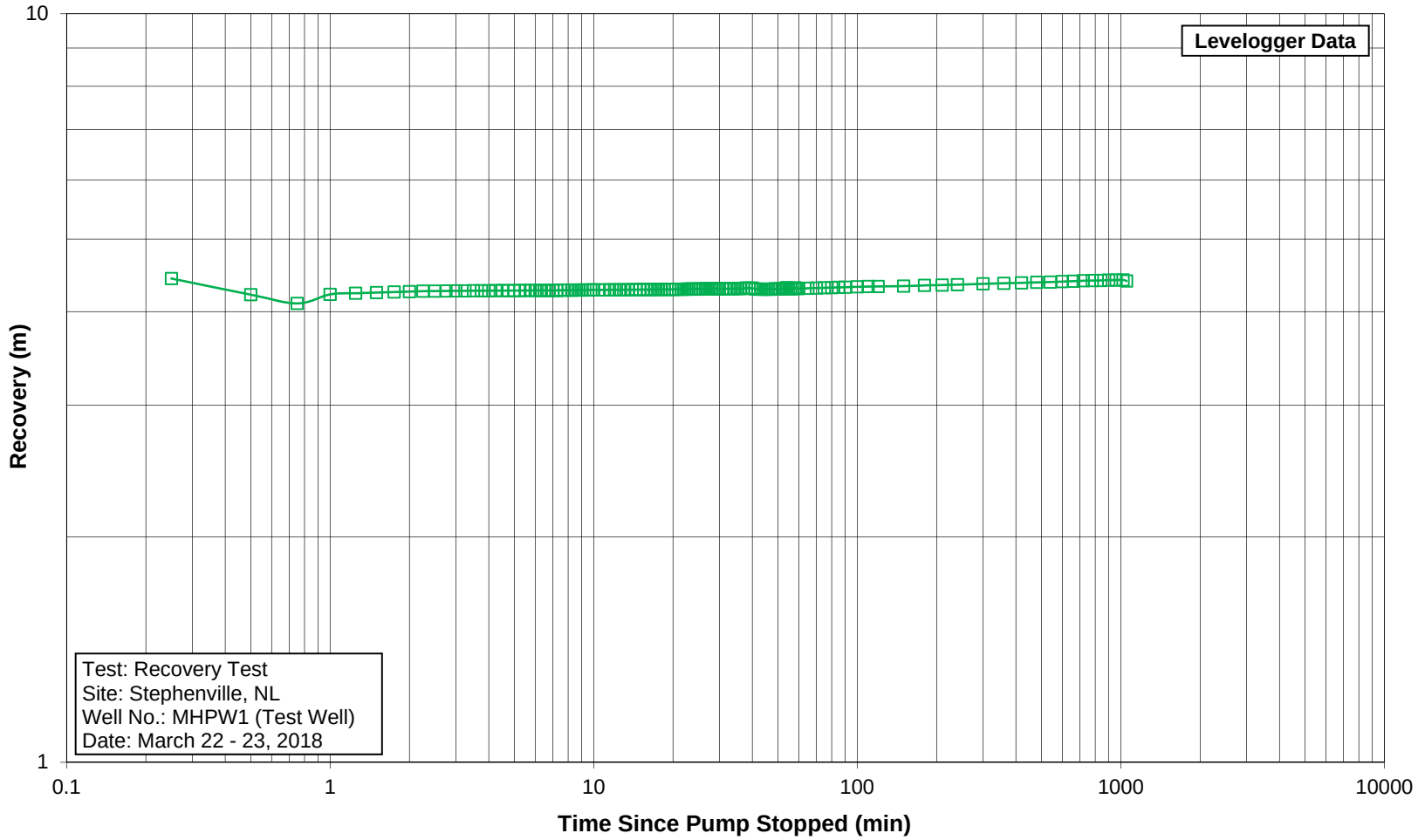


Figure 11 Plot of recovery versus time for water level recovery in the pumping well after the termination of the 72 hour aquifer test.

Project No.	Document Reference
3113E	FFC-NL-3113
Location	Date
Stephenville, NL	April 2018

FFC

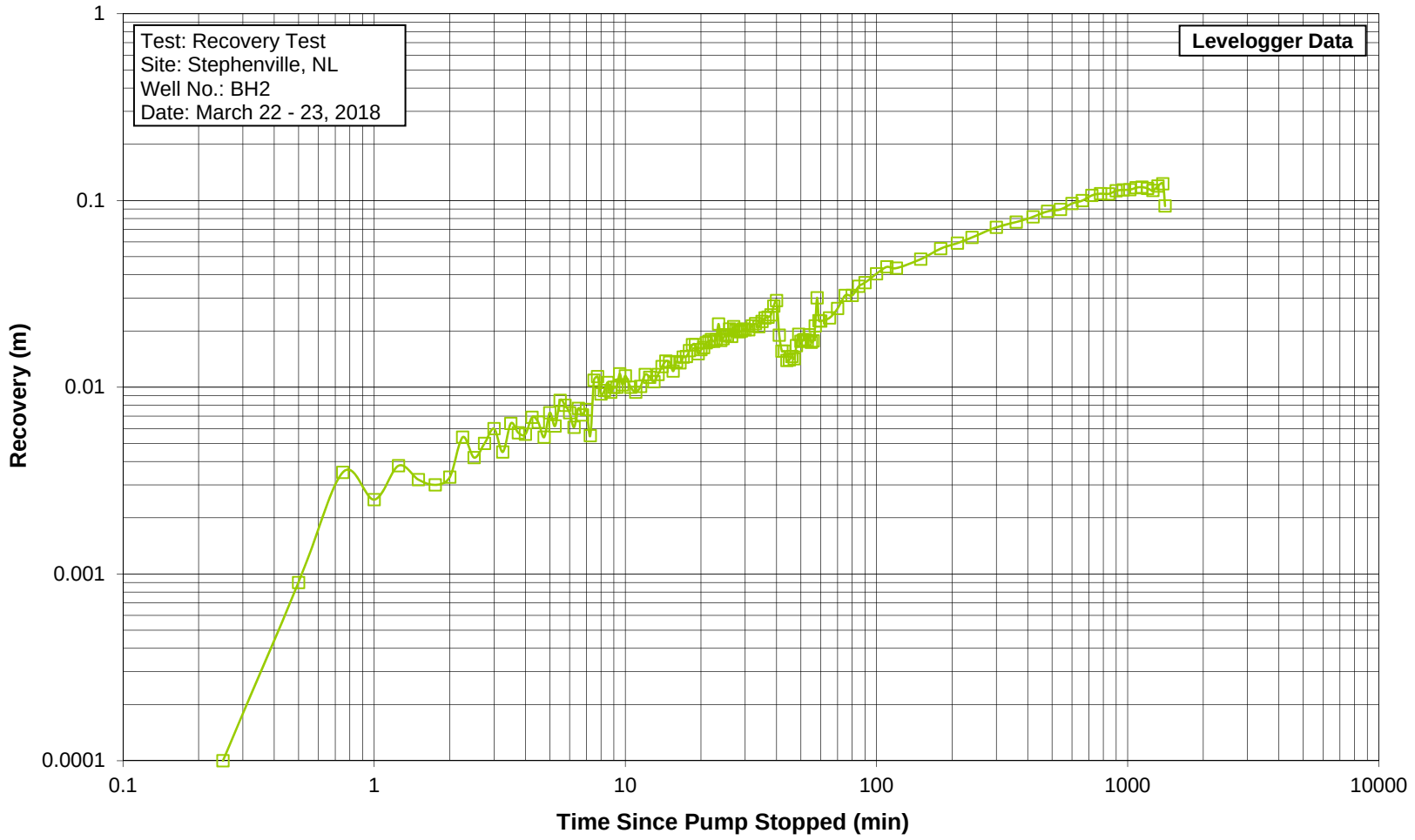


Figure 12 Plot of recovery versus time for water level recovery in the monitoring well, BH2, after termination of the 72 hour aquifer test on MHPW1.

Project No.	Document Reference
3113E	FFC-NL-3113
Location	Date
Stephenville, NL	April 2018

FFC

APPENDIX A

Driller's Records

Newfoundland Labrador

Department of Environment and Conservation
Water Resources Management Division
Well Construction Record

Well Identification Number (WIN)

Measurements: ☐ Metric ☑ US

Well Owner Information (must be the final owner of well or borehole)

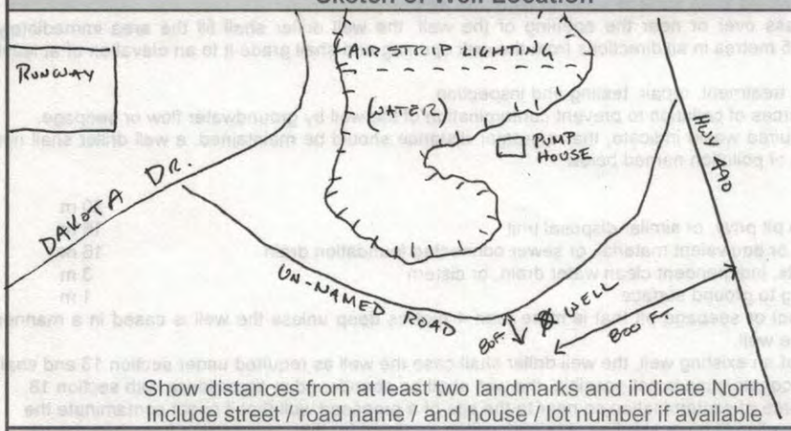
First Name	Last Name	Street Address		
MARINE HARVEST ATLANTIC CANADA		124 - 1334 ISLAND HIGHWAY, CAMPBELL RIVER, BC		
Town/City	**LGID** For Office Use Only	**LGID Name** For Office Use Only	**Postal Code**	**Telephone**
V9W 8H9			V9W 8H9	

Well/Borehole Location

Town/City	Street Address/Lot Number	Land Owner (Developer, Private, etc.)
STEPHENVILLE	BETWEEN HWY 490 / DAKOTA DRIVE	TOWN OF STEPHENVILLE

GPS Coordinates Latitude N 48 ° 32 ' 48.0 " Longitude W 58 ° 31 ' 15.4 "

Sketch of Well Location



Show distances from at least two landmarks and indicate North
Include street / road name / and house / lot number if available

Water Bearing Zones

Depth	Rate	Type
55 - 240	≈ 400 GPM	SAND

Type of Water Encountered

☑ Fresh ☐ Odourous ☐ Salt
☐ Cloudy ☑ Clear ☐ Coloured
☐ Other (Specify) _____

Borehole Lithology

Depth	Colour	Lithology
0 - 55	BROWN	COARSE SAND W/ COBBLES
55 - 230	BROWN	FINE SAND ≈ 30-40% PASSING 0.020 SLOT
230 - 235	~~FRACTURED~~ BROWN/GREEN WHITE/GREY	BROKEN SANDSTONE W/ CLEAN WASHED GRAVEL CONSISTING OF QUARTZ, LIMESTONE
235 - 260	GREY	SAND STONE (NO WATER)

Depth to Bedrock: 235 Ft **Depth of borehole containing casing:** 164 Ft **Total depth of borehole:** 219 Ft

Casing Information - recommended Sch 40, .280 Wall

Casing should be finished 0.60 metres (2 feet) above grade

Depth From	Depth To	Inside Diameter	Type	Thickness
0	164	8.125	A53	0.25

Height of the casing finished above grade: _____

Annular Space and Sealant

The annulus of the well should be sealed with an impermeable sealant from the bottom of the casing/drive shoe to the surface.

Depth From	Depth To	Type of Sealant Used
⊘	⊘	⊘

Reason why annulus was not sealed: TEST WELL

Screen Information

Was a screen installed? ☐ Yes ☐ No

From	To	Slot	Diameter	Material
154	219	# 20	6"	304 L TIGHT WIND FROM: 154 - 169 + 215.5 - 219

Drilling Method

☑ Rotary (Air) ☑ Hammer ☐ Reverse Rotary
☐ Other DUAL ROTARY
Drive Shoe installed? ☑ Yes ☐ No

Final Status of Well/Borehole

☐ Domestic ☐ Municipal ☐ Exploration ☐ Sealed Well
☐ Dewatering ☐ Geothermal ☐ Observation ☑ Other TEST WELL
PERMIT # GW9 502 - 2017

Pumping Test Results

Flowing Well: ☐ Yes ☑ No
If flowing, rate:

Static Water Level: 60 Ft

Recommended Pumping Rate: 200 GPM

Method:
☑ Air Lift ☐ Pump
☐ Other _____

Pump Intake at: 180 Duration: 1 HR

Recommended Pump Depth: 160

Pumping Rate during Test: 400 GPM

Estimated Safe Yield: 200 GPM

Licenced Water Well Construction Contractor Information

Comments: WELL DRILLED TO 260 FT BG. BACKFILLED TO 215 FT. TELESCOPIC SCREEN INSTALLED AND SANK TO 219 FT. SCREEN CONSISTS OF 10' 3" RISER AND K PACKER 51' 2" # 20 V-WIRE AND 3' 6" BAIL CASING WAS PULLED BACK TO 164 FT TO EXPOSE SCREEN. WILL RETURN TO SEAL IF USED FOR PRODUCTION.

Well Construction Company	Licence Number	Well Completed on: (Day – Month – Year)
BREWSTER WELL DRILLING	027 / 039	11 - 02 - 2018

Driller		Driller Assistant	
Sign	KYLE FETTERLY Print	Sign	IVAN GOUGH Print

This is a Legal Document *Safeguard with Home Owner's Documents*

If you have any questions regarding this document, please call Water Resources Management at 709-729-2563

White Copy – Department of Environment and Conservation Yellow Copy – Drilling Company Pink Copy – Well Owner

APPENDIX B

Reports of Grain Size Analysis

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

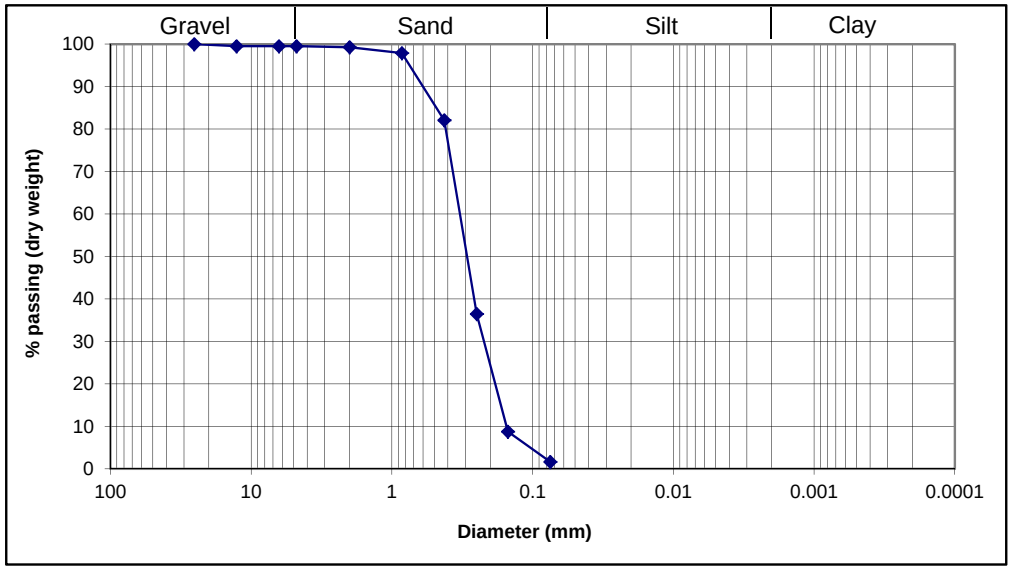
Sample No. : MHPW1-160-165

Depth below GS : 48.77 - 50.29 m
(160 - 165 ft)

Sieve Analysis

Dry weight of sample (g) = 734.02

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret	% Passing
2	50.8	-	-		
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	3.66	0.50	0.50	99.50
1/4"	6.35	0.00	0.00	0.50	99.50
4	4.76	0.00	0.00	0.50	99.50
10	2.00	1.68	0.23	0.73	99.27
20	0.85	10.19	1.39	2.12	97.88
40	0.425	115.95	15.80	17.91	82.09
60	0.25	334.85	45.62	63.53	36.47
100	0.15	203.38	27.71	91.24	8.76
200	0.075	52.28	7.12	98.36	1.64
pan	---	12.03	1.64	100.00	---
		734.02			



D_{10} = 0.16

D_{30} = 0.22

D_{60} = 0.33

Cu = 2.06

Cc = 0.92

USCS: SP (Poorly graded sand)

R_{200} = 98.36

R_4 = 0.50

R_4/R_{200} = 0.01

SF = 97.86

GF = 0.50

% Gravel = 0.50

% Sand = 97.86

% Silt & Clay = 1.64

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

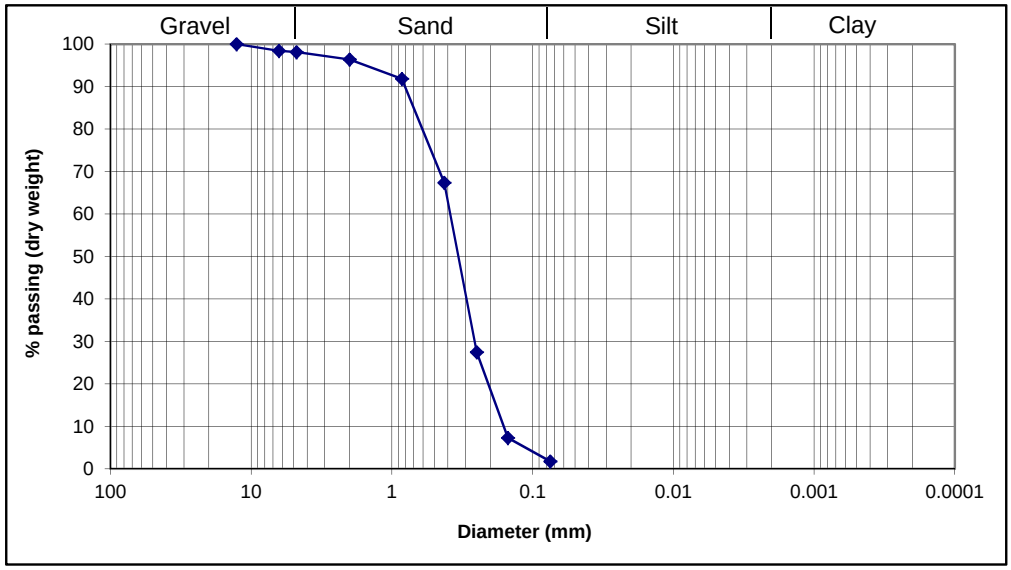
Sample No. : MHPW1-165-170

Depth below GS : 50.29 - 51.82 m
(165 - 170 ft)

Sieve Analysis

Dry weight of sample (g) = 434.51

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	6.87	1.58	1.58	98.42
4	4.76	1.28	0.29	1.88	98.12
10	2.00	7.61	1.75	3.63	96.37
20	0.85	19.66	4.52	8.15	91.85
40	0.425	106.32	24.47	32.62	67.38
60	0.25	173.40	39.91	72.53	27.47
100	0.15	87.65	20.17	92.70	7.30
200	0.075	24.05	5.53	98.23	1.77
pan	---	7.67	1.77	100.00	---
		434.51			



D_{10} = 0.16

D_{30} = 0.26

D_{60} = 0.38

Cu = 2.38

Cc = 1.11

USCS: SP (Poorly graded sand)

R_{200} = 98.23

R_4 = 1.88

R_4/R_{200} = 0.02

SF = 96.36

GF = 1.88

% Gravel = 1.88

% Sand = 96.36

% Silt & Clay = 1.77

% Clay = NA

CFEM: Sand, trace Gravel, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

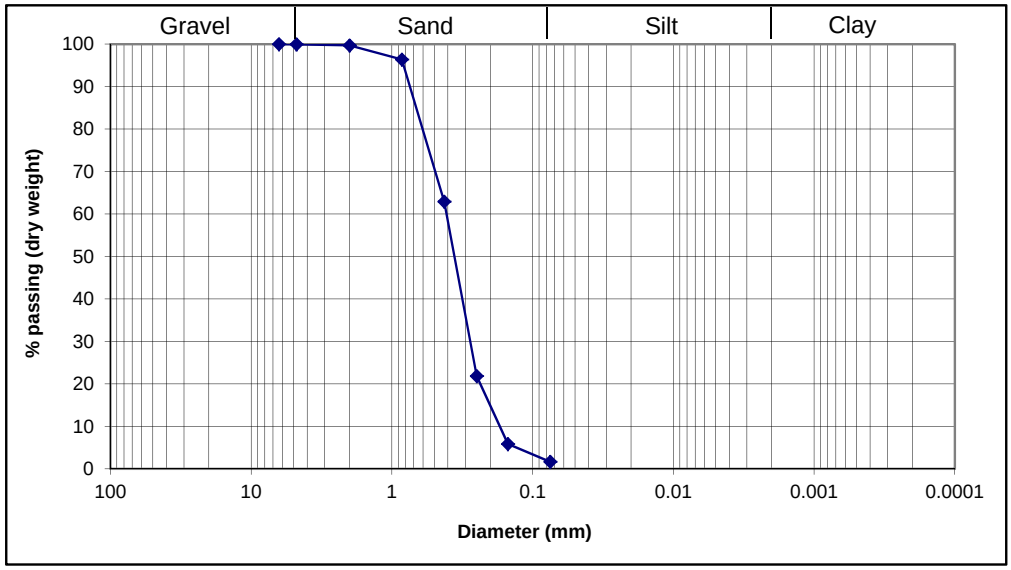
Sample No. : MHPW1-170-175

Depth below GS : 51.82 - 53.34 m
(170 - 175 ft)

Sieve Analysis

Dry weight of sample (g) = 434.30

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	0.22	0.05	0.05	99.95
10	2.00	1.04	0.24	0.29	99.71
20	0.85	14.47	3.33	3.62	96.38
40	0.425	145.38	33.47	37.10	62.90
60	0.25	178.32	41.06	78.16	21.84
100	0.15	69.45	15.99	94.15	5.85
200	0.075	18.21	4.19	98.34	1.66
pan	---	7.21	1.66	100.00	---
		434.30			



D_{10} = 0.17

D_{30} = 0.28

D_{60} = 0.41

Cu = 2.41

Cc = 1.12

USCS: SP (Poorly graded sand)

R_{200} = 98.34

R_4 = 0.05

R_4/R_{200} = 0.00

SF = 98.29

GF = 0.05

% Gravel = 0.05

% Sand = 98.29

% Silt & Clay = 1.66

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

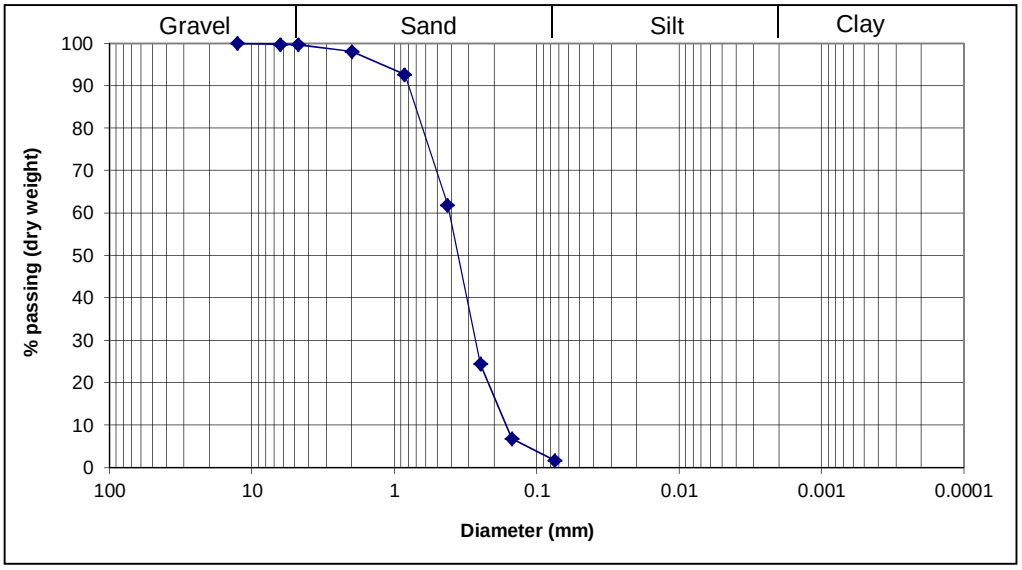
Sample No. : MHPW1-175-180

Depth below GS : 53.34 - 54.86 m
(175 - 180 ft)

Sieve Analysis

Dry weight of sample (g) = 462.23

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	1.13	0.24	0.24	99.76
4	4.76	0.36	0.08	0.32	99.68
10	2.00	7.19	1.56	1.88	98.12
20	0.85	25.31	5.48	7.35	92.65
40	0.425	141.93	30.71	38.06	61.94
60	0.25	173.38	37.51	75.57	24.43
100	0.15	81.28	17.58	93.15	6.85
200	0.075	23.36	5.05	98.21	1.79
pan	---	8.29	1.79	100.00	---
		462.23			



D_{10} = 0.16

D_{30} = 0.27

D_{60} = 0.41

Cu = 2.56

Cc = 1.11

USCS: SP (Poorly graded sand)

R_{200} = 98.21

R_4 = 0.32

R_4/R_{200} = 0.00

SF = 97.88

GF = 0.32

% Gravel = 0.32

% Sand = 97.88

% Silt & Clay = 1.79

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

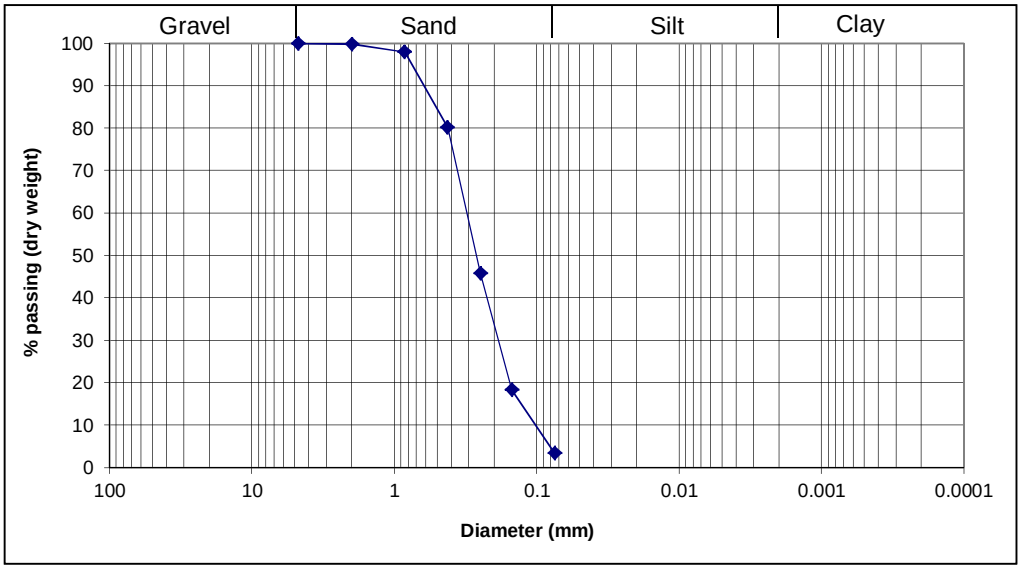
Sample No. : MHPW1-180-185

Depth below GS : 54.86 - 56.39 m
(180 - 185 ft)

Sieve Analysis

Dry weight of sample (g) = 458.75

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	0.68	0.15	0.15	99.85
20	0.85	8.42	1.84	1.98	98.02
40	0.425	81.53	17.77	19.76	80.24
60	0.25	157.81	34.40	54.16	45.84
100	0.15	125.92	27.45	81.60	18.40
200	0.075	68.46	14.92	96.53	3.47
pan	---	15.93	3.47	100.00	---
		458.75			



D_{10} = 0.1

D_{30} = 0.19

D_{60} = 0.31

Cu = 3.10

Cc = 1.16

USCS: SP (Poorly graded sand)

R_{200} = 96.53

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 96.53

GF = 0.00

% Gravel = 0.00

% Sand = 96.53

% Silt & Clay = 3.47

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

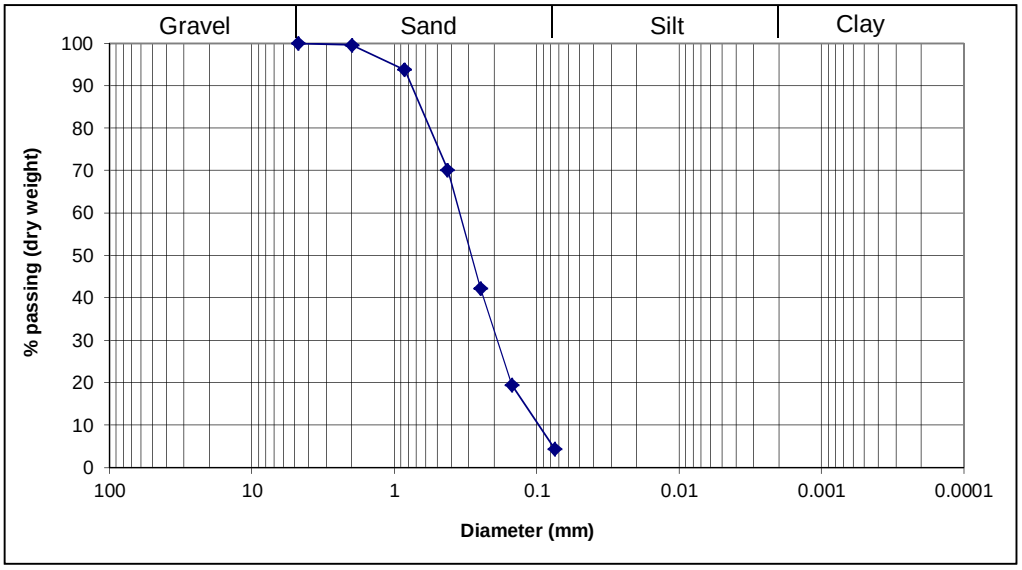
Sample No. : MHPW1-185-190

Depth below GS : 56.39 - 57.91 m
(185 - 190 ft)

Sieve Analysis

Dry weight of sample (g) = 429.71

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	1.59	0.37	0.37	99.63
20	0.85	25.02	5.82	6.19	93.81
40	0.425	101.61	23.65	29.84	70.16
60	0.25	119.92	27.91	57.75	42.25
100	0.15	97.52	22.69	80.44	19.56
200	0.075	65.03	15.13	95.57	4.43
pan	---	19.02	4.43	100.00	---
		429.71			



D_{10} = 0.095

D_{30} = 0.19

D_{60} = 0.35

Cu = 3.68

Cc = 1.09

USCS: SP (Poorly graded sand)

R_{200} = 95.57

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 95.57

GF = 0.00

% Gravel = 0.00

% Sand = 95.57

% Silt & Clay = 4.43

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

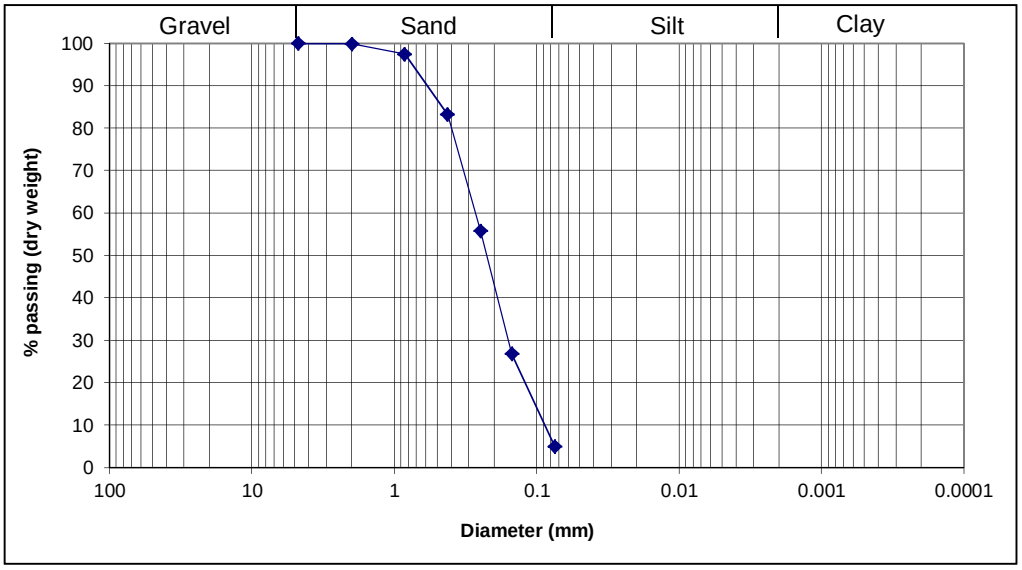
Sample No. : MHPW1-190-195

Depth below GS : 57.91 - 59.44 m
(190 - 195 ft)

Sieve Analysis

Dry weight of sample (g) = 588.54

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	0.55	0.09	0.09	99.91
20	0.85	13.90	2.36	2.46	97.54
40	0.425	84.06	14.28	16.74	83.26
60	0.25	161.35	27.42	44.15	55.85
100	0.15	170.70	29.00	73.16	26.84
200	0.075	127.95	21.74	94.90	5.10
pan	---	30.03	5.10	100.00	---
		588.54			



D_{10} = 0.087

D_{30} = 0.16

D_{60} = 0.27

Cu = 3.10

Cc = 1.09

USCS: SP (Poorly graded sand)

R_{200} = 94.90

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 94.90

GF = 0.00

% Gravel = 0.00

% Sand = 94.90

% Silt & Clay = 5.10

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

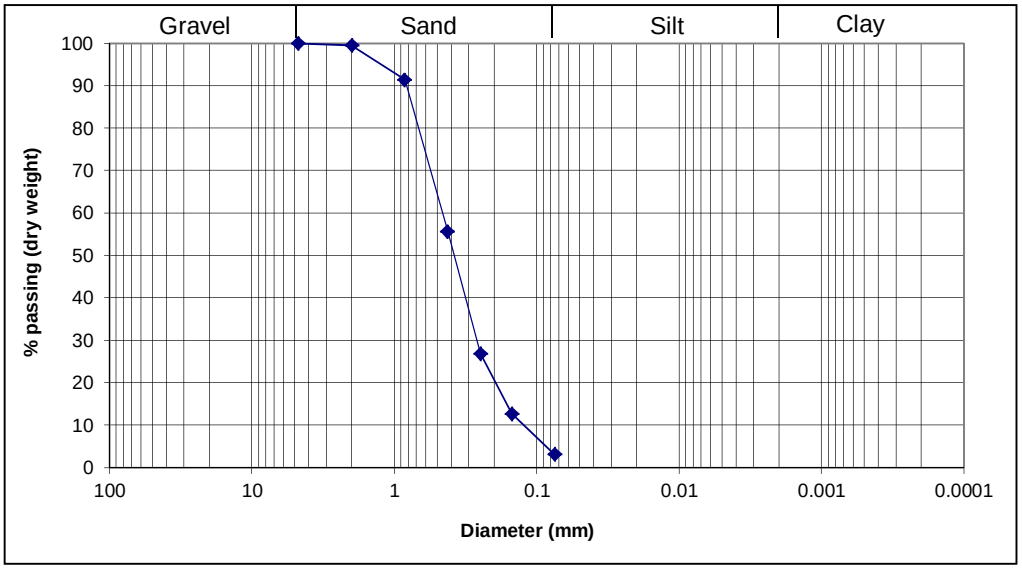
Sample No. : MHPW1-195-200

Depth below GS : 59.44 - 60.96 m
(195 - 200 ft)

Sieve Analysis

Dry weight of sample (g) = 604.39

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	2.66	0.44	0.44	99.56
20	0.85	48.75	8.07	8.51	91.49
40	0.425	216.37	35.80	44.31	55.69
60	0.25	173.97	28.78	73.09	26.91
100	0.15	85.58	14.16	87.25	12.75
200	0.075	57.91	9.58	96.83	3.17
pan	---	19.15	3.17	100.00	---
		604.39			



D_{10} = 0.12

D_{30} = 0.26

D_{60} = 0.46

Cu = 3.83

Cc = 1.22

USCS: SP (Poorly graded sand)

R_{200} = 96.83

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 96.83

GF = 0.00

% Gravel = 0.00

% Sand = 96.83

% Silt & Clay = 3.17

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

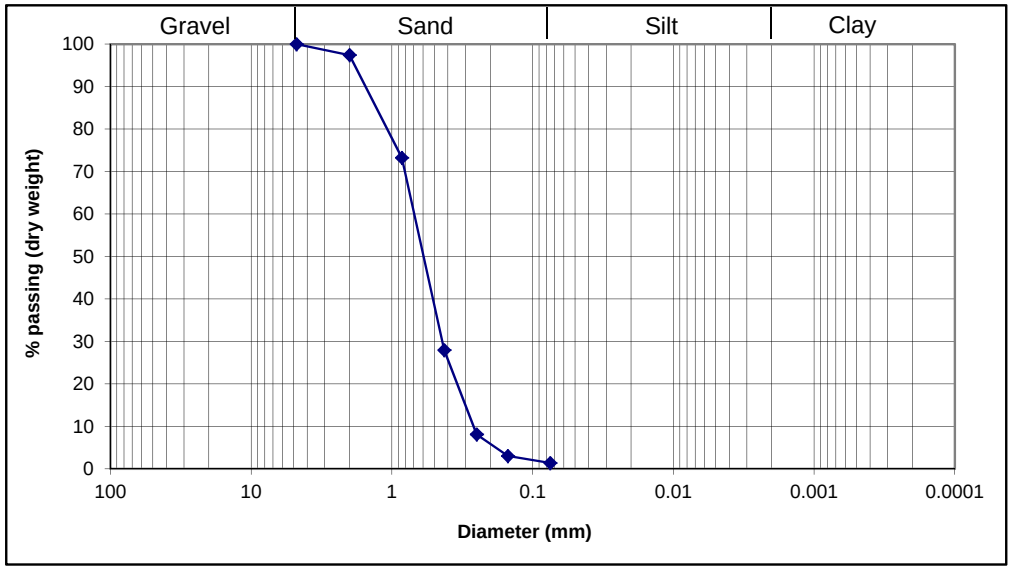
Sample No. : MHPW1-200-205

Depth below GS : 60.96 - 62.48 m
(200 - 205 ft)

Sieve Analysis

Dry weight of sample (g) = 516.24

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	13.30	2.58	2.58	97.42
20	0.85	124.78	24.17	26.75	73.25
40	0.425	233.85	45.30	72.05	27.95
60	0.25	102.51	19.86	91.90	8.10
100	0.15	26.10	5.06	96.96	3.04
200	0.075	8.55	1.66	98.61	1.39
pan	---	7.15	1.39	100.00	---
		516.24			



D_{10} = 0.265

D_{30} = 0.44

D_{60} = 0.7

Cu = 2.64

Cc = 1.04

USCS: SP (Poorly graded sand)

R_{200} = 98.61

R_4 = 0.00

R_4/R_{200} = 0.00

SF = 98.61

GF = 0.00

% Gravel = 0.00

% Sand = 98.61

% Silt & Clay = 1.39

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

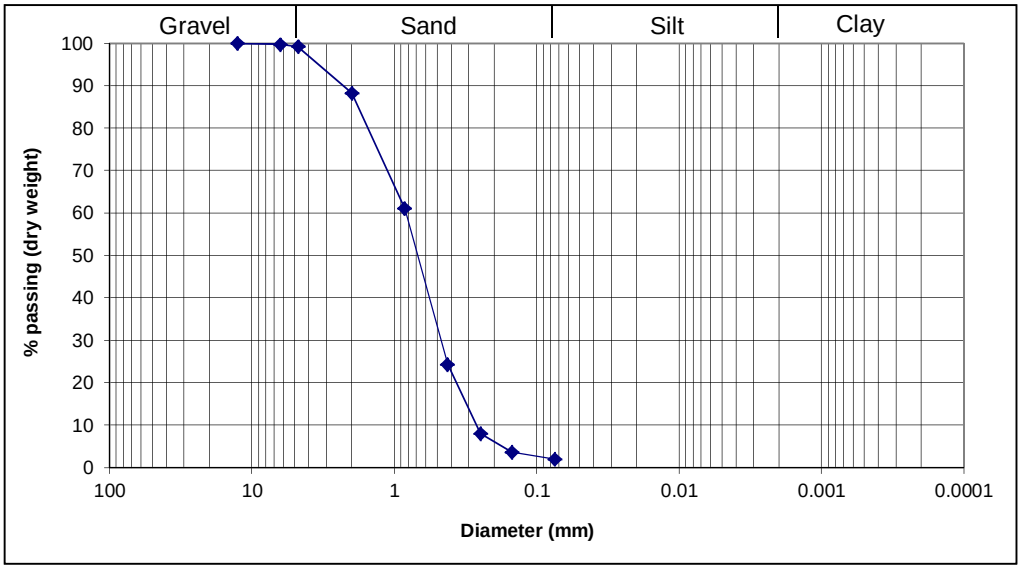
Sample No. : MHPW1-205-210

Depth below GS : 62.48 - 64.01 m
(205 - 210 ft)

Sieve Analysis

Dry weight of sample (g) = 572.85

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	1.20	0.21	0.21	99.79
4	4.76	3.13	0.55	0.76	99.24
10	2.00	62.76	10.96	11.71	88.29
20	0.85	155.88	27.21	38.92	61.08
40	0.425	210.45	36.74	75.66	24.34
60	0.25	93.31	16.29	91.95	8.05
100	0.15	24.89	4.34	96.29	3.71
200	0.075	9.64	1.68	97.98	2.02
pan	---	11.59	2.02	100.00	---
		572.85			



D_{10} = 0.27

D_{30} = 0.47

D_{60} = 0.81

Cu = 3.00

Cc = 1.01

USCS: SP (Poorly graded sand)

R_{200} = 97.98

R_4 = 0.76

R_4/R_{200} = 0.01

SF = 97.22

GF = 0.76

% Gravel = 0.76

% Sand = 97.22

% Silt & Clay = 2.02

% Clay = NA

CFEM: Sand, trace Silt/Clay

GRAIN SIZE ANALYSIS

Project : 3113 - Stephenville, NL

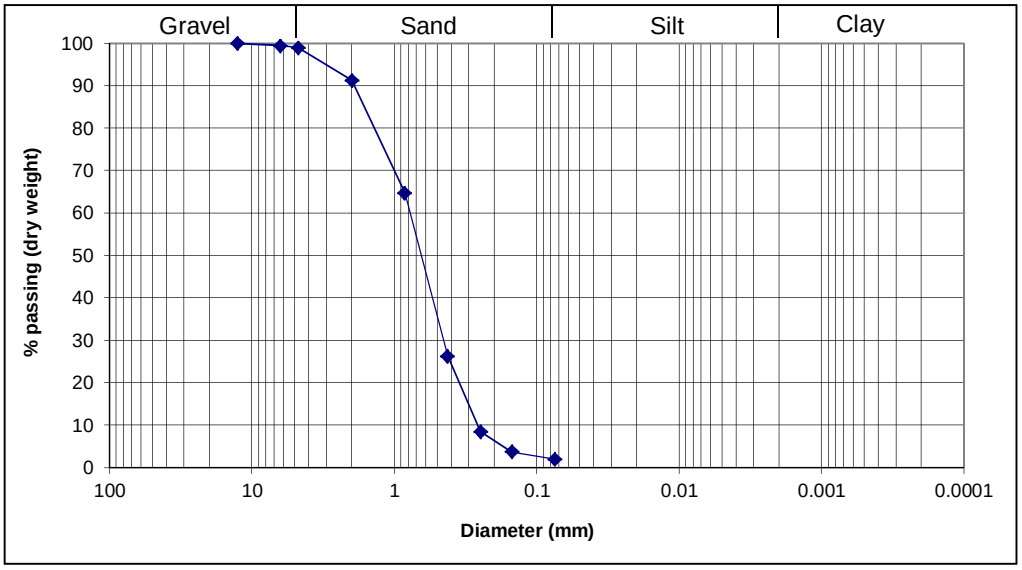
Sample No. : MHPW1-210-215

Depth below GS : 64.01 - 65.53 m
(210 - 215 ft)

Sieve Analysis

Dry weight of sample (g) = 446.43

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	2.62	0.59	0.59	99.41
4	4.76	1.56	0.35	0.94	99.06
10	2.00	34.37	7.70	8.64	91.36
20	0.85	118.45	26.53	35.17	64.83
40	0.425	171.93	38.51	73.68	26.32
60	0.25	79.29	17.76	91.44	8.56
100	0.15	21.38	4.79	96.23	3.77
200	0.075	7.94	1.78	98.01	1.99
pan	---	8.89	1.99	100.00	---
		446.43			



D_{10} = 0.26

D_{30} = 0.45

D_{60} = 0.77

Cu = 2.96

Cc = 1.01

USCS: SP (Poorly graded sand)

R_{200} = 98.01

R_4 = 0.94

R_4/R_{200} = 0.01

SF = 97.07

GF = 0.94

% Gravel = 0.94

% Sand = 97.07

% Silt & Clay = 1.99

% Clay = NA

CFEM: Sand, trace Silt/Clay

APPENDIX C

Records of Well Response for Step-Drawdown Tests and 72-Hours Aquifer Tests

Table C1 Recorded data during the step-drawdown test in the Test Well, MHPW1 (1 of 5).

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
Static	0.00	18.918	0.000
Step1	0.25	19.705	0.787
	0.50	20.052	1.134
	0.75	19.937	1.019
	1.00	19.688	0.769
	1.25	19.535	0.617
	1.50	19.610	0.692
	1.75	19.634	0.716
	2.00	19.571	0.653
	2.25	19.677	0.759
	2.50	19.674	0.756
	2.75	19.582	0.664
	3.00	19.614	0.695
	3.25	19.609	0.690
	3.50	19.647	0.729
	3.75	19.658	0.740
	4.00	19.613	0.695
	4.25	19.685	0.767
	4.50	19.601	0.683
	4.75	19.684	0.765
	5.00	19.599	0.681
	5.25	19.579	0.661
	5.50	19.580	0.662
	5.75	19.541	0.623
	6.00	19.633	0.715
	6.25	19.614	0.696
	6.50	19.646	0.728
	6.75	19.525	0.607
	7.00	19.619	0.701
	7.25	19.627	0.709
	7.50	19.639	0.720
	7.75	19.607	0.689
	8.00	19.563	0.645
	8.25	19.623	0.705
	8.50	19.625	0.707
	8.75	19.688	0.770
	9.00	19.734	0.816
	9.25	19.591	0.673
	9.50	19.643	0.725
	9.75	19.676	0.758
	10.00	19.600	0.682
	10.25	19.653	0.735
	10.50	19.598	0.680
	10.75	19.599	0.681
	11.00	19.591	0.673
	11.25	19.599	0.681
	11.50	19.646	0.728
	11.75	19.666	0.748
	12.00	19.624	0.706
	12.25	19.680	0.762
	12.50	19.605	0.687
	12.75	19.580	0.662
	13.00	19.682	0.764
	13.25	19.637	0.719
	13.50	19.747	0.829
	13.75	19.661	0.743
	14.00	19.538	0.620
	14.25	19.647	0.729
	14.50	19.717	0.799
	14.75	19.567	0.649
	15.00	19.657	0.739
	15.25	19.624	0.706
	15.50	19.641	0.723
	15.75	19.643	0.725
	16.00	19.611	0.693
	16.25	19.639	0.721
	16.50	19.607	0.689
	16.75	19.667	0.749
	17.00	19.651	0.733
	17.25	19.674	0.756
	17.50	19.641	0.723
	17.75	19.550	0.632
	18.00	19.606	0.688
	18.25	19.576	0.658
	18.50	19.702	0.784
	18.75	19.669	0.751
Step2	19.00	19.738	0.820
	19.25	19.867	0.949
	19.50	19.950	1.032
	19.75	19.980	1.062
	20.00	19.964	1.046
	20.25	20.988	2.070
	20.50	20.007	1.089
	20.75	19.964	1.046
	21.00	19.949	1.031
	21.25	19.971	1.053
	21.50	20.149	1.231
	21.75	20.151	1.233
	22.00	20.173	1.255
	22.25	20.257	1.339
	22.50	20.232	1.314
	22.75	20.246	1.328
	23.00	20.221	1.303
	23.25	20.213	1.295

Table C1 Recorded data during the step-drawdown test in the Test Well, MHPW1 (2 of 5).

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
	23.50	20.232	1.314
	23.75	20.266	1.348
	24.00	20.243	1.325
	24.25	20.209	1.291
	24.50	20.276	1.358
	24.75	20.295	1.377
	25.00	20.276	1.358
	25.25	20.264	1.346
	25.50	20.225	1.307
	25.75	20.205	1.287
	26.00	20.238	1.320
	26.25	20.314	1.396
	26.50	20.179	1.261
	26.75	20.269	1.351
	27.00	20.233	1.315
	27.25	20.265	1.347
	27.50	20.199	1.281
	27.75	20.230	1.312
	28.00	20.265	1.347
	28.25	20.273	1.355
	28.50	20.206	1.288
	28.75	20.261	1.343
	29.00	20.282	1.364
	29.25	20.203	1.285
	29.50	20.184	1.266
	29.75	20.246	1.328
	30.00	20.266	1.348
	30.25	20.259	1.341
	30.50	20.240	1.322
	30.75	20.174	1.256
	31.00	20.231	1.313
	31.25	20.237	1.319
	31.50	20.237	1.319
	31.75	20.213	1.295
	32.00	20.297	1.379
	32.25	20.195	1.277
	32.50	20.292	1.374
	32.75	20.291	1.373
	33.00	20.277	1.359
	33.25	20.303	1.385
	33.50	20.242	1.324
	33.75	20.263	1.345
	34.00	20.256	1.338
	34.25	20.218	1.300
	34.50	20.238	1.320
	34.75	20.253	1.335
	35.00	20.286	1.368

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
	35.25	20.230	1.312
	35.50	20.296	1.378
	35.75	20.288	1.370
	36.00	20.281	1.363
	36.25	20.231	1.313
	36.50	20.287	1.369
	36.75	20.233	1.315
	37.00	20.264	1.346
	37.25	20.276	1.358
	37.50	20.260	1.342
	37.75	20.261	1.343
	38.00	20.276	1.358
	38.25	20.231	1.313
	38.50	20.286	1.368
	38.75	20.239	1.321
	39.00	20.212	1.294
	39.25	20.218	1.300
	39.50	20.209	1.291
	39.75	20.237	1.319
	40.00	20.265	1.347
	40.25	20.281	1.363
	40.50	20.203	1.285
	40.75	20.252	1.334
	41.00	20.259	1.341
	41.25	20.265	1.347
	41.50	20.243	1.325
	41.75	20.252	1.334
	42.00	20.288	1.370
	42.25	20.224	1.306
	42.50	20.255	1.337
	42.75	20.233	1.315
	43.00	20.262	1.344
	43.25	20.229	1.311
	43.50	20.209	1.291
	43.75	20.267	1.349
	44.00	20.254	1.336
	44.25	20.245	1.327
	44.50	20.242	1.324
	44.75	20.250	1.332
	45.00	20.293	1.375
	45.25	20.307	1.389
	45.50	20.206	1.288
	45.75	20.250	1.332
	46.00	20.302	1.384
	46.25	20.280	1.362
	46.50	20.285	1.367
	46.75	20.261	1.343

Table C1 Recorded data during the step-drawdown test in the Test Well, MHPW1 (3 of 5).

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
Step3	47.00	20.259	1.341
	47.25	20.279	1.361
	47.50	20.247	1.329
	47.75	20.237	1.319
	48.00	20.287	1.369
	48.25	20.279	1.361
	48.50	20.293	1.375
	48.75	20.280	1.362
	49.00	20.280	1.362
	49.25	20.323	1.405
	49.50	20.277	1.359
	49.75	20.261	1.343
	50.00	20.266	1.348
	50.25	20.294	1.376
	50.50	20.297	1.379
	50.75	20.326	1.408
	51.00	20.236	1.318
	51.25	20.249	1.331
	51.50	20.226	1.308
	51.75	21.044	2.126
	52.00	21.209	2.291
	52.25	21.279	2.361
	52.50	21.219	2.301
	52.75	21.346	2.428
	53.00	21.344	2.426
	53.25	21.325	2.407
	53.50	21.373	2.455
	53.75	21.380	2.462
	54.00	21.490	2.572
	54.25	21.464	2.546
	54.50	21.399	2.481
	54.75	21.492	2.574
	55.00	21.503	2.585
	55.25	21.527	2.609
	55.50	21.589	2.671
	55.75	21.504	2.586
	56.00	21.537	2.619
	56.25	21.617	2.699
	56.50	21.596	2.678
	56.75	21.597	2.679
	57.00	21.544	2.626
	57.25	21.651	2.733
	57.50	21.460	2.542
	57.75	21.577	2.659
	58.00	21.610	2.692
	58.25	21.610	2.692
	58.50	21.587	2.669

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
	58.75	21.506	2.588
	59.00	21.545	2.627
	59.25	21.560	2.642
	59.50	21.593	2.675
	59.75	21.547	2.629
	60.00	21.655	2.737
	60.25	21.597	2.679
	60.50	21.702	2.784
	60.75	21.584	2.666
	61.00	21.557	2.639
	61.25	21.690	2.772
	61.50	21.518	2.600
	61.75	21.558	2.640
	62.00	21.567	2.649
	62.25	21.603	2.685
	62.50	21.571	2.653
	62.75	21.524	2.606
	63.00	21.636	2.718
	63.25	21.573	2.655
	63.50	21.586	2.668
	63.75	21.610	2.692
	64.00	21.620	2.702
	64.25	21.538	2.620
	64.50	21.551	2.633
	64.75	21.680	2.762
	65.00	21.615	2.697
	65.25	21.572	2.654
	65.50	21.494	2.576
	65.75	21.650	2.732
	66.00	21.590	2.672
	66.25	21.626	2.708
	66.50	21.653	2.735
	66.75	21.592	2.674
	67.00	21.663	2.745
	67.25	21.614	2.696
	67.50	21.535	2.617
	67.75	21.504	2.586
	68.00	21.584	2.666
	68.25	21.582	2.664
	68.50	21.630	2.712
	68.75	21.587	2.669
	69.00	21.622	2.704
	69.25	21.560	2.642
	69.50	21.616	2.698
	69.75	21.595	2.677
	70.00	21.635	2.717
	70.25	21.628	2.710

Table C1 Recorded data during the step-drawdown test in the Test Well, MHPW1 (4 of 5).

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
	70.50	21.672	2.754
	70.75	21.662	2.744
	71.00	21.595	2.677
	71.25	21.558	2.640
	71.50	21.598	2.680
	71.75	21.549	2.631
	72.00	21.559	2.641
	72.25	21.699	2.781
	72.50	21.556	2.638
	72.75	21.609	2.691
	73.00	21.452	2.534
	73.25	21.574	2.656
	73.50	21.563	2.645
	73.75	21.590	2.672
	74.00	21.501	2.583
	74.25	21.577	2.659
	74.50	21.596	2.678
	74.75	21.534	2.616
	75.00	21.642	2.724
	75.25	21.587	2.669
	75.50	21.586	2.668
	75.75	21.655	2.737
	76.00	21.633	2.715
	76.25	21.614	2.696
	76.50	21.638	2.720
	76.75	21.609	2.691
	77.00	21.586	2.668
	77.25	21.636	2.718
	77.50	21.623	2.705
	77.75	21.621	2.703
	78.00	21.630	2.712
	78.25	21.628	2.710
	78.50	21.590	2.672
	78.75	21.616	2.698
	79.00	21.612	2.694
	79.25	21.623	2.705
	79.50	21.563	2.645
	79.75	21.627	2.709
	80.00	21.559	2.641
	80.25	21.598	2.680
	80.50	21.547	2.629
	80.75	21.607	2.689
	81.00	21.641	2.723
	81.25	21.581	2.663
	81.50	21.575	2.657
	81.75	21.628	2.710
	82.00	21.516	2.598

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
	82.25	21.593	2.675
	82.50	21.583	2.665
	82.75	21.622	2.704
	83.00	21.614	2.696
	83.25	21.629	2.711
	83.50	21.650	2.732
	83.75	21.638	2.720
	84.00	21.659	2.741
	84.25	21.698	2.780
	84.50	21.630	2.712
	84.75	21.578	2.660
	85.00	21.635	2.717
	85.25	21.733	2.815
Step4	85.50	22.189	3.271
	85.75	22.384	3.466
	86.00	22.643	3.725
	86.25	22.952	4.034
	86.50	23.218	4.300
	86.75	23.269	4.351
	87.00	23.462	4.544
	87.25	23.566	4.648
	87.50	23.783	4.865
	87.75	23.899	4.981
	88.00	23.991	5.073
	88.25	23.950	5.032
	88.50	23.946	5.028
	88.75	23.954	5.036
	89.00	24.003	5.085
	89.25	23.957	5.039
	89.50	23.993	5.075
	89.75	24.014	5.096
	90.00	24.007	5.089
	90.25	24.001	5.083
	90.50	24.012	5.094
	90.75	24.038	5.120
	91.00	23.998	5.080
	91.25	24.020	5.102
	91.50	24.027	5.109
	91.75	23.982	5.064
	92.00	24.004	5.086
	92.25	24.050	5.132
	92.50	24.011	5.093
	92.75	23.982	5.064
	93.00	24.007	5.089
	93.25	23.954	5.036
	93.50	24.053	5.135
	93.75	24.031	5.113

Table C1 Recorded data during the step-drawdown test in the Test Well, MHPW1 (5 of 5).

Step	Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
	94.00	24.033	5.115
	94.25	24.019	5.101
	94.50	24.021	5.103
	94.75	24.043	5.125
	95.00	24.010	5.092
	95.25	24.054	5.136
	95.50	23.978	5.060
	95.75	24.046	5.128
	96.00	24.028	5.110
	96.25	24.031	5.113
	96.50	24.043	5.125
	96.75	24.013	5.095
	97.00	24.020	5.102
	97.25	24.022	5.104
	97.50	23.958	5.040
	97.75	24.002	5.084
	98.00	24.049	5.131
	98.25	24.007	5.089
	98.50	24.012	5.094
	98.75	24.086	5.168
	99.00	24.038	5.120
	99.25	23.995	5.077
	99.50	23.972	5.054
	99.75	23.991	5.073
	100.00	24.056	5.138
	100.25	24.003	5.085
	100.50	23.980	5.062
	100.75	24.024	5.106
	101.00	23.980	5.062
	101.25	24.023	5.105
	101.50	24.014	5.096
	101.75	24.005	5.087
	102.00	24.030	5.112
	102.25	24.009	5.091
	102.50	24.037	5.119
	102.75	24.017	5.099
	103.00	23.991	5.073
	103.25	24.054	5.136
	103.50	24.004	5.086
	103.75	24.082	5.164
	104.00	24.031	5.113
	104.25	23.983	5.065
	104.50	23.996	5.078
	104.75	24.063	5.145
	105.00	24.033	5.115
	105.25	23.992	5.074
	105.50	24.056	5.138
	105.75	24.095	5.177
	106.00	24.087	5.169
	106.25	24.009	5.091
	106.50	24.069	5.151
	106.75	24.063	5.145
	107.00	24.037	5.119
	107.25	24.031	5.113
	107.50	24.048	5.130
	107.75	24.028	5.110
	108.00	24.051	5.133
	108.25	24.072	5.154
	108.50	24.031	5.113
	108.75	24.048	5.130
	109.00	24.008	5.090
	109.25	24.063	5.145
	109.50	24.061	5.143
	109.75	24.036	5.118
	110.00	24.050	5.132
	110.25	24.084	5.166
	110.50	24.038	5.120
	110.75	24.086	5.168
	111.00	24.026	5.108
	111.25	24.051	5.133
	111.50	24.021	5.103
	111.75	24.053	5.135
	112.00	24.030	5.112
	112.25	23.991	5.073
	112.50	24.033	5.115
	112.75	24.062	5.144
	113.00	24.067	5.149
	113.25	24.076	5.158
	113.50	24.072	5.154
	113.75	24.023	5.105
	114.00	24.062	5.144
	114.25	24.053	5.135
	114.50	24.019	5.101
	114.75	24.030	5.112
	115.00	24.060	5.142
	115.25	24.052	5.134
	115.50	24.020	5.102
	115.75	24.060	5.142
	116.00	24.092	5.174
End	116.25	24.049	5.131

Table C2 Recorded data during the 72-hour aquifer test in the Test Well, MHPW1 (1 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
0 (Static)	18.968	0.000
0.08	20.396	1.428
0.33	20.832	1.864
0.58	21.839	2.871
0.83	22.728	3.760
1.08	23.026	4.058
1.33	23.111	4.143
1.58	23.087	4.119
1.83	23.092	4.124
2.08	23.118	4.150
2.33	23.174	4.206
2.58	23.150	4.182
2.83	23.139	4.171
3.08	23.157	4.189
3.33	23.170	4.202
3.58	23.157	4.189
3.83	23.151	4.183
4.08	23.159	4.191
4.33	23.130	4.162
4.58	23.175	4.207
4.83	23.191	4.223
5.08	23.144	4.176
5.33	23.136	4.168
5.58	23.156	4.188
5.83	23.156	4.188
6.08	23.188	4.220
6.33	23.165	4.197
6.58	23.157	4.189
6.83	23.163	4.195
7.08	23.193	4.225
7.33	23.156	4.188
7.58	23.167	4.199
7.83	23.177	4.209
8.08	23.137	4.169
8.33	23.173	4.205
8.58	23.164	4.196
8.83	23.201	4.233
9.08	23.155	4.187
9.33	23.172	4.204
9.58	23.138	4.170
9.83	23.195	4.227
10.08	23.137	4.169
10.58	23.177	4.209
11.08	23.155	4.187
11.58	23.189	4.221
12.08	23.172	4.204
12.58	23.215	4.247
13.08	23.184	4.216
13.58	23.181	4.213
14.08	23.136	4.168
14.58	23.202	4.234
15.08	23.155	4.187
15.58	23.151	4.183
16.08	23.164	4.196
16.58	23.166	4.198
17.08	23.142	4.174
17.58	23.181	4.213
18.08	23.180	4.212
18.58	23.168	4.200
19.08	23.134	4.166
19.58	23.154	4.186
20.08	23.151	4.183
20.58	23.205	4.237
21.08	23.167	4.199
21.58	23.171	4.203
22.08	23.135	4.167
22.58	23.164	4.196
23.08	23.163	4.195
23.58	23.178	4.210
24.08	23.160	4.192
24.58	23.181	4.213
25.08	23.163	4.195
25.58	23.179	4.211
26.08	23.167	4.199
26.58	23.139	4.171
27.08	23.152	4.184
27.58	23.173	4.205
28.08	23.200	4.232
28.58	23.162	4.194
29.08	23.178	4.210
29.58	23.165	4.197
30.08	23.208	4.240
31.08	23.166	4.198
32.08	23.138	4.170
33.08	23.189	4.221
34.08	23.162	4.194
35.08	23.195	4.227
36.08	23.191	4.223
37.08	23.177	4.209
38.08	23.196	4.228
39.08	23.208	4.240
40.08	23.233	4.265
41.08	23.207	4.239
42.08	23.183	4.215

Table C2 Recorded data during the 72-hour aquifer test in the Test Well, MHPW1 (2 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
43.08	23.215	4.247
44.08	23.209	4.241
45.08	23.197	4.229
46.08	23.164	4.196
47.08	23.158	4.190
48.08	23.196	4.228
49.08	23.172	4.204
50.08	23.153	4.185
51.08	23.172	4.204
52.08	23.179	4.211
53.08	23.213	4.245
54.08	23.228	4.260
55.08	23.207	4.239
56.08	23.187	4.219
57.08	23.177	4.209
58.08	23.185	4.217
59.08	23.184	4.216
60.08	23.163	4.195
61.08	23.175	4.207
62.08	23.200	4.232
63.08	23.204	4.236
64.08	23.193	4.225
65.08	23.225	4.257
66.08	23.219	4.251
67.08	23.230	4.262
68.08	23.185	4.217
69.08	23.218	4.250
70.08	23.222	4.254
71.08	23.178	4.210
72.08	23.202	4.234
73.08	23.192	4.224
74.08	23.201	4.233
75.08	23.220	4.252
76.08	23.223	4.255
77.08	23.190	4.222
78.08	23.213	4.245
79.08	23.238	4.270
80.08	23.211	4.243
81.08	23.239	4.271
82.08	23.232	4.264
83.08	23.219	4.251
84.08	23.243	4.275
85.08	23.202	4.234
86.08	23.166	4.198
87.08	23.174	4.206
88.08	23.216	4.248
89.08	23.245	4.277

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
90.08	23.218	4.250
95.08	23.234	4.266
100.08	23.225	4.257
105.08	23.242	4.274
110.08	23.191	4.223
115.08	23.241	4.273
120.08	23.222	4.254
125.08	23.221	4.253
130.08	23.220	4.252
135.08	23.170	4.202
140.08	23.243	4.275
145.08	23.200	4.232
150.08	23.255	4.287
155.08	23.227	4.259
160.08	23.186	4.218
165.08	23.218	4.250
170.08	23.241	4.273
175.08	23.231	4.263
180.08	23.218	4.250
185.08	23.250	4.282
190.08	23.250	4.282
195.08	23.220	4.252
200.08	23.233	4.265
205.08	23.285	4.317
210.08	23.226	4.258
215.08	23.241	4.273
220.08	23.239	4.271
225.08	23.186	4.218
230.08	23.278	4.310
235.08	23.236	4.268
240.08	23.297	4.329
245.08	23.271	4.303
250.08	23.239	4.271
255.08	23.239	4.271
260.08	23.215	4.247
265.08	23.318	4.350
270.08	23.252	4.284
275.08	23.288	4.320
280.08	23.251	4.283
285.08	23.258	4.290
290.08	23.309	4.341
295.08	23.260	4.292
300.08	23.278	4.310
305.08	23.267	4.299
310.08	23.255	4.287
315.08	23.307	4.339
320.08	23.296	4.328

Table C2 Recorded data during the 72-hour aquifer test in the Test Well, MHPW1 (3 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
325.08	23.262	4.294
330.08	23.303	4.335
335.08	23.306	4.338
340.08	23.314	4.346
345.08	23.243	4.275
350.08	23.273	4.305
355.08	23.261	4.293
360.08	23.296	4.328
370.08	23.273	4.305
380.08	23.241	4.273
390.08	23.331	4.363
400.08	23.285	4.317
410.08	23.265	4.297
420.08	23.272	4.304
430.08	23.276	4.308
440.08	23.303	4.335
450.08	23.324	4.356
460.08	23.283	4.315
470.08	23.279	4.311
480.08	23.279	4.311
490.08	23.294	4.326
500.08	23.321	4.353
510.08	23.306	4.338
520.08	23.281	4.313
530.08	23.323	4.355
540.08	23.282	4.314
550.08	23.332	4.364
560.08	23.307	4.339
570.08	23.352	4.384
580.08	23.316	4.348
590.08	23.305	4.337
600.08	23.297	4.329
610.08	23.321	4.353
620.08	23.339	4.371
630.08	23.326	4.358
640.08	23.344	4.376
650.08	23.329	4.361
660.08	23.312	4.344
670.08	23.338	4.370
680.08	23.317	4.349
690.08	23.335	4.367
700.08	23.322	4.354
710.08	23.325	4.357
720.08	23.316	4.348
730.08	23.327	4.359
740.08	23.340	4.372
750.08	23.329	4.361

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
760.08	23.351	4.383
770.08	23.329	4.361
780.08	23.368	4.400
790.08	23.341	4.373
800.08	23.348	4.380
810.08	23.309	4.341
820.08	23.338	4.370
830.08	23.340	4.372
840.08	23.351	4.383
850.08	23.333	4.365
860.08	23.351	4.383
870.08	23.336	4.368
880.08	23.344	4.376
890.08	23.338	4.370
900.08	23.334	4.366
910.08	23.370	4.402
920.08	23.344	4.376
930.08	23.326	4.358
940.08	23.314	4.346
950.08	23.351	4.383
960.08	23.341	4.373
970.08	23.366	4.398
980.08	23.338	4.370
990.08	23.368	4.400
1000.08	23.395	4.427
1010.08	23.359	4.391
1020.08	23.337	4.369
1030.08	23.370	4.402
1040.08	23.373	4.405
1050.08	23.367	4.399
1060.08	23.349	4.381
1070.08	23.361	4.393
1080.08	23.367	4.399
1090.08	23.364	4.396
1100.08	23.380	4.412
1110.08	23.367	4.399
1120.08	23.376	4.408
1130.08	23.363	4.395
1140.08	23.372	4.404
1150.08	23.360	4.392
1160.08	23.431	4.463
1170.08	23.368	4.400
1180.08	23.386	4.418
1190.08	23.382	4.414
1200.08	23.407	4.439
1210.08	23.386	4.418
1220.08	23.360	4.392

Table C2 Recorded data during the 72-hour aquifer test in the Test Well, MHPW1 (4 of 7).

Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
1230.08	23.374	4.406
1240.08	23.409	4.441
1250.08	23.414	4.446
1260.08	23.367	4.399
1270.08	23.344	4.376
1280.08	23.401	4.433
1290.08	23.367	4.399
1300.08	23.353	4.385
1310.08	23.345	4.377
1320.08	23.333	4.365
1330.08	23.394	4.426
1340.08	23.385	4.417
1350.08	23.389	4.421
1360.08	23.362	4.394
1370.08	23.390	4.422
1380.08	23.377	4.409
1390.08	23.398	4.430
1400.08	23.383	4.415
1410.08	23.408	4.440
1420.08	23.395	4.427
1430.08	23.371	4.403
1440.08	23.406	4.438
1450.08	23.352	4.384
1460.08	23.410	4.442
1470.08	23.384	4.416
1480.08	23.406	4.438
1490.08	23.413	4.445
1500.08	23.401	4.433
1510.08	23.373	4.405
1520.08	23.415	4.447
1530.08	23.386	4.418
1540.08	23.392	4.424
1550.08	23.395	4.427
1560.08	23.403	4.435
1570.08	23.391	4.423
1580.08	23.399	4.431
1590.08	23.401	4.433
1600.08	23.421	4.453
1610.08	23.415	4.447
1620.08	23.410	4.442
1630.08	23.395	4.427
1640.08	23.402	4.434
1650.08	23.379	4.411
1660.08	23.416	4.448
1670.08	23.409	4.441
1680.08	23.367	4.399
1690.08	23.397	4.429

Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
1700.08	23.391	4.423
1710.08	23.434	4.466
1720.08	23.377	4.409
1730.08	23.398	4.430
1740.08	23.453	4.485
1750.08	23.385	4.417
1760.08	23.445	4.477
1770.08	23.395	4.427
1780.08	23.417	4.449
1790.08	23.417	4.449
1800.08	23.400	4.432
1810.08	23.420	4.452
1820.08	23.445	4.477
1830.08	23.424	4.456
1840.08	23.391	4.423
1850.08	23.399	4.431
1860.08	23.408	4.440
1870.08	23.456	4.488
1880.08	23.423	4.455
1890.08	23.418	4.450
1900.08	23.409	4.441
1910.08	23.402	4.434
1920.08	23.426	4.458
1930.08	23.402	4.434
1940.08	23.424	4.456
1950.08	23.422	4.454
1960.08	23.429	4.461
1970.08	23.448	4.480
1980.08	23.423	4.455
1990.08	23.434	4.466
2000.08	23.385	4.417
2010.08	23.425	4.457
2020.08	23.447	4.479
2030.08	23.431	4.463
2040.08	23.416	4.448
2050.08	23.420	4.452
2060.08	23.430	4.462
2070.08	23.384	4.416
2080.08	23.373	4.405
2090.08	23.404	4.436
2100.08	23.427	4.459
2110.08	23.451	4.483
2120.08	23.416	4.448
2130.08	23.436	4.468
2140.08	23.428	4.460
2150.08	23.395	4.427
2160.08	23.432	4.464

Table C2 Recorded data during the 72-hour aquifer test in the Test Well, MHPW1 (5 of 7).

Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
2170.08	23.422	4.454
2180.08	23.443	4.475
2190.08	23.434	4.466
2200.08	23.457	4.489
2210.08	23.461	4.493
2220.08	23.411	4.443
2230.08	23.381	4.413
2240.08	23.443	4.475
2250.08	23.411	4.443
2260.08	23.471	4.503
2270.08	23.435	4.467
2280.08	23.401	4.433
2290.08	23.442	4.474
2300.08	23.438	4.470
2310.08	23.416	4.448
2320.08	23.453	4.485
2330.08	23.417	4.449
2340.08	23.452	4.484
2350.08	23.451	4.483
2360.08	23.416	4.448
2370.08	23.409	4.441
2380.08	23.460	4.492
2390.08	23.475	4.507
2400.08	23.417	4.449
2410.08	23.461	4.493
2420.08	23.456	4.488
2430.08	23.469	4.501
2440.08	23.468	4.500
2450.08	23.443	4.475
2460.08	23.441	4.473
2470.08	23.464	4.496
2480.08	23.456	4.488
2490.08	23.436	4.468
2500.08	23.414	4.446
2510.08	23.453	4.485
2520.08	23.456	4.488
2530.08	23.494	4.526
2540.08	23.477	4.509
2550.08	23.462	4.494
2560.08	23.465	4.497
2570.08	23.425	4.457
2580.08	23.419	4.451
2590.08	23.465	4.497
2600.08	23.474	4.506
2610.08	23.457	4.489
2620.08	23.458	4.490
2630.08	23.453	4.485

Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
2640.08	23.456	4.488
2650.08	23.476	4.508
2660.08	23.457	4.489
2670.08	23.478	4.510
2680.08	23.518	4.550
2690.08	23.456	4.488
2700.08	23.477	4.509
2710.08	23.422	4.454
2720.08	23.433	4.465
2730.08	23.463	4.495
2740.08	23.454	4.486
2750.08	23.448	4.480
2760.08	23.493	4.525
2770.08	23.463	4.495
2780.08	23.494	4.526
2790.08	23.473	4.505
2800.08	23.474	4.506
2810.08	23.513	4.545
2820.08	23.457	4.489
2830.08	23.508	4.540
2840.08	23.479	4.511
2850.08	23.489	4.521
2860.08	23.486	4.518
2870.08	23.486	4.518
2880.08	23.476	4.508
2890.08	23.482	4.514
2900.08	23.480	4.512
2910.08	23.481	4.513
2920.08	23.449	4.481
2930.08	23.472	4.504
2940.08	23.461	4.493
2950.08	23.467	4.499
2960.08	23.481	4.513
2970.08	23.482	4.514
2980.08	23.480	4.512
2990.08	23.492	4.524
3000.08	23.496	4.528
3010.08	23.468	4.500
3020.08	23.444	4.476
3030.08	23.460	4.492
3040.08	23.449	4.481
3050.08	23.472	4.504
3060.08	23.451	4.483
3070.08	23.506	4.538
3080.08	23.485	4.517
3090.08	23.458	4.490
3100.08	23.457	4.489

Table C2 Recorded data during the 72-hour aquifer test in the Test Well, MHPW1 (6 of 7).

Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
3110.08	23.488	4.520
3120.08	23.459	4.491
3130.08	23.469	4.501
3140.08	23.484	4.516
3150.08	23.439	4.471
3160.08	23.488	4.520
3170.08	23.477	4.509
3180.08	23.460	4.492
3190.08	23.490	4.522
3200.08	23.471	4.503
3210.08	23.494	4.526
3220.08	23.466	4.498
3230.08	23.460	4.492
3240.08	23.451	4.483
3250.08	23.493	4.525
3260.08	23.459	4.491
3270.08	23.446	4.478
3280.08	23.499	4.531
3290.08	23.525	4.557
3300.08	23.459	4.491
3310.08	23.509	4.541
3320.08	23.497	4.529
3330.08	23.468	4.500
3340.08	23.485	4.517
3350.08	23.470	4.502
3360.08	23.519	4.551
3370.08	23.512	4.544
3380.08	23.460	4.492
3390.08	23.504	4.536
3400.08	23.470	4.502
3410.08	23.495	4.527
3420.08	23.476	4.508
3430.08	23.522	4.554
3440.08	23.489	4.521
3450.08	23.468	4.500
3460.08	23.496	4.528
3470.08	23.460	4.492
3480.08	23.465	4.497
3490.08	23.489	4.521
3500.08	23.468	4.500
3510.08	23.471	4.503
3520.08	23.472	4.504
3530.08	23.468	4.500
3540.08	23.462	4.494
3550.08	23.509	4.541
3560.08	23.500	4.532
3570.08	23.499	4.531

Time *t (min)*	Depth *(m)*	Drawdown *dd (m)*
3580.08	23.474	4.506
3590.08	23.471	4.503
3600.08	23.461	4.493
3610.08	23.457	4.489
3620.08	23.525	4.557
3630.08	23.529	4.561
3640.08	23.506	4.538
3650.08	23.528	4.560
3660.08	23.517	4.549
3670.08	23.476	4.508
3680.08	23.493	4.525
3690.08	23.488	4.520
3700.08	23.483	4.515
3710.08	23.469	4.501
3720.08	23.517	4.549
3730.08	23.504	4.536
3740.08	23.505	4.537
3750.08	23.476	4.508
3760.08	23.471	4.503
3770.08	23.479	4.511
3780.08	23.507	4.539
3790.08	23.485	4.517
3800.08	23.511	4.543
3810.08	23.475	4.507
3820.08	23.541	4.573
3830.08	23.530	4.562
3840.08	23.531	4.563
3850.08	23.493	4.525
3860.08	23.476	4.508
3870.08	23.487	4.519
3880.08	23.473	4.505
3890.08	23.512	4.544
3900.08	23.481	4.513
3910.08	23.486	4.518
3920.08	23.515	4.547
3930.08	23.504	4.536
3940.08	23.483	4.515
3950.08	23.485	4.517
3960.08	23.493	4.525
3970.08	23.510	4.542
3980.08	23.529	4.561
3990.08	23.500	4.532
4000.08	23.507	4.539
4010.08	23.521	4.553
4020.08	23.537	4.569
4030.08	23.532	4.564
4040.08	23.529	4.561

Table C2 Recorded data during the 72-hour aquifer test in the Test Well, MHPW1 (7 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
4050.08	23.508	4.540
4060.08	23.529	4.561
4070.08	23.516	4.548
4080.08	23.532	4.564
4090.08	23.494	4.526
4100.08	23.474	4.506
4110.08	23.499	4.531
4120.08	23.493	4.525
4130.08	23.475	4.507
4140.08	23.542	4.574
4150.08	23.489	4.521
4160.08	23.522	4.554
4170.08	23.504	4.536
4180.08	23.481	4.513
4190.08	23.453	4.485
4200.08	23.486	4.518
4210.08	23.502	4.534
4220.08	23.520	4.552
4230.08	23.521	4.553
4240.08	23.499	4.531
4250.08	23.519	4.551
4260.08	23.479	4.511
4270.08	23.532	4.564
4280.08	23.467	4.499
4290.08	23.449	4.481
4300.08	23.513	4.545
4310.08	23.509	4.541
4320.08	23.490	4.522

Table C3 Recovery data after the 72-hour aquifer test in the Test Well, MHPW1 (1 of 4).

Time *(min)*	**Depth** *(m)*	**Recovery** *(m)*
0 (Start)	23.468	0.000
0.25	19.040	4.428
0.50	19.254	4.215
0.75	19.366	4.102
1.00	19.250	4.218
1.25	19.235	4.233
1.50	19.227	4.242
1.75	19.219	4.249
2.00	19.214	4.254
2.25	19.208	4.260
2.50	19.208	4.260
2.75	19.206	4.262
3.00	19.204	4.264
3.25	19.204	4.264
3.50	19.202	4.266
3.75	19.203	4.265
4.00	19.203	4.265
4.25	19.200	4.268
4.50	19.201	4.267
4.75	19.201	4.267
5.00	19.200	4.268
5.25	19.200	4.268
5.50	19.198	4.270
5.75	19.198	4.270
6.00	19.199	4.269
6.25	19.199	4.269
6.50	19.198	4.270
6.75	19.199	4.269
7.00	19.197	4.271
7.25	19.199	4.269
7.50	19.195	4.273
7.75	19.194	4.274
8.00	19.194	4.274
8.25	19.197	4.271
8.50	19.193	4.275
8.75	19.194	4.274
9.00	19.194	4.274
9.25	19.193	4.275
9.50	19.193	4.275
9.75	19.192	4.276
10.00	19.191	4.277
10.50	19.192	4.276
11.00	19.192	4.276
11.50	19.190	4.278
12.00	19.191	4.277
12.50	19.190	4.278
13.00	19.190	4.278
13.50	19.191	4.277
14.00	19.188	4.280
14.50	19.188	4.280
15.00	19.186	4.282
15.50	19.189	4.279
16.00	19.187	4.282
16.50	19.188	4.280
17.00	19.186	4.282
17.50	19.187	4.281
18.00	19.186	4.282
18.50	19.185	4.283
19.00	19.185	4.283
19.50	19.185	4.283
20.00	19.185	4.283
20.50	19.184	4.285
21.00	19.183	4.285
21.50	19.184	4.285
22.00	19.184	4.284
22.50	19.180	4.288
23.00	19.182	4.286
23.50	19.177	4.291
24.00	19.182	4.286
24.50	19.182	4.287
25.00	19.180	4.288
25.50	19.181	4.287
26.00	19.179	4.289
26.50	19.177	4.291
27.00	19.179	4.289
27.50	19.178	4.290
28.00	19.180	4.288
28.50	19.178	4.290
29.00	19.178	4.290
29.50	19.177	4.291
30.00	19.177	4.291
31.00	19.177	4.291
32.00	19.175	4.293
33.00	19.177	4.291
34.00	19.176	4.292
35.00	19.174	4.294
36.00	19.174	4.294
37.00	19.174	4.295
38.00	19.165	4.303
39.00	19.170	4.298
40.00	19.168	4.301
41.00	19.180	4.288
42.00	19.182	4.286
43.00	19.181	4.287

Table C3 Recovery data after the 72-hour aquifer test in the Test Well, MHPW1 (2 of 4).

Time (min)	Depth (m)	Recovery (m)
44.00	19.184	4.284
45.00	19.183	4.285
46.00	19.182	4.286
47.00	19.183	4.285
48.00	19.181	4.287
49.00	19.177	4.291
50.00	19.179	4.289
51.00	19.180	4.289
52.00	19.175	4.293
53.00	19.175	4.293
54.00	19.162	4.306
55.00	19.176	4.292
56.00	19.176	4.292
57.00	19.175	4.293
58.00	19.164	4.304
59.00	19.172	4.296
60.00	19.174	4.294
61.00	19.173	4.295
62.00	19.171	4.297
63.00	19.173	4.295
64.00	19.170	4.298
65.00	19.170	4.298
66.00	19.170	4.298
67.00	19.168	4.300
68.00	19.169	4.299
69.00	19.167	4.301
70.00	19.168	4.301
71.00	19.165	4.303
72.00	19.163	4.305
73.00	19.163	4.305
74.00	19.163	4.305
75.00	19.163	4.305
76.00	19.163	4.305
77.00	19.162	4.306
78.00	19.162	4.306
79.00	19.160	4.308
80.00	19.162	4.306
81.00	19.160	4.308
82.00	19.161	4.308
83.00	19.160	4.308
84.00	19.159	4.309
85.00	19.158	4.310
86.00	19.158	4.310
87.00	19.158	4.310
88.00	19.156	4.312
89.00	19.157	4.311
90.00	19.156	4.312

Time (min)	Depth (m)	Recovery (m)
95.00	19.153	4.315
100.00	19.151	4.317
105.00	19.148	4.320
110.00	19.146	4.322
115.00	19.143	4.326
120.00	19.146	4.322
125.00	19.146	4.322
130.00	19.145	4.323
135.00	19.145	4.323
140.00	19.145	4.323
145.00	19.142	4.326
150.00	19.141	4.327
155.00	19.138	4.330
160.00	19.138	4.330
165.00	19.136	4.332
170.00	19.132	4.336
175.00	19.130	4.338
180.00	19.131	4.337
185.00	19.132	4.336
190.00	19.131	4.337
195.00	19.131	4.337
200.00	19.128	4.340
205.00	19.127	4.341
210.00	19.128	4.340
215.00	19.125	4.343
220.00	19.125	4.343
225.00	19.124	4.344
230.00	19.120	4.348
235.00	19.126	4.342
240.00	19.122	4.346
245.00	19.119	4.349
250.00	19.119	4.349
255.00	19.117	4.352
260.00	19.117	4.351
265.00	19.118	4.350
270.00	19.112	4.356
275.00	19.113	4.355
280.00	19.114	4.354
285.00	19.112	4.356
290.00	19.113	4.355
295.00	19.111	4.357
300.00	19.111	4.357
305.00	19.111	4.357
310.00	19.111	4.357
315.00	19.110	4.358
320.00	19.112	4.356
325.00	19.111	4.357

Table C3 Recovery data after the 72-hour aquifer test in the Test Well, MHPW1 (3 of 4).

Time (min)	Depth (m)	Recovery (m)
330.00	19.108	4.360
335.00	19.108	4.360
340.00	19.107	4.361
345.00	19.110	4.358
350.00	19.108	4.360
355.00	19.108	4.360
360.00	19.104	4.364
365.00	19.104	4.364
370.00	19.104	4.364
375.00	19.103	4.365
380.00	19.102	4.366
385.00	19.103	4.365
390.00	19.103	4.365
395.00	19.100	4.369
400.00	19.096	4.372
405.00	19.097	4.371
410.00	19.096	4.372
415.00	19.098	4.370
420.00	19.098	4.370
425.00	19.097	4.371
430.00	19.097	4.371
435.00	19.095	4.373
440.00	19.093	4.375
445.00	19.092	4.376
450.00	19.092	4.377
455.00	19.091	4.377
460.00	19.092	4.376
465.00	19.090	4.378
470.00	19.088	4.380
475.00	19.088	4.380
480.00	19.091	4.377
485.00	19.088	4.380
490.00	19.090	4.378
495.00	19.090	4.378
500.00	19.086	4.382
505.00	19.086	4.382
510.00	19.084	4.384
515.00	19.083	4.385
520.00	19.084	4.384
525.00	19.086	4.382
530.00	19.082	4.386
535.00	19.083	4.385
540.00	19.088	4.380
545.00	19.088	4.380
550.00	19.086	4.382
555.00	19.088	4.380
560.00	19.084	4.384
565.00	19.086	4.382
570.00	19.083	4.386
575.00	19.082	4.386
580.00	19.082	4.386
585.00	19.082	4.386
590.00	19.083	4.385
595.00	19.081	4.387
600.00	19.080	4.388
605.00	19.081	4.387
610.00	19.080	4.388
615.00	19.079	4.390
620.00	19.079	4.389
625.00	19.077	4.391
630.00	19.076	4.392
635.00	19.075	4.393
640.00	19.074	4.394
645.00	19.073	4.396
650.00	19.074	4.394
655.00	19.075	4.393
660.00	19.076	4.392
665.00	19.074	4.394
670.00	19.074	4.394
675.00	19.075	4.393
680.00	19.074	4.394
685.00	19.073	4.395
690.00	19.073	4.395
695.00	19.072	4.396
700.00	19.072	4.396
705.00	19.073	4.395
720.00	19.069	4.399
725.00	19.069	4.399
730.00	19.069	4.399
735.00	19.068	4.400
740.00	19.068	4.400
745.00	19.068	4.401
750.00	19.066	4.402
755.00	19.067	4.401
760.00	19.068	4.400
765.00	19.065	4.403
770.00	19.067	4.401
775.00	19.064	4.404
780.00	19.066	4.402
785.00	19.066	4.402
790.00	19.064	4.404
795.00	19.066	4.403
800.00	19.064	4.404
805.00	19.067	4.401

Table C3 Recovery data after the 72-hour aquifer test in the Test Well, MHPW1 (4 of 4).

Time (min)	Depth (m)	Recovery (m)
810.00	19.066	4.402
815.00	19.067	4.402
820.00	19.065	4.403
825.00	19.066	4.402
830.00	19.065	4.403
835.00	19.065	4.403
840.00	19.066	4.402
845.00	19.063	4.405
850.00	19.065	4.403
855.00	19.063	4.405
860.00	19.062	4.406
865.00	19.063	4.405
870.00	19.062	4.406
875.00	19.061	4.407
880.00	19.062	4.406
885.00	19.062	4.406
890.00	19.062	4.406
895.00	19.062	4.406
900.00	19.061	4.407
905.00	19.060	4.408
910.00	19.061	4.407
915.00	19.060	4.408
920.00	19.060	4.408
925.00	19.061	4.407
930.00	19.059	4.409
935.00	19.060	4.408
940.00	19.060	4.408
945.00	19.061	4.407
950.00	19.060	4.408
955.00	19.060	4.408
960.00	19.061	4.408
965.00	19.060	4.408
970.00	19.060	4.408
975.00	19.058	4.410
980.00	19.057	4.411
985.00	19.058	4.410
990.00	19.058	4.410
995.00	19.057	4.411
1000.00	19.057	4.411
1005.00	19.059	4.409
1010.00	19.058	4.410
1015.00	19.059	4.409
1020.00	19.058	4.410
1025.00	19.058	4.410
1030.00	19.059	4.410
1035.00	19.058	4.410
1040.00	19.057	4.411
1045.00	19.058	4.410
1050.00	19.058	4.411

Table C4 Recorded data during the 72-hour aquifer test in the monitoring well, BH2 (1 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
0 (Static)	19.340	0.000
0.08	19.340	0.000
0.33	19.341	0.000
0.58	19.340	0.000
0.83	19.341	0.001
1.08	19.342	0.002
1.33	19.343	0.003
1.58	19.343	0.003
1.83	19.343	0.003
2.08	19.344	0.004
2.33	19.345	0.005
2.58	19.345	0.005
2.83	19.344	0.004
3.08	19.345	0.005
3.33	19.345	0.005
3.58	19.346	0.006
3.83	19.346	0.006
4.08	19.346	0.006
4.33	19.346	0.006
4.58	19.346	0.006
4.83	19.346	0.006
5.08	19.346	0.006
5.33	19.346	0.006
5.58	19.346	0.006
5.83	19.347	0.007
6.08	19.347	0.007
6.33	19.347	0.007
6.58	19.347	0.006
6.83	19.346	0.006
7.08	19.347	0.007
7.33	19.346	0.006
7.58	19.347	0.007
7.83	19.347	0.007
8.08	19.348	0.008
8.33	19.346	0.006
8.58	19.347	0.007
8.83	19.348	0.008
9.08	19.347	0.007
9.33	19.348	0.008
9.58	19.349	0.009
9.83	19.348	0.008
10.08	19.348	0.008
10.33	19.348	0.008
11.58	19.348	0.008
12.08	19.348	0.008
11.33	19.348	0.008
13.58	19.349	0.009

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
14.08	19.350	0.009
12.33	19.348	0.008
15.58	19.350	0.010
16.08	19.351	0.011
13.33	19.350	0.010
17.58	19.350	0.010
18.08	19.350	0.010
14.33	19.349	0.009
19.58	19.351	0.011
20.08	19.351	0.011
15.33	19.349	0.009
21.58	19.352	0.012
22.08	19.351	0.011
16.33	19.350	0.010
23.58	19.353	0.013
24.08	19.351	0.011
17.33	19.351	0.011
25.58	19.353	0.012
26.08	19.353	0.013
18.33	19.350	0.010
27.58	19.354	0.014
28.08	19.353	0.013
19.33	19.351	0.011
29.58	19.356	0.015
30.58	19.354	0.014
20.33	19.350	0.010
33.58	19.355	0.015
34.58	19.356	0.016
21.33	19.353	0.013
37.58	19.357	0.017
38.58	19.357	0.017
22.33	19.353	0.013
41.58	19.358	0.017
42.58	19.358	0.018
23.33	19.353	0.013
46.58	19.360	0.020
49.58	19.359	0.019
25.33	19.353	0.013
54.58	19.361	0.021
57.58	19.362	0.022
27.33	19.354	0.014
74.58	19.365	0.025
89.58	19.369	0.029
29.33	19.354	0.014
114.58	19.372	0.032
124.58	19.374	0.034
31.08	19.355	0.015

Table C4 Recorded data during the 72-hour aquifer test in the monitoring well, BH2 (2 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
149.58	19.378	0.038
159.58	19.379	0.039
32.83	19.355	0.015
33.33	19.355	0.015
194.58	19.386	0.046
204.58	19.386	0.046
35.08	19.355	0.015
229.58	19.390	0.050
239.58	19.390	0.050
36.83	19.356	0.016
37.33	19.357	0.017
274.58	19.394	0.054
284.58	19.394	0.054
39.08	19.357	0.017
309.58	19.398	0.058
319.58	19.398	0.058
40.83	19.358	0.018
41.33	19.358	0.018
354.58	19.399	0.059
364.58	19.400	0.060
43.08	19.359	0.019
389.58	19.403	0.063
399.58	19.403	0.063
44.83	19.358	0.018
45.33	19.358	0.018
434.58	19.406	0.066
444.58	19.408	0.068
47.08	19.359	0.019
469.58	19.410	0.070
479.58	19.411	0.071
48.83	19.360	0.020
49.33	19.360	0.020
514.58	19.413	0.073
524.58	19.413	0.073
51.08	19.359	0.018
549.58	19.418	0.078
559.58	19.418	0.078
52.83	19.360	0.020
53.33	19.360	0.020
594.58	19.419	0.079
604.58	19.420	0.079
55.08	19.360	0.020
629.58	19.422	0.082
639.58	19.423	0.083
56.83	19.361	0.021
57.33	19.362	0.022
674.58	19.427	0.087

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
684.58	19.427	0.087
739.58	19.428	0.088
789.58	19.432	0.092
66.33	19.363	0.023
68.83	19.363	0.023
944.58	19.442	0.102
994.58	19.446	0.106
76.58	19.367	0.027
79.08	19.366	0.026
1149.58	19.454	0.114
1199.58	19.457	0.117
86.83	19.368	0.028
89.33	19.369	0.029
1354.58	19.467	0.127
1404.58	19.472	0.132
97.08	19.370	0.030
1509.58	19.475	0.135
1559.58	19.478	0.138
104.83	19.372	0.032
107.33	19.372	0.032
1714.58	19.484	0.144
1764.58	19.487	0.147
115.08	19.372	0.032
117.58	19.373	0.033
1919.58	19.492	0.152
1969.58	19.494	0.154
125.33	19.374	0.034
127.83	19.375	0.035
2124.58	19.500	0.160
2174.58	19.503	0.163
135.58	19.376	0.036
138.08	19.376	0.036
2329.58	19.503	0.163
2379.58	19.507	0.167
145.83	19.378	0.038
148.33	19.378	0.038
2534.58	19.515	0.175
2584.58	19.518	0.178
156.08	19.380	0.040
158.58	19.381	0.041
2739.58	19.524	0.184
2789.58	19.525	0.185
166.33	19.380	0.040
168.83	19.382	0.041
2944.58	19.526	0.186
2994.58	19.524	0.184
176.58	19.381	0.041

Table C4 Recorded data during the 72-hour aquifer test in the monitoring well, BH2 (3 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
179.08	19.383	0.043
3149.58	19.525	0.185
3199.58	19.528	0.188
186.83	19.383	0.043
189.33	19.385	0.045
3354.58	19.530	0.190
3404.58	19.533	0.192
197.08	19.387	0.047
3559.58	19.533	0.193
207.33	19.387	0.046
3764.58	19.539	0.199
217.58	19.388	0.048
3969.58	19.548	0.208
227.83	19.390	0.050
4174.58	19.544	0.203
238.08	19.391	0.051
246.08	19.391	0.051
256.58	19.393	0.052
267.08	19.392	0.052
277.58	19.393	0.053
288.08	19.394	0.054
298.58	19.395	0.055
309.08	19.397	0.057
319.83	19.398	0.058
330.33	19.397	0.057
340.83	19.398	0.058
351.33	19.398	0.058
361.83	19.400	0.060
372.33	19.400	0.060
382.83	19.401	0.061
393.33	19.403	0.063
403.83	19.404	0.064
414.33	19.405	0.065
425.08	19.406	0.066
435.58	19.406	0.066
446.08	19.408	0.067
456.58	19.410	0.070
467.08	19.411	0.070
477.58	19.412	0.072
488.08	19.412	0.072
498.58	19.411	0.071
509.08	19.412	0.072
519.83	19.413	0.073
530.33	19.414	0.074
540.83	19.415	0.075
551.33	19.417	0.077
561.83	19.417	0.077

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
572.33	19.418	0.078
582.83	19.418	0.078
593.33	19.420	0.080
603.83	19.420	0.080
614.33	19.421	0.081
625.08	19.422	0.082
635.58	19.423	0.082
646.08	19.424	0.084
656.58	19.425	0.085
667.08	19.426	0.086
677.58	19.426	0.086
688.08	19.428	0.088
698.58	19.428	0.088
709.08	19.430	0.090
719.83	19.426	0.086
730.33	19.426	0.086
740.83	19.428	0.088
751.33	19.428	0.088
761.83	19.430	0.090
772.33	19.430	0.090
782.83	19.432	0.092
793.33	19.433	0.093
803.83	19.431	0.091
814.33	19.433	0.093
825.08	19.433	0.093
835.58	19.434	0.094
846.08	19.434	0.094
856.58	19.436	0.096
867.08	19.437	0.097
877.58	19.437	0.097
888.08	19.438	0.098
898.58	19.439	0.099
909.08	19.440	0.100
919.83	19.441	0.101
930.33	19.441	0.101
940.83	19.442	0.102
951.33	19.441	0.101
961.83	19.443	0.103
972.33	19.445	0.105
982.83	19.444	0.104
993.33	19.447	0.107
1003.83	19.447	0.107
1014.33	19.447	0.107
1025.08	19.448	0.108
1035.58	19.449	0.108
1046.08	19.452	0.111
1056.58	19.451	0.111

Table C4 Recorded data during the 72-hour aquifer test in the monitoring well, BH2 (4 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
1067.08	19.450	0.110
1077.58	19.451	0.111
1088.08	19.451	0.111
1098.58	19.452	0.111
1109.08	19.452	0.112
1119.83	19.452	0.112
1130.33	19.453	0.113
1140.83	19.454	0.114
1151.33	19.454	0.114
1161.83	19.455	0.115
1172.33	19.455	0.115
1182.83	19.455	0.115
1193.33	19.457	0.117
1203.83	19.458	0.118
1214.33	19.457	0.117
1225.08	19.458	0.118
1235.58	19.458	0.118
1246.08	19.460	0.119
1256.58	19.460	0.120
1267.08	19.461	0.121
1277.58	19.459	0.119
1288.08	19.462	0.122
1298.58	19.462	0.122
1309.08	19.465	0.125
1319.83	19.466	0.126
1330.33	19.466	0.126
1340.83	19.466	0.126
1351.33	19.467	0.127
1361.83	19.467	0.127
1372.33	19.470	0.130
1382.83	19.470	0.130
1393.33	19.470	0.130
1403.83	19.471	0.131
1414.33	19.471	0.131
1425.08	19.472	0.132
1435.58	19.473	0.133
1446.08	19.473	0.133
1456.58	19.474	0.134
1467.08	19.473	0.133
1477.58	19.474	0.134
1488.08	19.475	0.135
1498.58	19.475	0.135
1509.08	19.477	0.137
1519.83	19.476	0.136
1530.33	19.476	0.136
1540.83	19.478	0.138
1551.33	19.478	0.138

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
1561.83	19.478	0.138
1572.33	19.480	0.140
1582.83	19.478	0.138
1593.33	19.478	0.138
1603.83	19.479	0.139
1614.33	19.479	0.139
1625.08	19.480	0.140
1635.58	19.482	0.142
1646.08	19.481	0.141
1656.58	19.482	0.142
1667.08	19.482	0.142
1677.58	19.482	0.142
1688.08	19.482	0.142
1698.58	19.483	0.143
1709.08	19.484	0.144
1719.83	19.485	0.145
1730.33	19.486	0.146
1740.83	19.485	0.145
1751.33	19.487	0.147
1761.83	19.486	0.146
1772.33	19.487	0.147
1782.83	19.487	0.147
1793.33	19.486	0.146
1803.83	19.488	0.148
1814.33	19.488	0.148
1825.08	19.488	0.148
1835.58	19.488	0.148
1846.08	19.488	0.148
1856.58	19.488	0.148
1867.08	19.488	0.148
1877.58	19.489	0.149
1888.08	19.491	0.151
1898.58	19.491	0.151
1909.08	19.491	0.151
1919.83	19.491	0.151
1930.33	19.492	0.152
1940.83	19.492	0.152
1951.33	19.493	0.153
1961.83	19.493	0.153
1972.33	19.494	0.154
1982.83	19.496	0.156
1993.33	19.495	0.154
2003.83	19.495	0.155
2014.33	19.496	0.156
2025.08	19.495	0.155
2035.58	19.497	0.157
2046.08	19.495	0.155

Table C4 Recorded data during the 72-hour aquifer test in the monitoring well, BH2 (5 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
2056.58	19.496	0.156
2067.08	19.497	0.157
2077.58	19.497	0.157
2088.08	19.498	0.158
2098.58	19.499	0.159
2109.08	19.499	0.159
2119.83	19.500	0.160
2130.33	19.500	0.160
2140.83	19.500	0.160
2151.33	19.501	0.161
2161.83	19.501	0.161
2172.33	19.502	0.162
2182.83	19.502	0.162
2193.33	19.503	0.163
2203.83	19.503	0.163
2214.33	19.503	0.163
2225.08	19.503	0.163
2235.58	19.503	0.163
2246.08	19.504	0.164
2256.58	19.505	0.165
2267.08	19.504	0.164
2277.58	19.502	0.162
2288.08	19.503	0.163
2298.58	19.503	0.163
2309.08	19.504	0.164
2319.83	19.504	0.164
2330.33	19.503	0.163
2340.83	19.505	0.165
2351.33	19.505	0.165
2361.83	19.507	0.167
2372.33	19.506	0.166
2382.83	19.507	0.166
2393.33	19.508	0.168
2403.83	19.509	0.169
2414.33	19.511	0.171
2425.08	19.513	0.173
2435.58	19.514	0.174
2446.08	19.513	0.173
2456.58	19.514	0.174
2467.08	19.515	0.175
2477.58	19.515	0.175
2488.08	19.515	0.175
2498.58	19.515	0.175
2509.08	19.516	0.176
2519.83	19.516	0.176
2530.33	19.516	0.176
2540.83	19.517	0.177

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
2551.33	19.516	0.176
2561.83	19.518	0.178
2572.33	19.517	0.177
2582.83	19.519	0.179
2593.33	19.520	0.180
2603.83	19.519	0.179
2614.33	19.520	0.180
2625.08	19.520	0.180
2635.58	19.521	0.181
2646.08	19.522	0.182
2656.58	19.524	0.184
2667.08	19.524	0.183
2677.58	19.524	0.184
2688.08	19.522	0.182
2698.58	19.523	0.183
2709.08	19.525	0.185
2719.83	19.525	0.185
2730.33	19.525	0.185
2740.83	19.524	0.184
2751.33	19.523	0.183
2761.83	19.524	0.184
2772.33	19.525	0.185
2782.83	19.526	0.186
2793.33	19.525	0.185
2803.83	19.526	0.186
2814.33	19.526	0.186
2825.08	19.525	0.185
2835.58	19.527	0.187
2846.08	19.526	0.186
2856.58	19.525	0.185
2867.08	19.526	0.186
2877.58	19.527	0.187
2888.08	19.527	0.187
2898.58	19.528	0.188
2909.08	19.526	0.186
2919.83	19.525	0.185
2930.33	19.525	0.185
2940.83	19.526	0.186
2951.33	19.527	0.186
2961.83	19.526	0.186
2972.33	19.526	0.186
2982.83	19.524	0.184
2993.33	19.523	0.183
3003.83	19.523	0.183
3014.33	19.524	0.184
3025.08	19.524	0.184
3035.58	19.525	0.185

Table C4 Recorded data during the 72-hour aquifer test in the monitoring well, BH2 (6 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
3046.08	19.524	0.184
3056.58	19.525	0.185
3067.08	19.526	0.186
3077.58	19.526	0.186
3088.08	19.525	0.185
3098.58	19.526	0.186
3109.08	19.528	0.188
3119.83	19.526	0.186
3130.33	19.524	0.184
3140.83	19.525	0.185
3151.33	19.526	0.186
3161.83	19.525	0.185
3172.33	19.525	0.185
3182.83	19.527	0.187
3193.33	19.527	0.187
3203.83	19.528	0.188
3214.33	19.527	0.187
3225.08	19.529	0.189
3235.58	19.528	0.188
3246.08	19.527	0.187
3256.58	19.526	0.186
3267.08	19.526	0.186
3277.58	19.527	0.187
3288.08	19.528	0.188
3298.58	19.529	0.189
3309.08	19.530	0.189
3319.83	19.528	0.188
3330.33	19.530	0.190
3340.83	19.530	0.190
3351.33	19.531	0.191
3361.83	19.531	0.191
3372.33	19.532	0.192
3382.83	19.531	0.191
3393.33	19.532	0.192
3403.83	19.532	0.192
3414.33	19.532	0.192
3425.08	19.532	0.192
3435.58	19.532	0.192
3446.08	19.533	0.192
3456.58	19.532	0.192
3467.08	19.533	0.193
3477.58	19.533	0.193
3488.08	19.531	0.191
3498.58	19.532	0.192
3509.08	19.533	0.193
3519.83	19.532	0.192
3530.33	19.534	0.194
3540.83	19.534	0.194
3551.33	19.535	0.195
3561.83	19.535	0.195
3572.33	19.536	0.196
3582.83	19.535	0.195
3593.33	19.534	0.194
3603.83	19.536	0.196
3614.33	19.536	0.195
3625.08	19.537	0.197
3635.58	19.539	0.198
3646.08	19.538	0.198
3656.58	19.538	0.198
3667.08	19.537	0.197
3677.58	19.538	0.198
3688.08	19.540	0.200
3698.58	19.539	0.199
3709.08	19.540	0.200
3719.83	19.540	0.200
3730.33	19.538	0.198
3740.83	19.537	0.197
3751.33	19.538	0.198
3761.83	19.539	0.199
3772.33	19.541	0.201
3782.83	19.538	0.198
3793.33	19.544	0.204
3803.83	19.542	0.202
3814.33	19.545	0.204
3825.08	19.546	0.206
3835.58	19.546	0.206
3846.08	19.541	0.201
3856.58	19.541	0.201
3867.08	19.540	0.200
3877.58	19.538	0.198
3888.08	19.537	0.197
3898.58	19.538	0.198
3909.08	19.539	0.199
3919.83	19.541	0.201
3930.33	19.542	0.201
3940.83	19.544	0.204
3951.33	19.546	0.206
3961.83	19.547	0.207
3972.33	19.549	0.209
3982.83	19.550	0.210
3993.33	19.548	0.208
4003.83	19.550	0.210
4014.33	19.549	0.209
4025.08	19.547	0.207

Table C4 Recorded data during the 72-hour aquifer test in the monitoring well, BH2 (7 of 7).

Time *t (min)*	**Depth** *(m)*	**Drawdown** *dd (m)*
4035.58	19.545	0.205
4046.08	19.543	0.203
4056.58	19.544	0.204
4067.08	19.549	0.209
4077.58	19.553	0.213
4088.08	19.548	0.208
4098.58	19.545	0.205
4109.08	19.544	0.204
4119.83	19.544	0.204
4130.33	19.544	0.204
4140.83	19.544	0.204
4151.33	19.544	0.203
4161.83	19.546	0.206
4172.33	19.543	0.203
4182.83	19.545	0.205
4193.33	19.546	0.206
4203.83	19.547	0.207
4214.33	19.552	0.212
4225.08	19.551	0.211
4235.58	19.548	0.208
4246.08	19.544	0.204
4256.58	19.543	0.203
4267.08	19.544	0.204
4277.58	19.543	0.203
4288.08	19.542	0.202
4298.58	19.543	0.203
4309.08	19.542	0.202
4319.83	19.541	0.201

Table C5 Recovery data after the 72-hour aquifer test in the monitoring well, BH2 (1 of 5).

Time *(min)*	**Depth** *(m)*	**Recovery** *(m)*
0 (Start)	19.542	0.000
0.25	19.542	0.000
0.50	19.541	0.001
0.75	19.539	0.003
1.00	19.540	0.003
1.25	19.538	0.004
1.50	19.539	0.003
1.75	19.539	0.003
2.00	19.539	0.003
2.25	19.537	0.005
2.50	19.538	0.004
2.75	19.537	0.005
3.00	19.536	0.006
3.25	19.538	0.005
3.50	19.536	0.006
3.75	19.536	0.006
4.00	19.536	0.006
4.25	19.535	0.007
4.50	19.536	0.006
4.75	19.537	0.005
5.00	19.535	0.007
5.25	19.536	0.006
5.50	19.534	0.009
5.75	19.534	0.008
6.00	19.535	0.007
6.25	19.536	0.006
6.50	19.534	0.008
6.75	19.535	0.007
7.00	19.534	0.008
7.25	19.537	0.006
7.50	19.531	0.011
7.75	19.531	0.011
8.00	19.533	0.009
8.25	19.532	0.010
8.50	19.531	0.011
8.75	19.533	0.009
9.00	19.532	0.010
9.25	19.532	0.010
9.50	19.530	0.012
9.75	19.532	0.010
10.00	19.531	0.012
10.50	19.532	0.010
11.00	19.533	0.009
11.50	19.532	0.010
12.00	19.530	0.012
12.50	19.531	0.011
13.00	19.531	0.011

Time *(min)*	**Depth** *(m)*	**Recovery** *(m)*
13.50	19.530	0.012
14.00	19.529	0.013
14.50	19.528	0.014
15.00	19.528	0.014
15.50	19.530	0.012
16.00	19.528	0.014
16.50	19.529	0.014
17.00	19.528	0.015
17.50	19.527	0.015
18.00	19.526	0.016
18.50	19.525	0.017
19.00	19.525	0.017
19.50	19.527	0.015
20.00	19.526	0.016
20.50	19.526	0.016
21.00	19.525	0.017
21.50	19.524	0.018
22.00	19.524	0.018
22.50	19.524	0.018
23.00	19.524	0.018
23.50	19.520	0.022
24.00	19.524	0.018
24.50	19.524	0.018
25.00	19.523	0.019
25.50	19.523	0.019
26.00	19.522	0.020
26.50	19.523	0.019
27.00	19.521	0.021
27.50	19.522	0.020
28.00	19.522	0.020
28.50	19.522	0.020
29.00	19.522	0.020
29.50	19.522	0.020
30.00	19.522	0.020
31.00	19.522	0.020
32.00	19.521	0.021
33.00	19.520	0.022
34.00	19.521	0.021
35.00	19.520	0.023
36.00	19.519	0.023
37.00	19.518	0.024
38.00	19.518	0.024
39.00	19.515	0.027
40.00	19.513	0.029
41.00	19.523	0.019
42.00	19.526	0.016
43.00	19.526	0.016

Table C5 Recovery data after the 72-hour aquifer test in the monitoring well, BH2 (2 of 5).

Time (min)	Depth (m)	Recovery (m)
44.00	19.528	0.014
45.00	19.528	0.014
46.00	19.527	0.015
47.00	19.528	0.014
48.00	19.525	0.017
49.00	19.523	0.019
50.00	19.524	0.018
51.00	19.524	0.018
52.00	19.524	0.018
53.00	19.524	0.018
54.00	19.523	0.019
55.00	19.525	0.017
56.00	19.524	0.018
57.00	19.521	0.021
58.00	19.512	0.030
59.00	19.519	0.023
60.00	19.519	0.023
61.00	19.521	0.021
62.00	19.519	0.023
63.00	19.521	0.021
64.00	19.519	0.023
65.00	19.519	0.023
66.00	19.518	0.024
67.00	19.516	0.026
68.00	19.518	0.024
69.00	19.514	0.028
70.00	19.516	0.026
71.00	19.514	0.028
72.00	19.512	0.030
73.00	19.512	0.030
74.00	19.512	0.030
75.00	19.511	0.031
76.00	19.511	0.031
77.00	19.511	0.031
78.00	19.511	0.031
79.00	19.509	0.033
80.00	19.511	0.031
81.00	19.509	0.033
82.00	19.509	0.033
83.00	19.509	0.033
84.00	19.508	0.034
85.00	19.507	0.035
86.00	19.508	0.034
87.00	19.507	0.035
88.00	19.507	0.035
89.00	19.507	0.035
90.00	19.506	0.036
95.00	19.504	0.038
100.00	19.502	0.041
105.00	19.500	0.042
110.00	19.498	0.044
115.00	19.496	0.046
120.00	19.499	0.043
125.00	19.497	0.045
130.00	19.499	0.044
135.00	19.497	0.045
140.00	19.497	0.045
145.00	19.496	0.046
150.00	19.494	0.049
155.00	19.492	0.050
160.00	19.491	0.051
165.00	19.490	0.052
170.00	19.487	0.055
175.00	19.485	0.057
180.00	19.487	0.055
185.00	19.488	0.054
190.00	19.486	0.056
195.00	19.485	0.057
200.00	19.483	0.059
205.00	19.482	0.060
210.00	19.483	0.059
215.00	19.481	0.061
220.00	19.481	0.061
225.00	19.479	0.063
230.00	19.478	0.064
235.00	19.482	0.060
240.00	19.479	0.063
245.00	19.476	0.066
250.00	19.478	0.064
255.00	19.474	0.068
260.00	19.476	0.066
265.00	19.476	0.066
270.00	19.470	0.072
275.00	19.473	0.069
280.00	19.473	0.069
285.00	19.472	0.070
290.00	19.471	0.071
295.00	19.471	0.071
300.00	19.470	0.072
305.00	19.470	0.072
310.00	19.469	0.073
315.00	19.470	0.072
320.00	19.472	0.070
325.00	19.470	0.072

Table C5 Recovery data after the 72-hour aquifer test in the monitoring well, BH2 (3 of 5).

Time (min)	Depth (m)	Recovery (m)
330.00	19.467	0.075
335.00	19.468	0.074
340.00	19.467	0.075
345.00	19.469	0.073
350.00	19.467	0.075
355.00	19.468	0.075
360.00	19.465	0.077
365.00	19.464	0.078
370.00	19.464	0.078
375.00	19.464	0.078
380.00	19.463	0.079
385.00	19.461	0.081
390.00	19.462	0.080
395.00	19.461	0.081
400.00	19.459	0.083
405.00	19.460	0.082
410.00	19.460	0.082
415.00	19.460	0.082
420.00	19.460	0.082
425.00	19.459	0.083
430.00	19.459	0.083
435.00	19.457	0.085
440.00	19.456	0.086
445.00	19.456	0.087
450.00	19.454	0.088
455.00	19.455	0.087
460.00	19.455	0.087
465.00	19.454	0.088
470.00	19.453	0.089
475.00	19.451	0.091
480.00	19.455	0.087
485.00	19.452	0.090
490.00	19.453	0.089
495.00	19.452	0.090
500.00	19.450	0.092
505.00	19.449	0.093
510.00	19.449	0.093
515.00	19.449	0.093
520.00	19.449	0.093
525.00	19.450	0.092
530.00	19.448	0.094
535.00	19.448	0.094
540.00	19.453	0.090
545.00	19.450	0.092
550.00	19.451	0.091
555.00	19.450	0.092
560.00	19.448	0.094
565.00	19.448	0.094
570.00	19.447	0.095
575.00	19.448	0.095
580.00	19.447	0.095
585.00	19.448	0.095
590.00	19.447	0.095
595.00	19.446	0.096
600.00	19.446	0.096
605.00	19.445	0.097
610.00	19.444	0.098
615.00	19.443	0.099
620.00	19.444	0.098
625.00	19.442	0.100
630.00	19.442	0.100
635.00	19.440	0.102
640.00	19.439	0.103
645.00	19.439	0.103
650.00	19.442	0.100
655.00	19.442	0.100
660.00	19.442	0.100
665.00	19.439	0.103
670.00	19.440	0.102
675.00	19.441	0.101
680.00	19.440	0.102
685.00	19.440	0.102
690.00	19.440	0.102
695.00	19.437	0.105
700.00	19.437	0.105
705.00	19.439	0.103
720.00	19.436	0.106
725.00	19.435	0.107
730.00	19.436	0.106
735.00	19.435	0.108
740.00	19.435	0.107
745.00	19.434	0.108
750.00	19.434	0.108
755.00	19.434	0.108
760.00	19.434	0.108
765.00	19.433	0.109
770.00	19.434	0.108
775.00	19.431	0.111
780.00	19.433	0.109
785.00	19.433	0.109
790.00	19.431	0.111
795.00	19.433	0.109
800.00	19.433	0.109
805.00	19.434	0.108

Table C5 Recovery data after the 72-hour aquifer test in the monitoring well, BH2 (4 of 5).

Time (min)	Depth (m)	Recovery (m)
810.00	19.434	0.108
815.00	19.434	0.108
820.00	19.434	0.108
825.00	19.432	0.110
830.00	19.432	0.110
835.00	19.433	0.109
840.00	19.434	0.108
845.00	19.431	0.111
850.00	19.432	0.111
855.00	19.431	0.111
860.00	19.430	0.112
865.00	19.430	0.112
870.00	19.430	0.112
875.00	19.430	0.113
880.00	19.429	0.113
885.00	19.430	0.113
890.00	19.430	0.112
895.00	19.429	0.113
900.00	19.429	0.113
905.00	19.429	0.114
910.00	19.429	0.113
915.00	19.428	0.114
920.00	19.429	0.113
925.00	19.429	0.113
930.00	19.428	0.114
935.00	19.428	0.114
940.00	19.429	0.113
945.00	19.430	0.112
950.00	19.429	0.114
955.00	19.429	0.113
960.00	19.428	0.114
965.00	19.427	0.115
970.00	19.427	0.115
975.00	19.426	0.116
980.00	19.426	0.116
985.00	19.425	0.117
990.00	19.426	0.117
995.00	19.425	0.117
1000.00	19.427	0.115
1005.00	19.427	0.115
1010.00	19.425	0.117
1015.00	19.426	0.116
1020.00	19.428	0.114
1025.00	19.427	0.115
1030.00	19.428	0.114
1035.00	19.426	0.116
1040.00	19.427	0.115
1045.00	19.426	0.116
1050.00	19.426	0.116
1055.00	19.426	0.116
1060.00	19.426	0.117
1065.00	19.425	0.117
1070.00	19.425	0.117
1075.00	19.425	0.117
1080.00	19.425	0.117
1085.00	19.425	0.117
1090.00	19.425	0.117
1095.00	19.424	0.118
1100.00	19.425	0.117
1105.00	19.425	0.117
1110.00	19.424	0.118
1115.00	19.424	0.118
1120.00	19.425	0.117
1125.00	19.424	0.118
1130.00	19.426	0.116
1135.00	19.425	0.117
1140.00	19.424	0.118
1145.00	19.424	0.118
1150.00	19.425	0.118
1155.00	19.425	0.117
1160.00	19.426	0.116
1165.00	19.424	0.118
1170.00	19.424	0.118
1175.00	19.425	0.117
1180.00	19.426	0.116
1185.00	19.427	0.115
1190.00	19.426	0.117
1195.00	19.426	0.116
1200.00	19.426	0.116
1205.00	19.426	0.116
1210.00	19.426	0.116
1215.00	19.426	0.116
1220.00	19.426	0.116
1225.00	19.426	0.116
1230.00	19.426	0.116
1235.00	19.428	0.114
1240.00	19.428	0.114
1245.00	19.428	0.114
1250.00	19.429	0.113
1255.00	19.429	0.113
1260.00	19.429	0.113
1265.00	19.428	0.114
1270.00	19.426	0.116
1275.00	19.425	0.117

Table C5 Recovery data after the 72-hour aquifer test in the monitoring well, BH2 (5 of 5).

Time *(min)*	**Depth** *(m)*	**Recovery** *(m)*
1280.00	19.427	0.115
1285.00	19.431	0.111
1290.00	19.428	0.114
1295.00	19.425	0.117
1300.00	19.426	0.117
1305.00	19.424	0.118
1310.00	19.424	0.118
1315.00	19.423	0.119
1320.00	19.423	0.119
1325.00	19.422	0.120
1330.00	19.423	0.119
1335.00	19.422	0.120
1340.00	19.423	0.119
1345.00	19.421	0.121
1350.00	19.421	0.121
1355.00	19.421	0.121
1360.00	19.420	0.122
1365.00	19.421	0.121
1370.00	19.420	0.122
1375.00	19.421	0.121
1380.00	19.419	0.123
1385.00	19.420	0.122
1390.00	19.428	0.114
1395.00	19.428	0.114
1400.00	19.431	0.111
1405.00	19.432	0.110

APPENDIX D

Laboratory Analytical Reports of Chemical and Bacteriological Analysis

Run Date: 22/03/18 Western Health Care Corp. - LAB **LIVE** Page: 1
Run Time: 0916 Corner Brook, NL
Department Of Laboratory ** LIVE **

RECEIVED MAR 2 8 2018

NAME: PW,SEOK EUNJEONG

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000885R **OLL:** 19/03/18-1835 **COLLECTED BY:** ES
RECD: 20/03/18-1522 **SOURCE:** WATER

COMMENTS: NAME:EUNJEONG SEOK FRACFLOW CONSULTANTS INC ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:739-7270 BARCODE NUMBER:44516 SPECIMEN TYPE:DRILLED WELL

Procedure	Result	Verified	Site
	***** MICROBIOLOGY *****		
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	21/03/18-1538	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE
Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:
☑ Satisfactory ☐ Sub-standard
☐ Unsatisfactory ☐ Unable to Interpret

Comments:

Mar. 29/18 Melanie Deane
Date Environmental Health Officer III

Run Date: 23/03/18
Run Time: 1545

Western Health Care Corp. - LAB **LIVE**
Corner Brook, NL
Department Of Laboratory

Page: 5

** LIVE **

NAME: PW,THOMPSON SHAWN

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000927R **OLL:** 21/03/18-0832 **RECD:** 22/03/18-1104 **COLLECTED BY:** ST **SOURCE:** WATER

COMMENTS: NAME:SHAWN THOMPSON ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:239-2270 BARCODE NUMBER:44515 SPECIMEN TYPE:DRILLED WELL FRACFLOW CONSULTANTS INC

Procedure	Result	Verified	Site
	***** MICROBIOLOGY *****		
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	23/03/18-1144	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE
Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:
☑ Satisfactory ☐ Sub-standard
☐ Unsatisfactory ☐ Unable to Interpret

Comments:

Mar 26, 2018
Date

Environmental Health Officer III

Run Date: 23/03/18 Western Health Care Corp. - LAB **LIVE** Page: 6
Run Time: 1545 Corner Brook, NL
Department Of Laboratory ** LIVE **

NAME: PW,THOMPSON SHAWN

Report for: GOV.SERV.CENTRE-STEPHEN

SPEC #: 18:WA0000928R **OLL:** 21/03/18-1412 **COLLECTED BY:** ST
RECD: 22/03/18-1106 **SOURCE:** WATER

COMMENTS: NAME:SHAWN THOMPSON ADDRESS:154 MAJORS PATH ST JOHNS A1A 5A1 TELEPHONE:739-7270 BARCODE NUMBER:50769 SPECIMEN TYPE:DRILLED WELL FRACFLOW CONSULTANTS INC

Procedure	Result	Verified	Site
	*** MICROBIOLOGY ***		
> **BACTERIOLOGICAL WATER ANALYSIS**	Final	23/03/18-1144	
TOTAL COLIFORMS	ABSENT / 100ML		
FECAL COLIFORM (E. COLI)	ABSENT / 100ML		

GOVERNMENT SERVICE CENTRE
Stephenville Office
643-8650

INTERPRETATION OF WATER TEST RESULTS:
☑ Satisfactory ☐ Sub-standard
☐ Unsatisfactory ☐ Unable to Interpret

Comments:

Mar 26, 2018
Date

David Jones
Environmental Health Officer III

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113-Stephenville, NL

AGAT WORK ORDER: 18K322806

WATER ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

DATE REPORTED: Apr 03, 2018

PAGES (INCLUDING COVER): 14

VERSION*: 2

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES
VERSION 2:Version 2.0 supersedes Version 1.0. Updated RDL for Hg. Issued April 3, 2018.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

				SAMPLE DESCRIPTION:	3113-MHPW1-WS1
				SAMPLE TYPE:	Water
				DATE SAMPLED:	2018-03-19
Parameter	Unit	G / S	RDL		9144903
Dissolved Aluminum	ug/L	Variable	5		<5
Dissolved Antimony	ug/L		2		<2
Dissolved Arsenic	ug/L	5	2		<2
Dissolved Barium	ug/L		5		41
Dissolved Beryllium	ug/L		2		<2
Dissolved Bismuth	ug/L		2		<2
Dissolved Boron	ug/L	29000,	5		21
Dissolved Cadmium	ug/L	1.0, 0.09	0.017		<0.017
Dissolved Chromium	ug/L		1		2
Dissolved Cobalt	ug/L		1		<1
Dissolved Copper	ug/L	Equation	2		4
Dissolved Iron	ug/L	300	50		<50
Dissolved Lead	ug/L	Equation	0.5		0.8
Dissolved Manganese	ug/L		2		3
Dissolved Molybdenum	ug/L	73	2		<2
Dissolved Nickel	ug/L	Equation	2		<2
Dissolved Selenium	ug/L	1.0	1		<1
Dissolved Silver	ug/L	0.25	0.1		<0.1
Dissolved Strontium	ug/L		5		84
Dissolved Thallium	ug/L	0.8	0.1		<0.1
Dissolved Tin	ug/L		2		<2
Dissolved Titanium	ug/L		2		<2
Dissolved Uranium	ug/L	33, 15	0.1		0.4
Dissolved Vanadium	ug/L		2		<2
Dissolved Zinc	ug/L	30	5		81

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

9144903 Analysis completed on a filtered sample.

Certified By:

AGAT Laboratories

57 Old Pennywell Road, Unit I
St. John's, NL
CANADA A1E 6A8
TEL (709)747-8573
FAX (709 747-2139
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

Parameter	Unit	G / S	RDL	3113-MHPW1-WS1 Water 2018-03-19 9144903	3113-MHPW1-WS2 Water 2018-03-20 9144904
SAMPLE DESCRIPTION:				3113-MHPW1-WS1	3113-MHPW1-WS2
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2018-03-19	2018-03-20
pH		6.5-9.0		8.11	8.11
Reactive Silica as SiO2	mg/L		0.5	10.9	7.4
Chloride	mg/L	640, 120	1	13	12
Fluoride	mg/L	0.12	0.12	<0.12	<0.12
Sulphate	mg/L		2	5	4
Alkalinity	mg/L		5	142	142
True Color	TCU	Narrative	5	13	14
Turbidity	NTU	Narrative	0.1	0.8	1.1
Electrical Conductivity	umho/cm		1	310	313
Nitrate + Nitrite as N	mg/L		0.05	0.43	0.37
Nitrate as N	mg/L	550, 13	0.05	0.43	0.37
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.03	0.05
Total Organic Carbon	mg/L		0.5	<0.5	<0.5
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01
Total Sodium	mg/L		0.1	8.2	8.1
Total Potassium	mg/L		0.1	1.0	0.9
Total Calcium	mg/L		0.1	50.3	47.0
Total Magnesium	mg/L		0.1	6.9	6.9
Bicarb. Alkalinity (as CaCO3)	mg/L		5	142	142
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	172	166
Hardness	mg/L			154	146
Langelier Index (@20C)	NA			0.35	0.33
Langelier Index (@ 4C)	NA			0.03	0.01
Saturation pH (@ 20C)	NA			7.76	7.78
Saturation pH (@ 4C)	NA			8.08	8.10
Anion Sum	me/L			3.34	3.29

Certified By:

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

Parameter	Unit	G / S	RDL	3113-MHPW1-WS1 Water 2018-03-19 9144903	3113-MHPW1-WS2 Water 2018-03-20 9144904
Cation sum	me/L			3.47	3.30
% Difference/ Ion Balance (NS)	%			1.9	0.2
Total Aluminum	ug/L	Variable	5	8	7
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2
Total Barium	ug/L		5	39	39
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L	29000,	5	12	6
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L	Equation	1	44	13
Total Iron	ug/L	300	50	89	65
Total Lead	ug/L	Equation	0.5	4.5	1.8
Total Manganese	ug/L		2	4	3
Total Molybdenum	ug/L	73	2	<2	<2
Total Nickel	ug/L	Equation	2	2	<2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03
Total Selenium	ug/L	1	1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1
Total Strontium	ug/L		5	84	86
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.4	0.4
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L	30	5	82	23

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Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

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Certificate of Analysis

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Various Inorganics (Water)

DATE RECEIVED: 2018-03-23

DATE REPORTED: 2018-04-03

				SAMPLE DESCRIPTION:	3113-MHPW1-WS1
				SAMPLE TYPE:	Water
				DATE SAMPLED:	2018-03-19
Parameter	Unit	G / S	RDL		9144903
Dissolved Organic Carbon	mg/L		0.5		<0.5
Mercury	mg/L	0.000026	0.000026		<0.000026
Mercury Digest					y
Total Kjeldahl Nitrogen as N	mg/L		0.4		0.5
Bromide	mg/L		0.05		<0.05

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

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Guideline Violation

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
9144903	3113-MHPW1-WS1	NS-CCME FWAL	Dissolved Metals	Dissolved Zinc	ug/L	30	81
9144903	3113-MHPW1-WS1	NS-CCME FWAL	Standard Water Analysis + Total Metals	Total Zinc	ug/L	30	82

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis

RPT Date: Apr 03, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Standard Water Analysis + Total Metals															
pH	9144903	9144903	8.11	8.10	0.1%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	9133260	7.0	10	35.3%	< 0.5	113%	80%	120%		80%	120%	120%	80%	120%
Chloride	9148923		(256)	(263)	2.5%	< 1	91%	80%	120%	NA	80%	120%	NA	80%	120%
Fluoride	9148923		<0.12	<0.12	NA	< 0.12	107%	80%	120%	NA	80%	120%	97%	80%	120%
Sulphate	9148923		23	23	3.4%	< 2	109%	80%	120%	NA	80%	120%	NA	80%	120%
Alkalinity	9144903	9144903	142	142	0.3%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9142642		8	10	NA	< 5	120%	80%	120%	NA			NA		
Turbidity	9142642		87.2	86.8	0.5%	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9144903	9144903	310	312	0.7%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9148923		(7.64)	(7.95)	3.9%	< 0.05	98%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrite as N	9148923		0.41	0.42	1.9%	< 0.05	103%	80%	120%	NA	80%	120%	100%	80%	120%
Ammonia as N	1	9142979	<0.03	<0.03	NA	< 0.03	95%	80%	120%		80%	120%	92%	80%	120%
Total Organic Carbon	1	9143876	8.5	8.3	2.4%	< 0.5	94%	80%	120%		80%	120%	83%	80%	120%
Ortho-Phosphate as P	1	9133260	0.14	0.16	13.3%	< 0.01	115%	80%	120%		80%	120%	113%	80%	120%
Total Sodium	9149177		39.8	41.3	3.6%	< 0.1	103%	80%	120%	100%	80%	120%	NA	70%	130%
Total Potassium	9149177		1.3	1.4	8.3%	< 0.1	101%	80%	120%	99%	80%	120%	NA	70%	130%
Total Calcium	9149177		8.2	8.6	4.8%	< 0.1	107%	80%	120%	101%	80%	120%	NA	70%	130%
Total Magnesium	9149177		0.9	1.0	7.7%	< 0.1	105%	80%	120%	101%	80%	120%	85%	80%	120%
Bicarb. Alkalinity (as CaCO3)	9144903	9144903	142	142	0.3%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9144903	9144903	<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9144903	9144903	<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9149177		101	109	7.6%	< 5	107%	80%	120%	106%	80%	120%	103%	70%	130%
Total Antimony	9149177		<2	<2	NA	< 2	98%	80%	120%	112%	80%	120%	103%	70%	130%
Total Arsenic	9149177		<2	<2	NA	< 2	97%	80%	120%	100%	80%	120%	97%	70%	130%
Total Barium	9149177		25	25	NA	< 5	98%	80%	120%	98%	80%	120%	NA	70%	130%
Total Beryllium	9149177		<2	<2	NA	< 2	100%	80%	120%	102%	80%	120%	97%	70%	130%
Total Bismuth	9149177		<2	<2	NA	< 2	108%	80%	120%	116%	80%	120%	98%	70%	130%
Total Boron	9149177		12	12	NA	< 5	100%	80%	120%	108%	80%	120%	101%	70%	130%
Total Cadmium	9149177		0.047	0.049	NA	< 0.017	98%	80%	120%	99%	80%	120%	94%	70%	130%
Total Chromium	9149177		<1	<1	NA	< 1	107%	80%	120%	108%	80%	120%	102%	70%	130%
Total Cobalt	9149177		<1	<1	NA	< 1	119%	80%	120%	120%	80%	120%	119%	70%	130%
Total Copper	9149177		96	100	3.7%	< 1	109%	80%	120%	113%	80%	120%	NA	70%	130%
Total Iron	9149177		227	239	NA	< 50	116%	80%	120%	119%	80%	120%	NA	70%	130%
Total Lead	9149177		2.4	2.4	NA	< 0.5	118%	80%	120%	119%	80%	120%	102%	70%	130%
Total Manganese	9149177		16	16	3.6%	< 2	113%	80%	120%	113%	80%	120%	NA	70%	130%
Total Molybdenum	9149177		<2	<2	NA	< 2	99%	80%	120%	103%	80%	120%	107%	70%	130%
Total Nickel	9149177		<2	<2	NA	< 2	107%	80%	120%	110%	80%	120%	103%	70%	130%
Total Phosphorous	9149177		0.02	0.02	NA	< 0.02	97%	80%	120%	87%	80%	120%	104%	70%	130%
Total Selenium	9149177		<1	<1	NA	< 1	92%	80%	120%	96%	80%	120%	87%	70%	130%

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 18K322806
PROJECT: 3113-Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 03, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Silver	9149177		<0.1	<0.1	NA	< 0.1	107%	80%	120%	108%	80%	120%	99%	70%	130%
Total Strontium	9149177		28	28	0.0%	< 5	104%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9149177		<0.1	<0.1	NA	< 0.1	110%	80%	120%	114%	80%	120%	104%	70%	130%
Total Tin	9149177		<2	<2	NA	< 2	98%	80%	120%	101%	80%	120%	101%	70%	130%
Total Titanium	9149177		<2	<2	NA	< 2	104%	80%	120%	105%	80%	120%	100%	70%	130%
Total Uranium	9149177		0.6	0.6	1.3%	< 0.1	109%	80%	120%	110%	80%	120%	107%	70%	130%
Total Vanadium	9149177		<2	<2	NA	< 2	103%	80%	120%	104%	80%	120%	106%	70%	130%
Total Zinc	9149177		11	10	NA	< 5	108%	80%	120%	109%	80%	120%	92%	70%	130%
Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.															
Dissolved Metals															
Dissolved Aluminum	9150500		<5	<5	NA	< 5	108%	80%	120%	106%	80%	120%	93%	70%	130%
Dissolved Antimony	9150500		<2	<2	NA	< 2	95%	80%	120%	106%	80%	120%	115%	70%	130%
Dissolved Arsenic	9150500		7	6	NA	< 2	97%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Barium	9150500		98	98	0.3%	< 5	100%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Beryllium	9150500		<2	<2	NA	< 2	102%	80%	120%	106%	80%	120%	107%	70%	130%
Dissolved Bismuth	9150500		<2	<2	NA	< 2	93%	80%	120%	105%	80%	120%	NA	70%	130%
Dissolved Boron	9150500		140	138	1.8%	< 5	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Cadmium	9150500		0.026	0.025	NA	< 0.017	97%	80%	120%	99%	80%	120%	103%	70%	130%
Dissolved Chromium	9150500		2	3	NA	< 1	92%	80%	120%	97%	80%	120%	102%	70%	130%
Dissolved Cobalt	9150500		2	2	NA	< 1	103%	80%	120%	108%	80%	120%	114%	70%	130%
Dissolved Copper	9150500		<2	<2	NA	< 2	95%	80%	120%	99%	80%	120%	83%	70%	130%
Dissolved Iron	9150500		<50	<50	NA	< 50	100%	80%	120%	102%	80%	120%	98%	70%	130%
Dissolved Lead	9150500		<0.5	<0.5	NA	< 0.5	100%	80%	120%	101%	80%	120%	90%	70%	130%
Dissolved Manganese	9150500		1140	1100	3.1%	< 2	99%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9150500		<2	<2	NA	< 2	93%	80%	120%	97%	80%	120%	97%	70%	130%
Dissolved Nickel	9150500		12	12	0.4%	< 2	95%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Selenium	9150500		2	2	NA	< 1	104%	80%	120%	103%	80%	120%	NA	70%	130%
Dissolved Silver	9150500		<0.1	<0.1	NA	< 0.1	95%	80%	120%	100%	80%	120%	95%	70%	130%
Dissolved Strontium	9150500		1230	1190	3.5%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9150500		<0.1	<0.1	NA	< 0.1	99%	80%	120%	103%	80%	120%	98%	70%	130%
Dissolved Tin	9150500		<2	<2	NA	< 2	96%	80%	120%	99%	80%	120%	98%	70%	130%
Dissolved Titanium	9150500		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	94%	70%	130%
Dissolved Uranium	9150500		0.4	0.4	NA	< 0.1	95%	80%	120%	98%	80%	120%	102%	70%	130%
Dissolved Vanadium	9150500		3	3	NA	< 2	91%	80%	120%	92%	80%	120%	113%	70%	130%
Dissolved Zinc	9150500		8	8	NA	< 5	93%	80%	120%	95%	80%	120%	94%	70%	130%
Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.															
Various Inorganics (Water)															
Mercury	1	9143899	<0.	<0.	NA	< 0.000026	100%	80%	120%		80%	120%	99%	70%	130%

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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 03, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Kjeldahl Nitrogen as N	1	9142487	0.5	0.5	NA	< 0.4	120%	80%	120%		80%	120%	90%	80%	120%
Bromide	9148923		0.09	0.10	NA	< 0.05	94%	80%	120%	NA	80%	120%	114%	80%	120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K322806

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Mercury	MET-121-6100 & MET-121-6107	SM 3112 B	CVAAS
Mercury Digest	MET-121-6100 & MET-121-6107	EPA 245.5	CV/AA
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER
Bromide	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

AGAT Laboratories

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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☑ Good ☐ Poor (see notes)
Arrival Temperature: 3.8 C
Hold Time:
AGAT Job Number: 18K322806
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113-Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3880

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☐ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☑ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☑ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☑ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P2O5)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other: Diss Organic Carbon	Other: Bromide & TKN	Hazardous (Y/N)
3113-MHPW1-WS1	March 19, 2018 18:35	Water	6	Doc & Diss.Metal filtered		✓	✓	✓																		✓	✓	
3113-MHPW1-WS2	March 20, 2018 11:48	Water	4	Diss.Metal filtered		✓	✓																					

Samples Relinquished By (Print Name)	Date/Time	Samples Received By (Print Name)	Date/Time
Eunjeong Seok	March 23/18	Emma Penney	Mar. 23/18
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time
	10:07	Emma Penney	10:06am

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

Document ID: DIV-133-1501 002
Date revised: January 2016

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CLIENT NAME: FRACFLOW CONSULTANTS
154 MAJOR'S PATH
ST. JOHN'S PATH, NL A1A5A1
(709) 739-7270

ATTENTION TO: John Gale

PROJECT: 3113-Stephenville, NL

AGAT WORK ORDER: 18K323461

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

WATER ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

DATE REPORTED: Apr 19, 2018

PAGES (INCLUDING COVER): 21

VERSION*: 2

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES
VERSION 2:Version 2.0 supersedes Version 1.0. Corrected sampling dates. Issued April 19th, 2018.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

				3113-MHPW1-WS3	3113-MHPW1-WS5
SAMPLE DESCRIPTION:				WS3	WS5
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149302
Benzene	mg/L		0.001	<0.001	<0.001
Toluene	mg/L		0.001	<0.001	<0.001
Ethylbenzene	mg/L		0.001	<0.001	<0.001
Xylene (Total)	mg/L		0.001	<0.001	<0.001
C6-C10 (less BTEX)	mg/L		0.01	<0.01	<0.01
>C10-C16 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C16-C21 Hydrocarbons	mg/L		0.05	<0.05	<0.05
>C21-C32 Hydrocarbons	mg/L		0.01	<0.01	<0.01
Modified TPH (Tier 1)	mg/L		0.1	<0.1	<0.1
Resemblance Comment				NR	NR
Return to Baseline at C32				Y	Y
Surrogate	Unit	Acceptable Limits			
Isobutylbenzene - EPH	%	70-130		111	119
Isobutylbenzene - VPH	%	70-130		89	94
n-Dotriacontane - EPH	%	70-130		112	122

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9149300-9149302 Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
FR - Product in Fuel Oil Range
LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Dissolved Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: 3113-MHPW1-WS3	3113-MHPW1-WS5
				SAMPLE TYPE: Water	Water
				DATE SAMPLED: 2018-03-21	2018-03-22
				9149300	9149302
Dissolved Aluminum	ug/L		5	<5	<5
Dissolved Antimony	ug/L		2	<2	<2
Dissolved Arsenic	ug/L		2	<2	<2
Dissolved Barium	ug/L		5	40	39
Dissolved Beryllium	ug/L		2	<2	<2
Dissolved Bismuth	ug/L		2	<2	<2
Dissolved Boron	ug/L		5	7	7
Dissolved Cadmium	ug/L		0.017	<0.017	<0.017
Dissolved Chromium	ug/L		1	2	2
Dissolved Cobalt	ug/L		1	<1	<1
Dissolved Copper	ug/L		2	<2	<2
Dissolved Iron	ug/L		50	<50	<50
Dissolved Lead	ug/L		0.5	<0.5	<0.5
Dissolved Manganese	ug/L		2	2	<2
Dissolved Molybdenum	ug/L		2	<2	<2
Dissolved Nickel	ug/L		2	6	<2
Dissolved Selenium	ug/L		1	<1	<1
Dissolved Silver	ug/L		0.1	<0.1	<0.1
Dissolved Strontium	ug/L		5	83	83
Dissolved Thallium	ug/L		0.1	<0.1	<0.1
Dissolved Tin	ug/L		2	<2	<2
Dissolved Titanium	ug/L		2	<2	<2
Dissolved Uranium	ug/L		0.1	0.3	0.3
Dissolved Vanadium	ug/L		2	<2	<2
Dissolved Zinc	ug/L		5	28	29

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9149300-9149302 Analysis completed on a filtered sample.

Certified By:

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AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Mercury Analysis in Water (Total)

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

SAMPLE DESCRIPTION:				3113-MHPW1-WS5
SAMPLE TYPE:				Water
DATE SAMPLED:				2018-03-22
Parameter	Unit	G / S	RDL	9149302
Total Mercury	ug/L	0.026	0.026	<0.026

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Certified By: Laura Baker

AGAT Laboratories

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AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

				3113-MHPW1-WS3	3113-MHPW1-WS4
SAMPLE DESCRIPTION:				3113-MHPW1-WS3	3113-MHPW1-WS4
SAMPLE TYPE:				Water	Water
DATE SAMPLED:				2018-03-21	2018-03-22
Parameter	Unit	G / S	RDL	9149300	9149305
pH		6.5-9.0		8.14	8.13
Reactive Silica as SiO2	mg/L		0.5	6.0	5.7
Chloride	mg/L	640, 120	1	12	12
Fluoride	mg/L	0.12	0.12	<0.12	<0.12
Sulphate	mg/L		2	4	4
Alkalinity	mg/L		5	143	143
True Color	TCU	Narrative	5	<5	<5
Turbidity	NTU	Narrative	0.1	0.5	0.9
Electrical Conductivity	umho/cm		1	321	323
Nitrate + Nitrite as N	mg/L		0.05	0.36	0.39
Nitrate as N	mg/L	550, 13	0.05	0.36	0.39
Nitrite as N	mg/L	0.06	0.05	<0.05	<0.05
Ammonia as N	mg/L	Fact Sheet	0.03	0.04	0.04
Total Organic Carbon	mg/L		0.5	<0.5	0.7
Ortho-Phosphate as P	mg/L		0.01	0.08	0.07
Total Sodium	mg/L		0.1	8.2	8.3
Total Potassium	mg/L		0.1	0.9	0.9
Total Calcium	mg/L		0.1	50.0	47.3
Total Magnesium	mg/L		0.1	7.2	7.1
Bicarb. Alkalinity (as CaCO3)	mg/L		5	143	143
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10
Hydroxide	mg/L		5	<5	<5
Calculated TDS	mg/L		1	170	167
Hardness	mg/L			154	147
Langelier Index (@20C)	NA			0.38	0.35
Langelier Index (@ 4C)	NA			0.06	0.03
Saturation pH (@ 20C)	NA			7.76	7.78
Saturation pH (@ 4C)	NA			8.08	8.10
Anion Sum	me/L			3.31	3.31

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

Parameter	Unit	G / S	RDL	3113-MHPW1-WS3 Water 2018-03-21 9149300	3113-MHPW1-WS4 Water 2018-03-22 9149305
Cation sum	me/L			3.48	3.34
% Difference/ Ion Balance (NS)	%			2.5	0.4
Total Aluminum	ug/L	Variable	5	<5	<5
Total Antimony	ug/L		2	<2	<2
Total Arsenic	ug/L	5	2	<2	<2
Total Barium	ug/L		5	39	39
Total Beryllium	ug/L		2	<2	<2
Total Bismuth	ug/L		2	<2	<2
Total Boron	ug/L	29000,	5	7	7
Total Cadmium	ug/L	1.0, 0.09	0.017	<0.017	<0.017
Total Chromium	ug/L		1	<1	<1
Total Cobalt	ug/L		1	<1	<1
Total Copper	ug/L	Equation	1	4	1
Total Iron	ug/L	300	50	65	68
Total Lead	ug/L	Equation	0.5	0.6	0.6
Total Manganese	ug/L		2	3	3
Total Molybdenum	ug/L	73	2	<2	<2
Total Nickel	ug/L	Equation	2	2	2
Total Phosphorous	mg/L	Fact Sheet	0.02	0.03	0.03
Total Selenium	ug/L	1	1	<1	<1
Total Silver	ug/L	0.25	0.1	<0.1	<0.1
Total Strontium	ug/L		5	86	88
Total Thallium	ug/L	0.8	0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2
Total Titanium	ug/L		2	<2	<2
Total Uranium	ug/L	33, 15	0.1	0.4	0.4
Total Vanadium	ug/L		2	<2	<2
Total Zinc	ug/L	30	5	26	15

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to CCME FWAL - update 2015
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Certified By:

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

				3113-MHPW1-
		SAMPLE DESCRIPTION:		WS5
		SAMPLE TYPE:		Water
		DATE SAMPLED:		2018-03-22
Parameter	Unit	G / S	RDL	9149302
pH				8.13
Reactive Silica as SiO2	mg/L		0.5	5.7
Chloride	mg/L		1	12
Fluoride	mg/L		0.12	<0.12
Sulphate	mg/L		2	4
Alkalinity	mg/L		5	143
True Color	TCU		5	<5
Turbidity	NTU		0.1	0.7
Electrical Conductivity	umho/cm		1	322
Nitrate + Nitrite as N	mg/L		0.05	0.37
Nitrate as N	mg/L		0.05	0.37
Nitrite as N	mg/L		0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03
Total Organic Carbon	mg/L		0.5	1.7
Ortho-Phosphate as P	mg/L		0.01	0.08
Total Sodium	mg/L		0.1	8.2
Total Potassium	mg/L		0.1	0.9
Total Calcium	mg/L		0.1	49.7
Total Magnesium	mg/L		0.1	6.8
Bicarb. Alkalinity (as CaCO3)	mg/L		5	143
Carb. Alkalinity (as CaCO3)	mg/L		10	<10
Hydroxide	mg/L		5	<5
Calculated TDS	mg/L		1	169
Hardness	mg/L			152
Langelier Index (@20C)	NA			0.37
Langelier Index (@ 4C)	NA			0.05
Saturation pH (@ 20C)	NA			7.76
Saturation pH (@ 4C)	NA			8.08
Anion Sum	me/L			3.31

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

CLIENT NAME: FRACFLOW CONSULTANTS

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Total Metals+ DOC,TKN,Bromide

DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

				SAMPLE DESCRIPTION:	3113-MHPW1-WS5
				SAMPLE TYPE:	Water
				DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL		9149302
Cation sum	me/L				3.42
% Difference/ Ion Balance (NS)	%				1.7
Total Aluminum	ug/L		5		<5
Total Antimony	ug/L		2		<2
Total Arsenic	ug/L		2		<2
Total Barium	ug/L		5		39
Total Beryllium	ug/L		2		<2
Total Bismuth	ug/L		2		<2
Total Boron	ug/L		5		6
Total Cadmium	ug/L		0.017		<0.017
Total Chromium	ug/L		1		<1
Total Cobalt	ug/L		1		<1
Total Copper	ug/L		1		1
Total Iron	ug/L		50		63
Total Lead	ug/L		0.5		<0.5
Total Manganese	ug/L		2		3
Total Molybdenum	ug/L		2		<2
Total Nickel	ug/L		2		2
Total Phosphorous	mg/L		0.02		0.02
Total Selenium	ug/L		1		<1
Total Silver	ug/L		0.1		<0.1
Total Strontium	ug/L		5		87
Total Thallium	ug/L		0.1		<0.1
Total Tin	ug/L		2		<2
Total Titanium	ug/L		2		<2
Total Uranium	ug/L		0.1		0.3
Total Vanadium	ug/L		2		<2
Total Zinc	ug/L		5		22
Bromide	µg/L		50		<50

Certified By:

AGAT Laboratories
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DATE RECEIVED: 2018-03-26

DATE REPORTED: 2018-04-19

			SAMPLE DESCRIPTION:	3113-MHPW1-WS5
			SAMPLE TYPE:	Water
			DATE SAMPLED:	2018-03-22
Parameter	Unit	G / S	RDL	9149302
TKN Digest				Y
Total Kjeldahl Nitrogen as N	mg/L		0.4	<0.4
Dissolved Organic Carbon	mg/L		0.5	<0.5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

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Quality Assurance

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AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Trace Organics Analysis

RPT Date: Apr 19, 2018

PARAMETER	Batch	Sample Id	DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
			Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level															
Benzene	1	9149010	< 0.001	< 0.001	NA	< 0.001	103%	70%	130%	112%	70%	130%	NA		
Toluene	1	9149010	< 0.001	< 0.001	NA	< 0.001	106%	70%	130%	108%	70%	130%	NA		
Ethylbenzene	1	9149010	< 0.001	< 0.001	NA	< 0.001	104%	70%	130%	102%	70%	130%	NA		
Xylene (Total)	1	9149010	< 0.001	< 0.001	NA	< 0.001	109%	70%	130%	110%	70%	130%	NA		
C6-C10 (less BTEX)	1	9149010	< 0.01	< 0.01	NA	< 0.01	100%	70%	130%	106%	70%	130%	106%	70%	130%
>C10-C16 Hydrocarbons	1	9149302	< 0.05	< 0.05	NA	< 0.05	109%	70%	130%	123%	70%	130%	125%	70%	130%
>C16-C21 Hydrocarbons	1	9149302	< 0.05	< 0.05	NA	< 0.05	116%	70%	130%	123%	70%	130%	125%	70%	130%
>C21-C32 Hydrocarbons	1	9149302	< 0.01	< 0.01	NA	< 0.01	104%	70%	130%	123%	70%	130%	125%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.
If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

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PROJECT: 3113-Stephenville, NL
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SAMPLING SITE:
SAMPLED BY:

Water Analysis

RPT Date: Apr 19, 2018

PARAMETER	Batch	Sample Id	DUPLICATE Dup #1	DUPLICATE Dup #2	DUPLICATE RPD	Method Blank	REFERENCE MATERIAL Measured Value	REFERENCE MATERIAL Acceptable Limits Lower	REFERENCE MATERIAL Acceptable Limits Upper	METHOD BLANK SPIKE Recovery	METHOD BLANK SPIKE Acceptable Limits Lower	METHOD BLANK SPIKE Acceptable Limits Upper	MATRIX SPIKE Recovery	MATRIX SPIKE Acceptable Limits Lower	MATRIX SPIKE Acceptable Limits Upper
Standard Water Analysis + Total Metals															
pH	9148925		7.75	7.77	0.3%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	9149300	6.0	5.9	1.7%	< 0.5	98%	80%	120%		80%	120%	100%	80%	120%
Chloride	9149375		4	4	NA	< 1	92%	80%	120%	NA	80%	120%	90%	80%	120%
Fluoride	9149375		<0.12	<0.12	NA	< 0.12	104%	80%	120%	NA	80%	120%	90%	80%	120%
Sulphate	9149375		<2	<2	NA	< 2	113%	80%	120%	NA	80%	120%	94%	80%	120%
Alkalinity	9148925		213	213	0.1%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9149300	9149300	<5	6	NA	< 5	105%	80%	120%	NA			NA		
Turbidity	9149300	9149300	0.5	0.4	NA	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9148925		1530	1540	0.5%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9149375		0.20	0.18	NA	< 0.05	101%	80%	120%	NA	80%	120%	82%	80%	120%
Nitrite as N	9149375		<0.05	<0.05	NA	< 0.05	105%	80%	120%	NA	80%	120%	87%	80%	120%
Ammonia as N	1	9144766	0.03	0.02	NA	< 0.03	92%	80%	120%		80%	120%	95%	80%	120%
Total Organic Carbon	1	9149300	<0.5	<0.5	NA	< 0.5	108%	80%	120%		80%	120%	105%	80%	120%
Ortho-Phosphate as P	1	9149300	0.08	0.07	13.3%	< 0.01	115%	80%	120%		80%	120%	90%	80%	120%
Total Sodium	9150501		19.1	19.8	3.7%	< 0.1	105%	80%	120%	108%	80%	120%	NA	70%	130%
Total Potassium	9150501		1.7	1.6	1.7%	< 0.1	103%	80%	120%	104%	80%	120%	NA	70%	130%
Total Calcium	9150501		85.9	88.9	3.4%	< 0.1	109%	80%	120%	106%	80%	120%	NA	70%	130%
Total Magnesium	9150501		9.4	9.2	2.4%	< 0.1	105%	80%	120%	107%	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	9148925		213	213	0.1%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9148925		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9148925		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9150501		9	9	NA	< 5	108%	80%	120%	109%	80%	120%	97%	70%	130%
Total Antimony	9150501		<2	<2	NA	< 2	92%	80%	120%	103%	80%	120%	98%	70%	130%
Total Arsenic	9150501		<2	<2	NA	< 2	98%	80%	120%	92%	80%	120%	97%	70%	130%
Total Barium	9150501		49	49	0.2%	< 5	99%	80%	120%	97%	80%	120%	NA	70%	130%
Total Beryllium	9150501		<2	<2	NA	< 2	102%	80%	120%	105%	80%	120%	97%	70%	130%
Total Bismuth	9150501		<2	<2	NA	< 2	97%	80%	120%	106%	80%	120%	92%	70%	130%
Total Boron	9150501		12	11	NA	< 5	104%	80%	120%	102%	80%	120%	102%	70%	130%
Total Cadmium	9150501		0.051	0.050	NA	< 0.017	98%	80%	120%	97%	80%	120%	93%	70%	130%
Total Chromium	9150501		<1	<1	NA	< 1	107%	80%	120%	107%	80%	120%	106%	70%	130%
Total Cobalt	9150501		<1	<1	NA	< 1	105%	80%	120%	103%	80%	120%	103%	70%	130%
Total Copper	9150501		34	33	2.5%	< 1	107%	80%	120%	103%	80%	120%	NA	70%	130%
Total Iron	9150501		90	85	NA	< 50	114%	80%	120%	115%	80%	120%	113%	70%	130%
Total Lead	9150501		11.6	11.5	0.6%	< 0.5	107%	80%	120%	105%	80%	120%	NA	70%	130%
Total Manganese	9150501		373	386	3.3%	< 2	115%	80%	120%	114%	80%	120%	NA	70%	130%
Total Molybdenum	9150501		<2	<2	NA	< 2	92%	80%	120%	94%	80%	120%	102%	70%	130%
Total Nickel	9150501		4	4	NA	< 2	106%	80%	120%	104%	80%	120%	97%	70%	130%
Total Phosphorous	9150501		0.03	0.03	NA	< 0.02	106%	80%	120%	91%	80%	120%	101%	70%	130%
Total Selenium	9150501		<1	<1	NA	< 1	96%	80%	120%	85%	80%	120%	92%	70%	130%

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Quality Assurance

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SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Silver	9150501		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	95%	70%	130%
Total Strontium	9150501		288	298	3.1%	< 5	102%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9150501		<0.1	<0.1	NA	< 0.1	103%	80%	120%	105%	80%	120%	97%	70%	130%
Total Tin	9150501		<2	<2	NA	< 2	95%	80%	120%	94%	80%	120%	95%	70%	130%
Total Titanium	9150501		<2	<2	NA	< 2	107%	80%	120%	108%	80%	120%	86%	70%	130%
Total Uranium	9150501		<0.1	<0.1	NA	< 0.1	101%	80%	120%	100%	80%	120%	98%	70%	130%
Total Vanadium	9150501		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	110%	70%	130%
Total Zinc	9150501		41	41	1.9%	< 5	112%	80%	120%	109%	80%	120%	122%	70%	130%
Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.															
Standard Water Analysis + Total Metals+ DOC,TKN,Bromide															
pH	9148925		7.75	7.77	0.3%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Chloride	9149375		4	4	NA	< 1	92%	80%	120%	NA	80%	120%	90%	80%	120%
Fluoride	9149375		<0.12	<0.12	NA	< 0.12	104%	80%	120%	NA	80%	120%	90%	80%	120%
Sulphate	9149375		<2	<2	NA	< 2	113%	80%	120%	NA	80%	120%	94%	80%	120%
Alkalinity	9148925		213	213	0.1%	< 5	97%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9149300	9149300	<5	6	NA	< 5	105%	80%	120%	NA			NA		
Turbidity	9149300	9149300	0.5	0.4	NA	< 0.1	101%	80%	120%	NA			NA		
Electrical Conductivity	9148925		1530	1540	0.5%	< 1	102%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9149375		0.20	0.18	NA	< 0.05	101%	80%	120%	NA	80%	120%	82%	80%	120%
Nitrite as N	9149375		<0.05	<0.05	NA	< 0.05	105%	80%	120%	NA	80%	120%	87%	80%	120%
Total Sodium	9150501		19.1	19.8	3.7%	< 0.1	105%	80%	120%	108%	80%	120%	NA	70%	130%
Total Potassium	9150501		1.7	1.6	1.7%	< 0.1	103%	80%	120%	104%	80%	120%	NA	70%	130%
Total Calcium	9150501		85.9	88.9	3.4%	< 0.1	109%	80%	120%	106%	80%	120%	NA	70%	130%
Total Magnesium	9150501		9.4	9.2	2.4%	< 0.1	105%	80%	120%	107%	80%	120%	NA	80%	120%
Bicarb. Alkalinity (as CaCO3)	9148925		213	213	0.1%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9148925		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9148925		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9150501		9	9	NA	< 5	108%	80%	120%	109%	80%	120%	97%	70%	130%
Total Antimony	9150501		<2	<2	NA	< 2	92%	80%	120%	103%	80%	120%	98%	70%	130%
Total Arsenic	9150501		<2	<2	NA	< 2	98%	80%	120%	92%	80%	120%	97%	70%	130%
Total Barium	9150501		49	49	0.2%	< 5	99%	80%	120%	97%	80%	120%	NA	70%	130%
Total Beryllium	9150501		<2	<2	NA	< 2	102%	80%	120%	105%	80%	120%	97%	70%	130%
Total Bismuth	9150501		<2	<2	NA	< 2	97%	80%	120%	106%	80%	120%	92%	70%	130%
Total Boron	9150501		12	11	NA	< 5	104%	80%	120%	102%	80%	120%	102%	70%	130%
Total Cadmium	9150501		0.051	0.050	NA	< 0.017	98%	80%	120%	97%	80%	120%	93%	70%	130%
Total Chromium	9150501		<1	<1	NA	< 1	107%	80%	120%	107%	80%	120%	106%	70%	130%
Total Cobalt	9150501		<1	<1	NA	< 1	105%	80%	120%	103%	80%	120%	103%	70%	130%
Total Copper	9150501		34	33	2.5%	< 1	107%	80%	120%	103%	80%	120%	NA	70%	130%
Total Iron	9150501		90	85	NA	< 50	114%	80%	120%	115%	80%	120%	113%	70%	130%

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SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 2018

PARAMETER	Batch	Sample Id	DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
			Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Lead	9150501		11.6	11.5	0.6%	< 0.5	107%	80%	120%	105%	80%	120%	NA	70%	130%
Total Manganese	9150501		373	386	3.3%	< 2	115%	80%	120%	114%	80%	120%	NA	70%	130%
Total Molybdenum	9150501		<2	<2	NA	< 2	92%	80%	120%	94%	80%	120%	102%	70%	130%
Total Nickel	9150501		4	4	NA	< 2	106%	80%	120%	104%	80%	120%	97%	70%	130%
Total Phosphorous	9150501		0.03	0.03	NA	< 0.02	106%	80%	120%	91%	80%	120%	101%	70%	130%
Total Selenium	9150501		<1	<1	NA	< 1	96%	80%	120%	85%	80%	120%	92%	70%	130%
Total Silver	9150501		<0.1	<0.1	NA	< 0.1	99%	80%	120%	102%	80%	120%	95%	70%	130%
Total Strontium	9150501		288	298	3.1%	< 5	102%	80%	120%	103%	80%	120%	NA	70%	130%
Total Thallium	9150501		<0.1	<0.1	NA	< 0.1	103%	80%	120%	105%	80%	120%	97%	70%	130%
Total Tin	9150501		<2	<2	NA	< 2	95%	80%	120%	94%	80%	120%	95%	70%	130%
Total Titanium	9150501		<2	<2	NA	< 2	107%	80%	120%	108%	80%	120%	86%	70%	130%
Total Uranium	9150501		<0.1	<0.1	NA	< 0.1	101%	80%	120%	100%	80%	120%	98%	70%	130%
Total Vanadium	9150501		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	110%	70%	130%
Total Zinc	9150501		41	41	1.9%	< 5	112%	80%	120%	109%	80%	120%	122%	70%	130%
Bromide	9149375		<50	<50	NA	< 50	92%	80%	120%	NA	80%	120%	88%	80%	120%
Total Kjeldahl Nitrogen as N	1	9144766	0.4	0.5	NA	< 0.4	98%	80%	120%		80%	120%	105%	80%	120%
Dissolved Metals															
Dissolved Aluminum	9150500		<5	<5	NA	< 5	108%	80%	120%	106%	80%	120%	93%	70%	130%
Dissolved Antimony	9150500		<2	<2	NA	< 2	95%	80%	120%	106%	80%	120%	115%	70%	130%
Dissolved Arsenic	9150500		7	6	NA	< 2	97%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Barium	9150500		98	98	0.3%	< 5	100%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Beryllium	9150500		<2	<2	NA	< 2	102%	80%	120%	106%	80%	120%	107%	70%	130%
Dissolved Bismuth	9150500		<2	<2	NA	< 2	93%	80%	120%	105%	80%	120%	NA	70%	130%
Dissolved Boron	9150500		140	138	1.8%	< 5	104%	80%	120%	107%	80%	120%	NA	70%	130%
Dissolved Cadmium	9150500		0.026	0.025	NA	< 0.017	97%	80%	120%	99%	80%	120%	103%	70%	130%
Dissolved Chromium	9150500		2	3	NA	< 1	92%	80%	120%	97%	80%	120%	102%	70%	130%
Dissolved Cobalt	9150500		2	2	NA	< 1	103%	80%	120%	108%	80%	120%	114%	70%	130%
Dissolved Copper	9150500		<2	<2	NA	< 2	95%	80%	120%	99%	80%	120%	83%	70%	130%
Dissolved Iron	9150500		<50	<50	NA	< 50	100%	80%	120%	102%	80%	120%	98%	70%	130%
Dissolved Lead	9150500		<0.5	<0.5	NA	< 0.5	100%	80%	120%	101%	80%	120%	90%	70%	130%
Dissolved Manganese	9150500		1140	1100	3.1%	< 2	99%	80%	120%	102%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9150500		<2	<2	NA	< 2	93%	80%	120%	97%	80%	120%	97%	70%	130%
Dissolved Nickel	9150500		12	12	0.4%	< 2	95%	80%	120%	98%	80%	120%	NA	70%	130%
Dissolved Selenium	9150500		2	2	NA	< 1	104%	80%	120%	103%	80%	120%	NA	70%	130%
Dissolved Silver	9150500		<0.1	<0.1	NA	< 0.1	95%	80%	120%	100%	80%	120%	95%	70%	130%
Dissolved Strontium	9150500		1230	1190	3.5%	< 5	103%	80%	120%	104%	80%	120%	NA	70%	130%
Dissolved Thallium	9150500		<0.1	<0.1	NA	< 0.1	99%	80%	120%	103%	80%	120%	98%	70%	130%
Dissolved Tin	9150500		<2	<2	NA	< 2	96%	80%	120%	99%	80%	120%	98%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

AGAT Laboratories
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Quality Assurance

CLIENT NAME: FRACFLOW CONSULTANTS
AGAT WORK ORDER: 18K323461
PROJECT: 3113-Stephenville, NL
ATTENTION TO: John Gale
SAMPLING SITE:
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Apr 19, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Dissolved Titanium	9150500		<2	<2	NA	< 2	105%	80%	120%	104%	80%	120%	94%	70%	130%
Dissolved Uranium	9150500		0.4	0.4	NA	< 0.1	95%	80%	120%	98%	80%	120%	102%	70%	130%
Dissolved Vanadium	9150500		3	3	NA	< 2	91%	80%	120%	92%	80%	120%	113%	70%	130%
Dissolved Zinc	9150500		8	8	NA	< 5	93%	80%	120%	95%	80%	120%	94%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Mercury Analysis in Water (Total)

Total Mercury	1	9151513	<0.05	<0.05	NA	< 0.026	95%	80%	120%		80%	120%	97%	80%	120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Dissolved Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Mercury	MET-121-6100 & MET-121-6107	SM 3112 B	CV/AA
pH	INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

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Method Summary

CLIENT NAME: FRACFLOW CONSULTANTS

AGAT WORK ORDER: 18K323461

PROJECT: 3113-Stephenville, NL

ATTENTION TO: John Gale

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bromide	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
TKN Digest			COLORIMETER
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER
Dissolved Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER

AGAT Laboratories

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B3B 1M2
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Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 7 · 1
Hold Time:
AGAT Job Number: 18K323461
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113-Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3881

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☑ PIRI
☑ Tier 1 ☐ Res ☐ Pot ☑ Coarse
☐ Tier 2 ☐ Com ☑ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☑ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☑ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment	Field Filtered/Preserved	Standard Water Analysis	Metals: ☑ Total ☑ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P2O5)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☑ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other: Diss Organic Carbon	Other: Bromide & TKN	Hazardous (Y/N)
3113-MHPW1-WS3	March 21, 2018 08:30	Water	9	1x500, 3x100, 2x250, 3x40		✓	✓								✓													
				Diss.Metal filtered																								
3113-MHPW1-WS5	March 22, 2018 17:27	Water	11	1x500, 5x100, 2x250, 3x40		✓	✓	✓							✓											✓	✓	
				Doc & Diss.Metal filtered																								

Samples Relinquished By (Print Name):	Date/Time	Samples Received By (Print Name):	Date/Time	
Eunjeong Seok	March 26/18	A. Canning	03/26/18	Pink Copy - Client
Samples Relinquished By (Sign):	Date/Time	Samples Received By (Sign):	Date/Time	Yellow Copy - AGAT
E Seok	12:45		12:45	White Copy- AGAT

AGAT Laboratories

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P: 902.468.8718 • F: 902.468.8924

Chain of Custody Record

Laboratory Use Only
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 7.1
Hold Time:
AGAT Job Number: 18K323461
Notes:

Report Information
Company: Fracflow Consultants Inc. (NL)
Contact: John Gale
Address: 154 Major's Path
St. John's, NL
Phone: 709-739-7270 Fax: 709-753-5101
Client Project #: 3113-Stephenville, NL
AGAT Quotation: S/O
Please Note: If quotation number is not provided client will be billed full price for analysis.

Report Information (Please print):
1. Name: John Gale (john_ffc@nfld.net)
Email: Eunjeong Seok (eunjeong_ffc@nfld.net)
2. Name: Karen Andrews (karen_ffc@nfld.net)
Email:

Report Format
☐ Single Sample per page
☑ Multiple Sample per page
☑ Excel Format Included
☐ Export:

Turnaround Time Required (TAT)
Regular TAT ☑ 5 to 7 working days
Rush TAT ☐ Same day ☐ 1 day ☐ 2 days ☐ 3 days
Date Required:

Invoice To Same Yes ☑ / No ☐
Company:
Contact: Karen Andrews (karen_ffc@nfld.net)
Address:
Phone: Fax:
PO/Credit Card#: 3881

Regulatory Requirements (Check):
☑ List Guidelines on Report ☐ Do not list Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☐ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Fuel ☐ Lube
☑ CCME ☐ CDWQ
☐ Industrial ☐ NSEQS-Cont Sites
☐ Commercial ☐ HRM 101
☐ Res/Park ☐ Storm Water
☐ Agricultural ☐ Waste Water
☑ FWAL
☐ Sediment ☐ Other

Drinking Water Sample: ☐ Yes ☑ No **Salt Water Sample:** ☐ Yes ☑ No
Reg. No.:

Sample Identification	Date/Time Sampled	Sample Matrix	# Containers	Comments – Site/Sample Info. Sample Containment
3113-MHPW1-WS4	March 22, 2018 7:54	Water	4	1x500, 3x100

Field Filtered/Preserved	Standard Water Analysis	Metals: ☑ Total ☐ Diss ☐ Available	Mercury	☐ BOD ☐ CBOD	Grain Size (coarse/fine)	☐ TOC - Miss ☐ FOC - Miss	Phosphates (total as P2O5)	Chromium (Tri & Hexavalent)	Phenols	Tier 1: TPH/BTEX (PIRI) ☐ low level	Tier 2: TPH/BTEX Fractionation	CCME-CWS TPH/BTEX	VOC	Oil & Grease (TOG)	BNAE EPA 625 - Miss	PAH	PCB	Marine Sediment Package	Dioxins & Furans	Fecal Coliform ☐ MPN ☐ MF	Other:	Other:	Hazardous (Y/N)
	✓	✓																					

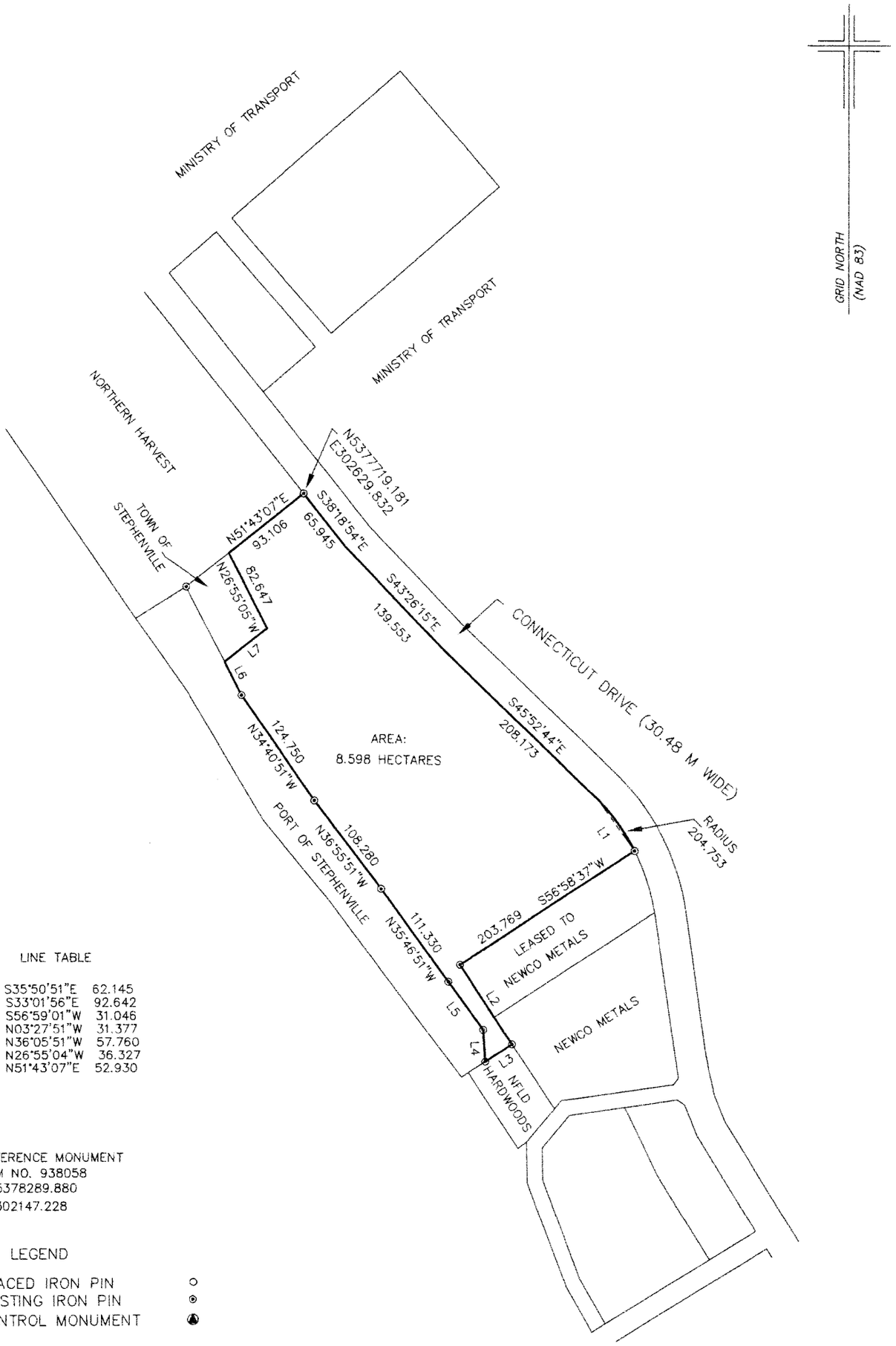
Samples Relinquished By (Print Name)	Date/Time	Samples Received By (Print Name)	Date/Time
Eunjeong Seok	March 26/18	Adam M	03/26/18
Samples Relinquished By (Sign)	Date/Time	Samples Received By (Sign)	Date/Time
	12:45		12:45

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

Nº: FFC-3113-COC-08

Document ID: DIV-133-1501.002
Date revised: January 2018

APPENDIX C: LEGAL SURVEY AND DESCRIPTION



LINE TABLE

L1	S35°50'51"E	62.145
L2	S33°01'56"E	92.642
L3	S56°59'01"W	31.046
L4	N03°27'51"W	31.377
L5	N36°05'51"W	57.760
L6	N26°55'04"W	36.327
L7	N51°43'07"E	52.930

REFERENCE MONUMENT
CM NO. 938058
N5378289.880
E302147.228

LEGEND

PLACED IRON PIN ○
EXISTING IRON PIN ⊙
CONTROL MONUMENT ◭

E. K. FUDGE
NEWFOUNDLAND
SURVEYOR
PROVINCE OF NEWFOUNDLAND

LAND SURVEY FOR THE TOWN OF STEPHENVILLE

CONNECTICUT DRIVE, STEPHENVILLE, NL.

SCALE 1 : 5000

DATE DECEMBER 15th, 2017

DRAWING No. SV-CD-MARINE-1A REVISED JULY 6th, 2018

Description

Land of the Town of Stephenville

Connecticut Drive, Stephenville, NL.

All that piece or parcel of land situate, lying and being west of Connecticut Drive, Stephenville, Province of Newfoundland and Labrador, abutted and bounded as follows;

That is to say, beginning at a point, said point being the most northeasterly corner of the lot; having Grid Co-ordinates (NAD 83) N5377719.181; E302629.832;

Running thence from the above described point of beginning along the westerly limits of Connecticut Drive S38°18'54"E distance 65.945 metres; S43°26'15"E distance 139.553 metres; S45°52'44"E distance 208.173 metres and following the arc of a clockwise curve (radius 204.753 m) having a chord bearing S35°50'51"E distance 62.145 metres;

Thence running by property leased to Newco Metals S56°58'37"W distance 203.769 metres;

Thence running by property leased to Newco Metals and property of Newco Metals S33°01'56"E distance 92.642 metres;

Thence running by property of NFLD Hardwoods S56°59'01"W distance 31.046 metres;

Thence running by property of Port of Stephenville N03°27'51"W distance 31.377 metres; N36°05'51"W distance 57.760 metres; N35°46'51"W distance 111.330 metres; N36°55'51"W distance 108.280 metres; N34°40'51"w distance 124.750 metres and N26°55'05"W distance 36.327 metres;

Thence running by property of the Town of Stephenville N51°43'07"E distance 52.930 metres and N26°55'05"W distance 82.647 metres;

Thence running by property of Northern Harvest N51°43'07"E distance 93.106 metres to the point of beginning; containing 8.598 hectares as shown and delineated on attached Drawing No. SV-CD-MARINE-1A.

All bearings refer to Grid North (NAD 83)

Enos K. Fudge

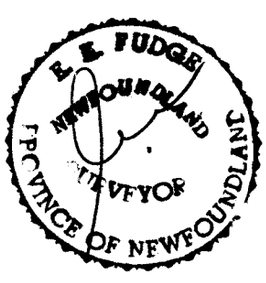
Newfoundland Land Surveyor

Enos Fudge Surveys

SV-CD-MARINE-1A

December 15th, 2017

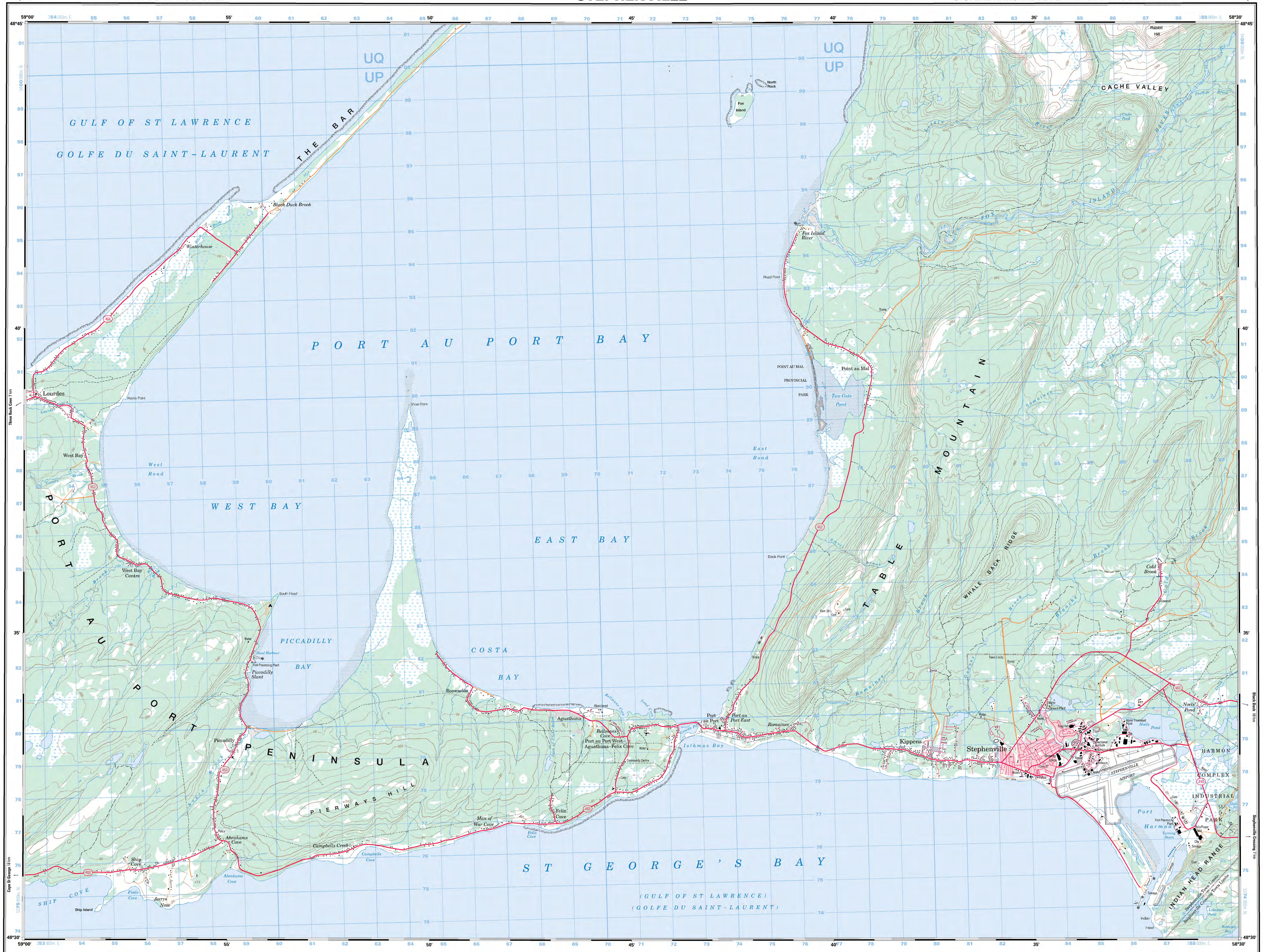
Revised: July 6th, 2018

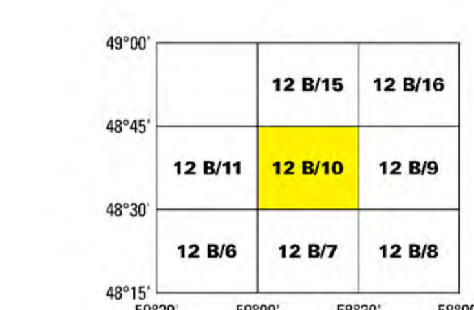


APPENDIX D: AERIAL PHOTOS

1. 1:50:000 map of the area
2. Arial photos of the proposed expansion site over time

STEPHENVILLE





Produced by the Centre for Topographic Information, Natural Resources Canada. Boundaries and toponyms current as of 2000; road network current as of 1996; all other information current as of 1984. Published in 2000.

Visit our Web site: http://maps.NRCan.gc.ca/

For corrections, additions or comments concerning the content of this map, please contact us either by telephone at 1–800–465–6277, by facsimile at 1–800–661–6277 or by electronic mail at: topo.maps@NRCan.gc.ca

This map is not to be used for air or marine navigation.

True North / Nord géographique
21°29' (382 mils)
1°19' (23 mils)

Use diagram only to obtain numerical values
Approximate Mean Declination 2000 for centre of map
Annual change decreasing 6.7'

N'utiliser le diagramme que pour obtenir les valeurs numériques
Déclinaison moyenne approximative au centre de la carte en 2000
Variation annuelle décroissante 6,7'

Transverse Mercator Projection • Projection transverse de Mercator

North American Datum 1983
Système de référence nord-américain de 1983

Coordinate conversion **NAD 83 (WGS 84) to NAD 27**
Mean values for this map–
Geographic: Latitude • add 0.0"
Longitude • add 2.7"
Grid: Northing • subtract 219 m
Easting • subtract 59 m

Conversion des coordonnées **NAD 83 (WGS 84) à NAD 27**
Valeurs moyennes pour cette carte–
Coordonnées géographiques : Latitude • additionner 0,0"
Longitude • additionner 2,7"
Quadrillage : Ordonnée (N) • soustraire 219 m
Abscisse (E) • soustraire 59 m

STEPHENVILLE

NEWFOUNDLAND • TERRE-NEUVE

1/50 000

1 centimetre on the map represents 500 metres on the ground
1 centimètre sur la carte représente 500 mètres au sol

Contour Interval: 20 Metres
Elevations in Metres above Mean Sea Level

Équidistance des courbes : 20 mètres
Altitudes en mètres au-dessus du niveau moyen de la mer

Établie par le Centre d'information topographique, Ressources naturelles Canada. Limites et toponymes à jour en 2000; réseau routier à jour en 1996; tous les autres renseignements à jour en 1984. Publiée en 2000.

Visitez notre site Web : http://cartes.RNCan.gc.ca/

Pour toutes corrections, additions ou commentaires concernant le contenu de cette carte, veuillez nous contacter soit par téléphone au 1–800–465–6277, par télécopieur au 1–800–661–6277 ou par courrier électronique à : cartes.topo@RNCan.gc.ca

Cette carte ne doit pas être utilisée pour la navigation aérienne ou maritime.

12 B/10 Edition 7 Édition NAD 83 Series A 781 Série

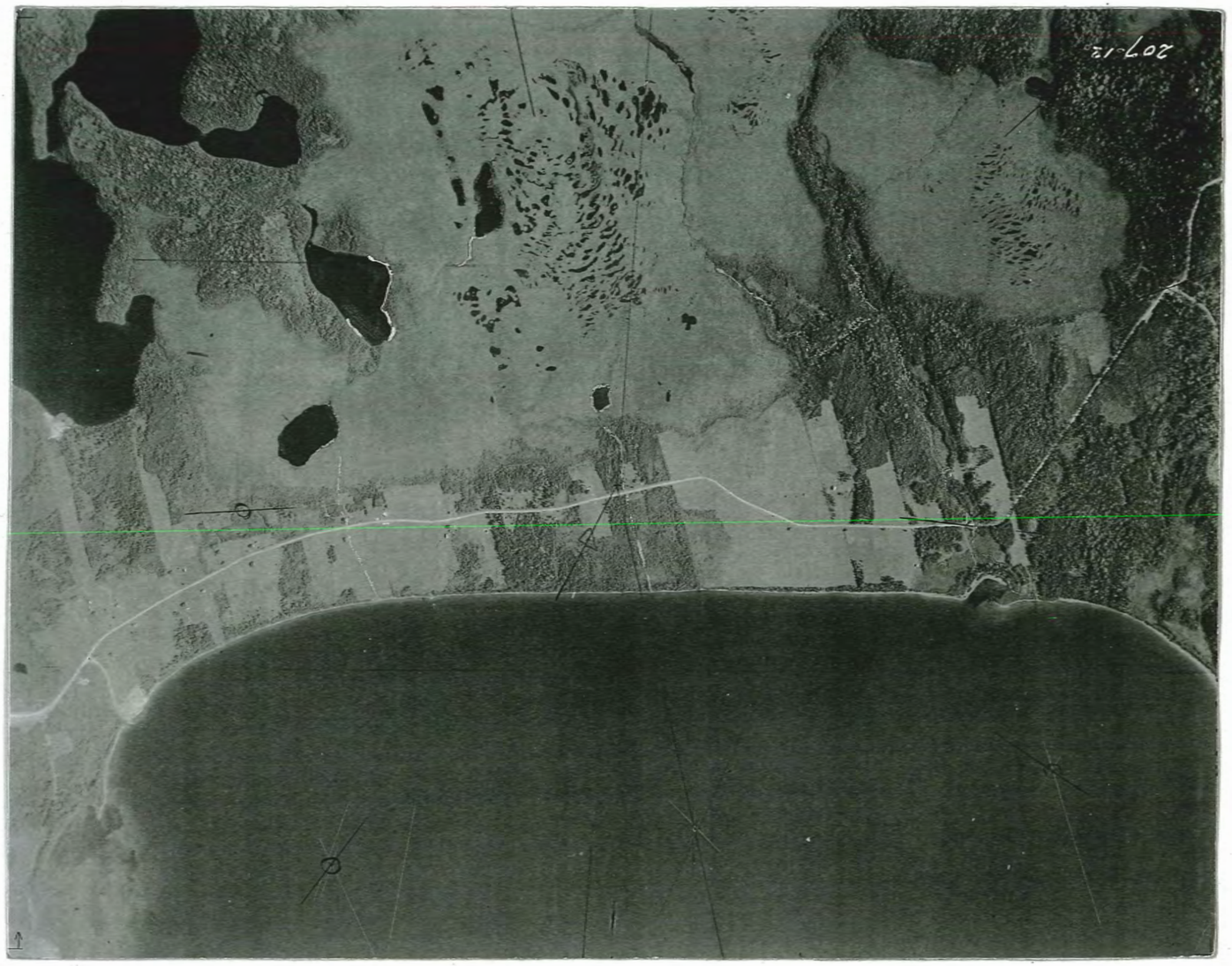
Natural Resources Canada / Ressources naturelles Canada

CANADIAN TOPOGRAPHIC MAPS / CARTES TOPOGRAPHIQUES DU CANADA

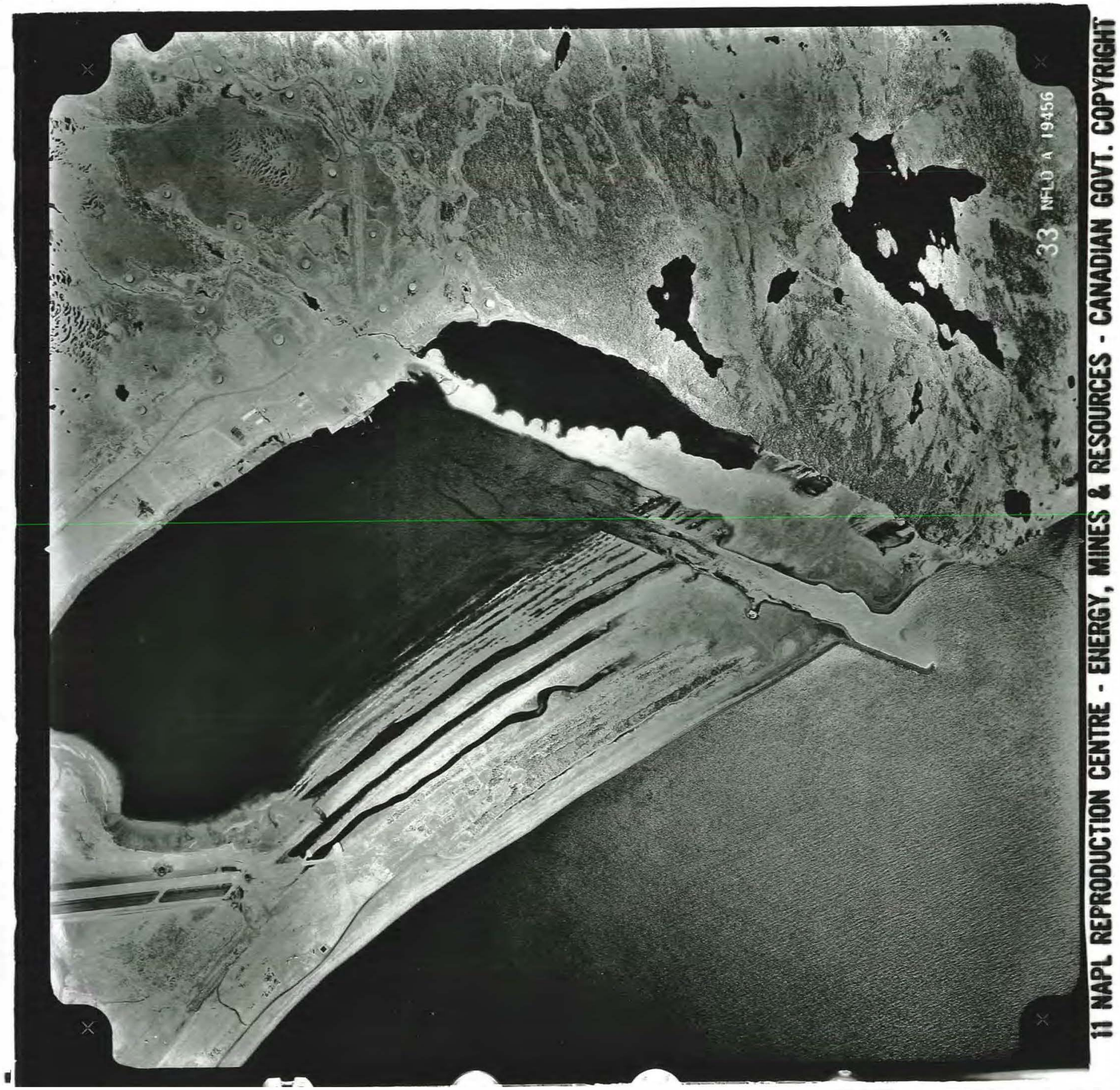
12 B/10 1/50 000

STEPHENVILLE

1941



1966


33 NFLD A 19456
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NEWFOUNDLAND & LABRADOR - DEPARTMENT OF FOREST RESOURCES & LANDS
Mapping Division, Howley Building, Higgins Line, St. John's, Newfoundland

1974

1974

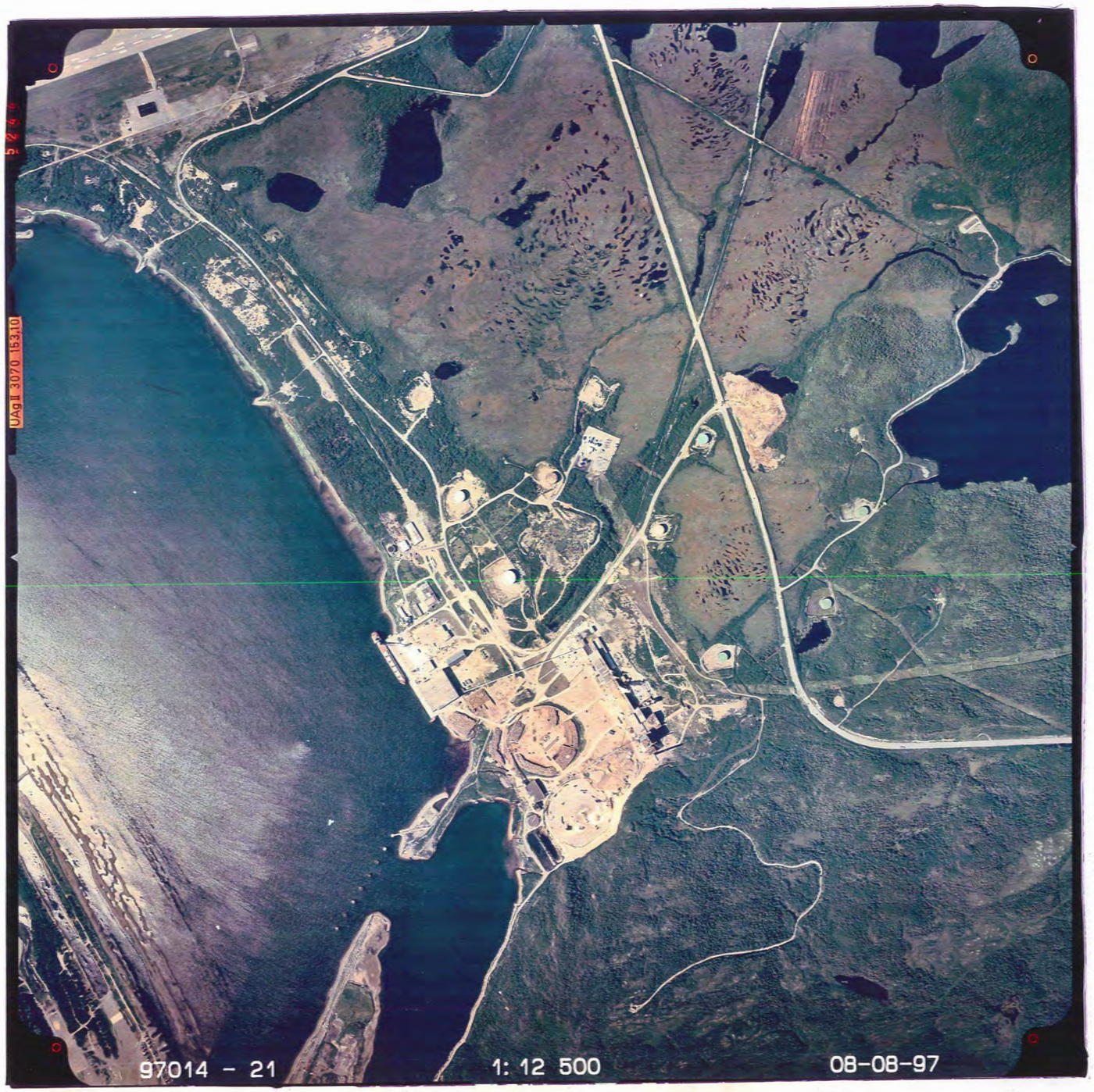
GOVERNMENT OF
NEWFOUNDLAND
AND LABRADOR

Department of
GOVERNMENT SERVICES AND LANDS

Address:
PO Box 8700

1984

1984



1997

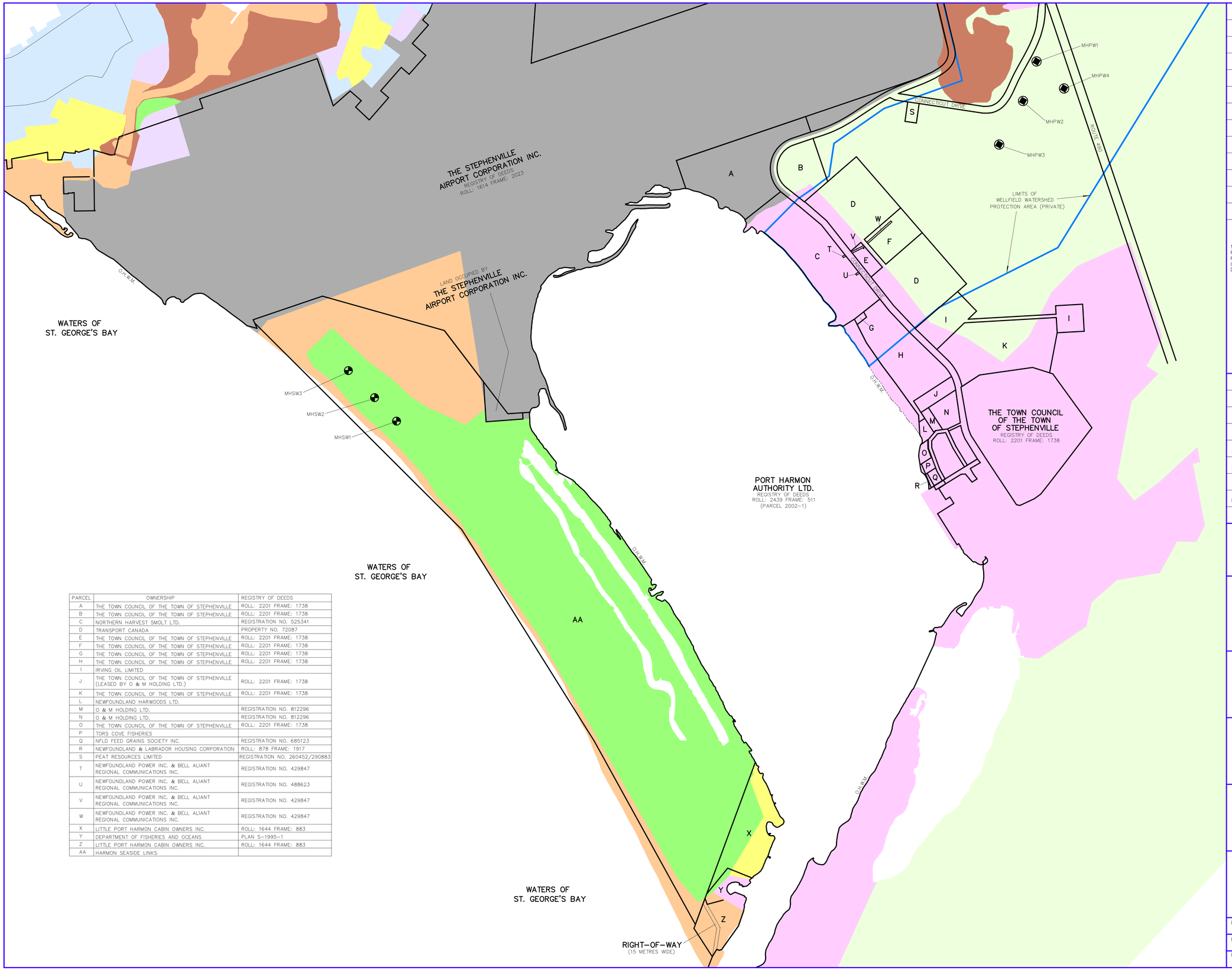
2016

10017-204.jpg

APPENDIX E: ZONING AND LAND OWNERSHIP

Please note that the Zoning and Ownership Map was commissioned by MHAC prior to the purchase of NHS.

Appendices



PARCEL	OWNERSHIP	REGISTRY OF DEEDS
A	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
B	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
C	NORTHERN HARVEST SMOLT LTD.	REGISTRATION NO. 525341
D	TRANSPORT CANADA	PROPERTY NO. 72087
E	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
F	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
G	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
H	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
I	IRVING OIL LIMITED	
J	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE (LEASED BY O & M HOLDING LTD.)	ROLL: 2201 FRAME: 1738
K	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
L	NEWFOUNDLAND HARWOODS LTD.	
M	O & M HOLDING LTD.	REGISTRATION NO. 812296
N	O & M HOLDING LTD.	REGISTRATION NO. 812296
O	THE TOWN COUNCIL OF THE TOWN OF STEPHENVILLE	ROLL: 2201 FRAME: 1738
P	TORS COVE FISHERIES	
Q	NFLD FEED GRAINS SOCIETY INC.	REGISTRATION NO. 685123
R	NEWFOUNDLAND & LABRADOR HOUSING CORPORATION	ROLL: 878 FRAME: 1917
S	PEAT RESOURCES LIMITED	REGISTRATION NO. 260452/290883
T	NEWFOUNDLAND POWER INC. & BELL ALIANT REGIONAL COMMUNICATIONS INC.	REGISTRATION NO. 429847
U	NEWFOUNDLAND POWER INC. & BELL ALIANT REGIONAL COMMUNICATIONS INC.	REGISTRATION NO. 488623
V	NEWFOUNDLAND POWER INC. & BELL ALIANT REGIONAL COMMUNICATIONS INC.	REGISTRATION NO. 429847
W	NEWFOUNDLAND POWER INC. & BELL ALIANT REGIONAL COMMUNICATIONS INC.	REGISTRATION NO. 429847
X	LITTLE PORT HARMON CABIN OWNERS INC.	ROLL: 1644 FRAME: 883
Y	DEPARTMENT OF FISHERIES AND OCEANS	PLAN S-1995-1
Z	LITTLE PORT HARMON CABIN OWNERS INC.	ROLL: 1644 FRAME: 883
AA	HARMON SEASIDE LINKS	

LEGEND

- COMMERCIAL ZONE
- COMMUNITY SERVICE ZONE
- ENVIRONMENTAL PROTECTION ZONE
- INDUSTRIAL ZONE
- STEPHENVILLE AIRPORT ZONE
- OPEN SPACE / PARK ZONE
- RESIDENTIAL ZONE
- RURAL ZONE
- CLIMATE CHANGE FLOOD ZONE
- LEGAL SURVEY BOUNDARIES
- PROPOSED FRESH WATER WELL
- PROPOSED SALT WATER WELL

NOTES:

1. REGISTRY INFO SHOWN IS BASED ON A SEARCH OF THE REGISTRY OF DEEDS FOR THE PROVINCE OF NEWFOUNDLAND AND LABRADOR AS OF MAY 18, 2018. THERE IS NO LEGAL REQUIREMENT FOR AN INDIVIDUAL OR CORPORATE ENTITY TO REGISTER A DEED OF CONVEYANCE AND AS SUCH THERE IS A POSSIBILITY THAT THERE MAY BE UNREGISTERED DEEDS WHICH MAY RELATE TO PROPERTIES IN/AROUND THIS AREA.

NO.	DESCRIPTION	DATE	BY
3	ISSUED FOR REVIEW	06/21/2018	R.B.
2	ISSUED FOR REVIEW	06/01/2018	R.B.
1	ISSUED FOR REVIEW	05/18/2018	R.B.

REVISIONS

A – PLAN,SECTION,ELEVATION,OR DETAIL NO.

B – NO. OF DRAWING WHERE ABOVE IS DRAWN

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CONSULTANT

EDWARDS AND ASSOCIATES LTD.

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TEL: 709-279-1990, FAX 709-279-2185

PROJECT

NORTHERN HARVEST SMOLT LTD.
P.O. BOX 460
ST. ALBAN'S, NL, A0H 2E0

DRAWING

LAND OWNERSHIP MAP

DRAWN BY: R.B.	CHECKED BY: R.B.	APPROVED BY: R.B.
MPA PROJECT NO: N/A	DRAWING FILE: 6871_LOM.dwg	EAL PROJECT NO.: 6871
DATE: MAY 18, 2018	SCALE: 1:7500	DRAWING NO. 1